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Energy and exergy analysis of deaerator from combined-cycle power plant

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Abstract: Energy and exergy analysis of deaerator from combined-cycle power plant is presented in this paper. The deaerator is analyzed in three operating regimes and in various ambient conditions. The lowest deaerator energy loss of 525.60 kW and the highest energy efficiency of 78.21 % are obtained for the lowest water temperature at the deaerator outlet - in the same operating regime is obtained the lowest deaerator exergy efficiency. Decrease in the ambient temperature resulted simultaneously with an increase in deaerator exergy destruction and with increase in exergy efficiency. Deaerator exergy efficiency in each operating regime and for each observed ambient temperature significantly varies (from 13.82 % to 45.94 %). From the efficiency aspect, deaerator energy and exergy analysis show diametrically opposed results in two observed operating regimes.

KEYWORDS: DEAERATOR, COMBINED-CYCLE POWER PLANT, ENERGY ANALYSIS, EXERGY ANALYSIS

1. Introduction

Steam power plants (independent plants [1] or part of some complex plants [2]) have regenerative condensate/feed water heating system which is used for condensate/feed water heating before its return to steam generator (or more of them) [3, 4]. Condensate/feed water heating resulted with a fuel savings and with increasing of steam power plant efficiency [5]. Such heating system consists of many components which exact number and the complexity of the entire system depends on many parameters.

An inevitable component of condensate/feed water heating system is a deaerator which has two functions: function of deaerating (removing of dissolved gasses from condensate/feed water to prevent erosion of heat exchangers, pipelines and steam generator parts) and function of condensate/feed water heating. Deaerator divides regenerative heating system in two parts - low pressure part between steam condenser and deaerator and high pressure part between deaerator and steam generator, as can be seen for example in [6].

This paper presents an energy and exergy analysis of deaerator which is part of a regenerative heating system in combined-cycle power plant. Analyzed deaerator is investigated in three operating regimes and at three different ambient temperatures in order to obtain a complete picture of its operation. It is interesting that energy and exergy efficiencies in two of three deaerator regimes show diametrically opposed results, what will be explained and discussed in detail.

2. Description and main characteristics of the analyzed deaerator from combined-cycle power plant

In this analysis is observed the deaerator from combined-cycle power plant, which is used in water/steam part of a combined system [7]. General deaerator scheme and operating points required for the analysis are presented in Fig. 1. Condensate from the main steam condenser [8] is delivered to the analyzed deaerator by using a condensate pump (operating point 1, Fig. 1) [9]. Another input into the analyzed deaerator is steam extracted from the steam turbine (operating point 2, Fig. 1). As presented in Fig. 1, one part of steam extracted from the turbine is used for deaerating and the rest of extracted steam is used for water heating. Analyzed deaerator has only one major fluid stream outlet - it is water stream which is delivered to the main feed water pump (operating point 3, Fig. 1). Due to deaerating and heating processes into the analyzed deaerator, water at the deaerator outlet (in operating point 3) has higher temperature in comparison with condensate at the deaerator inlet (in operating point 1). Another fluid stream outlet from the analyzed deaerator is a stream of gases (which cannot be condensed) and which are released after the deaerating process. Due to low mass flow rate of gasses released after deaerating process (in comparison to other deaerator fluid streams), its stream can be neglected in the deaerator energy and exergy analysis, as shown in the literature [10].

Fig. 1. Main scheme and required operating points of the analyzed deaerator

3. Energy and exergy analysis equations

3.1. Overall equations for the energy and exergy analysis of any control volume

The first law of thermodynamics defines energy [11], while the second law of thermodynamics defines exergy analysis [12] of any control volume. Energy analysis of control volume is completely independent of the ambient conditions in which control volume operates [13], while the exergy analysis is significantly influenced by the ambient conditions [14].

Control volume energy analysis

For control volume in steady state, mass flow rate and energy balances, according to [15, 16], can be defined by Eq. 1 and Eq. 2. It should be noted that mass flow rate balance (Eq. 1) assumes no leakage throughout control volume, while in energy balance (Eq. 2) potential and kinetic energies are disregarded:

\[ \sum m_{in} = \sum m_{out} \]  
\[ \sum m_{in} h_{in} + \dot{Q} = \sum m_{out} h_{out} + \dot{P} \]  

The energy of any fluid flow can be calculated as presented in [17]:

\[ \dot{E}_{en} = m \cdot h \]  

Overall control volume energy efficiency, according to [18], can be defined as:

\[ \eta_{en} = \frac{\text{Energy output}}{\text{Energy input}} \]
3.2. Energy and exergy analysis equations of the investigated deaerator from combined-cycle power plant

Energy and exergy analysis equations of the investigated deaerator from combined-cycle power plant [22] are based on deaerator operating points presented in Fig. 1. Both analyses (energy and exergy) are of “black box” type, which means that in such analyses deaerator inner structure is irrelevant, it is important only fluid flow streams to and from the deaerator.

Energy analysis of a deaerator

- Deaerator energy power input:
  \[ E_{\text{en,in}} = \dot{m}_1 \cdot h_1 + \dot{m}_2 \cdot h_2. \]  

- Deaerator energy power output:
  \[ E_{\text{en,out}} = \dot{m}_3 \cdot h_3. \]  

- Deaerator energy power loss (deaerator energy destruction):
  \[ E_{\text{en,D}} = E_{\text{en,in}} - E_{\text{en,out}} = \dot{m}_1 \cdot h_1 + \dot{m}_2 \cdot h_2 - \dot{m}_3 \cdot h_3. \]  

- Deaerator energy efficiency:
  \[ \eta_{\text{en}} = \frac{E_{\text{en,out}}}{E_{\text{en,in}}} = \frac{m_3 \cdot v_3}{m_1 \cdot e_1 + m_2 \cdot e_2}. \]  

Exergy analysis of a deaerator

- Deaerator exergy power input:
  \[ E_{\text{ex,in}} = \dot{m}_1 \cdot e_1 + \dot{m}_2 \cdot e_2. \]  

- Deaerator exergy power output:
  \[ E_{\text{ex,out}} = m_3 \cdot e_3. \]  

- Deaerator exergy power loss (deaerator exergy destruction):
  \[ E_{\text{ex,D}} = E_{\text{ex,in}} - E_{\text{ex,out}} = \dot{m}_1 \cdot e_1 + \dot{m}_2 \cdot e_2 - m_3 \cdot e_3. \]  

- Deaerator exergy efficiency:
  \[ \eta_{\text{ex}} = \frac{E_{\text{ex,out}}}{E_{\text{ex,in}}} = \frac{m_3 \cdot e_3}{m_1 \cdot e_1 + m_2 \cdot e_2}. \]  

4. Analyzed deaerator steam/water parameters in three operating regimes

Steam/water parameters (pressures, temperatures and mass flow rates) in each operating point of the analyzed deaerator (Fig. 1) are found in [7] and presented in Table 1 for the first deaerator operating regime, in Table 2 for the second deaerator operating regime and in Table 3 for the third deaerator operating regime. Deaerator operating regimes are related to the water temperature at the deaerator outlet – the highest water temperature at the deaerator outlet denotes first operating regime (Table 1), while the lowest water temperature at the deaerator outlet denotes last (third) operating regime, Table 3.

Steam/water specific enthalpies, specific entropies and specific exergies are calculated by using NIST-REFPROP 9.0 software [23]. Steam/water specific enthalpies presented in Table 1, Table 2 and Table 3 are calculated for the following ambient state: temperature of 15 °C = 288 K and a pressure of 1 bar.

Table 1. Steam/water parameters of the analyzed deaerator – Operating regime 1 [7]

<table>
<thead>
<tr>
<th>O.P.*</th>
<th>Temperature (K)</th>
<th>Pressure (bar)</th>
<th>Mass flow rate (kg/s)</th>
<th>Specific enthalpy (kJ/kg)</th>
<th>Specific entropy (kJ/kg·K)</th>
<th>Specific exergy (kJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>362.16</td>
<td>10</td>
<td>12.90</td>
<td>373.60</td>
<td>1.1807</td>
<td>35.116</td>
</tr>
<tr>
<td>2</td>
<td>453.03</td>
<td>10</td>
<td>1.04</td>
<td>2777.10</td>
<td>6.5850</td>
<td>882.190</td>
</tr>
<tr>
<td>3</td>
<td>368.45</td>
<td>10</td>
<td>13.94</td>
<td>400.05</td>
<td>1.2531</td>
<td>40.713</td>
</tr>
</tbody>
</table>

* O.P. = Operating Point; Operating points refer to Fig. 1.

Table 2. Steam/water parameters of the analyzed deaerator – Operating regime 2 [7]

<table>
<thead>
<tr>
<th>O.P.*</th>
<th>Temperature (K)</th>
<th>Pressure (bar)</th>
<th>Mass flow rate (kg/s)</th>
<th>Specific enthalpy (kJ/kg)</th>
<th>Specific entropy (kJ/kg·K)</th>
<th>Specific exergy (kJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>354.07</td>
<td>10</td>
<td>5.93</td>
<td>339.63</td>
<td>1.0859</td>
<td>28.467</td>
</tr>
<tr>
<td>2</td>
<td>453.03</td>
<td>10</td>
<td>0.40</td>
<td>2777.10</td>
<td>6.5850</td>
<td>882.190</td>
</tr>
<tr>
<td>3</td>
<td>359.36</td>
<td>10</td>
<td>6.33</td>
<td>361.84</td>
<td>1.1481</td>
<td>32.744</td>
</tr>
</tbody>
</table>

* O.P. = Operating Point; Operating points refer to Fig. 1.

Table 3. Steam/water parameters of the analyzed deaerator – Operating regime 3 [7]

<table>
<thead>
<tr>
<th>O.P.*</th>
<th>Temperature (K)</th>
<th>Pressure (bar)</th>
<th>Mass flow rate (kg/s)</th>
<th>Specific enthalpy (kJ/kg)</th>
<th>Specific entropy (kJ/kg·K)</th>
<th>Specific exergy (kJ/kg)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>293.15</td>
<td>10</td>
<td>9.12</td>
<td>84.85</td>
<td>0.2963</td>
<td>1.091</td>
</tr>
<tr>
<td>2</td>
<td>453.03</td>
<td>10</td>
<td>0.59</td>
<td>2777.10</td>
<td>6.5850</td>
<td>882.190</td>
</tr>
<tr>
<td>3</td>
<td>319.35</td>
<td>10</td>
<td>9.71</td>
<td>194.31</td>
<td>0.6539</td>
<td>7.551</td>
</tr>
</tbody>
</table>

* O.P. = Operating Point; Operating points refer to Fig. 1.

5. The results of deaerator energy and exergy analyses with discussion

5.1. The results of deaerator energy analysis

The results of deaerator energy analysis in each observed operating regime remains the same regardless of the conditions of the ambient in which deaerator operates. According to Eq. 12, in each deaerator operating regime energy power input is the sum of the deaerator energy power output and energy power loss (energy destruction) – which are presented in Fig. 2.

From Fig. 2 can be observed that in Operating regime 1 deaerator has the highest energy power output (5576.70 kW) and simultaneously the highest energy power loss (2130.93 kW). In comparison with Operating regime 1, in deaerator Operating regime...
2 energy power output and energy power loss significantly decreases, while in Operating regime 3 deaerator has the lowest energy power output (1886.75 kW) and the lowest energy power loss (525.60 kW).

It can be concluded that the decrease in temperature of water at deaerator outlet (operating point 3, Fig. 1) resulted with a decrease in deaerator energy power output and simultaneously with decrease in deaerator energy power loss (energy destruction).

![Fig. 2. Change in energy power output and energy power loss of the analyzed deaerator in three operating regimes](image)

From Operating regime 1 to Operating regime 3 deaerator energy efficiency continuously increases (from 72.35 % in Operating regime 1 to 78.21 % in Operating regime 3), Fig. 3. This trend of deaerator energy efficiency is reverse proportional to deaerator energy power loss (energy destruction) which continuously decreases from Operating regime 1 to Operating regime 3, Fig. 2 and Fig. 3.

Furthermore, it can be concluded that analyzed deaerator has the highest energy efficiency (and the lowest energy power loss) at the lowest temperature of water at the deaerator outlet, Fig. 3 and Table 3.

![Fig. 3. Change in energy efficiency of the analyzed deaerator in three operating regimes](image)

5.2. The results of deaerator exergy analysis

Deaerator exergy analysis is performed in all three operating regimes and for three different ambient temperatures (5 °C, 10 °C and 15 °C) in order to investigate the deaerator exergy destruction and efficiency in different states of the ambient.

From Fig. 4 can be seen that analyzed deaerator has different trends when compared exergy and energy destructions (Fig. 2). Both energy and exergy destructions (losses) are the highest for deaerator Operating regime 1, but the lowest deaerator exergy destruction occurs in Operating regime 2, regardless of the observed ambient temperature (the lowest deaerator energy destruction occurs in Operating regime 3 – Fig. 2).

Decrease in the ambient temperature resulted with an increase in deaerator exergy destruction, regardless of observed operating regime. Detaerator exergy destruction in Operating regime 1 is the highest influenced with the change in the ambient temperature, while deaerator exergy destruction in Operating regime 3 is the lowest influenced with the change in the ambient temperature, Fig. 4.

![Fig. 4. Change in the exergy destruction of the analyzed deaerator in three operating regimes and at three ambient temperatures](image)

Decrease of the ambient temperature increases deaerator exergy destruction (Fig. 4) and simultaneously increases deaerator exergy efficiency, regardless of the observed operating regime, Fig. 5.

In Operating regime 1 analyzed deaerator has the highest exergy efficiencies which vary from 41.41 % at the ambient temperature of 15 °C to 45.94 % at the ambient temperature of 5 °C. In the same operating regime, the deaerator has the lowest energy efficiency (72.35 %, Fig. 3).

In Operating regime 2, at the same ambient temperature, deaerator exergy efficiency is slightly lower in comparison with Operating regime 1.

Deaerator Operating regime 3 is the most interesting to observe (in this operating regime the water temperature at the deaerator outlet is the lowest, Table 3). In Operating regime 3, analyzed deaerator has the highest energy efficiency (78.21 %, Fig. 3), while its exergy efficiency does not exceed 21.03 %, even at the lowest ambient temperature, Fig. 5. Such low exergy efficiency of deaerator in Operating regime 3 is the result of low fluid temperatures (water inlet and outlet), which are very close to the ambient temperature – Table 3.

Deaerator Operating regimes 1 and 3 are the best example of one control volume operating regimes in which energy and exergy analysis gives totally opposed results from the efficiency aspect, Fig. 3 and Fig. 5.

![Fig. 5. Change in exergy efficiency of the analyzed deaerator in three operating regimes and at three ambient temperatures](image)

6. Conclusions

In this paper is presented energy and exergy analysis of deaerator from combined-cycle power plant. It is analyzed the change in energy and exergy losses and efficiencies in three deaerator operating regimes and for three different ambient temperatures. The most important conclusions of the analysis are:

- Deaerator energy analysis shows that a decrease in the water temperature at deaerator outlet resulted with simultaneous decrease of deaerator energy loss and increase in energy efficiency. The lowest deaerator energy loss and the highest energy efficiency (525.60 kW and 78.21 %) are obtained for the lowest water temperature at the deaerator outlet of 319.35 K (Operating regime 3).
- The highest deaerator exergy destruction (exergy loss), regardless of the ambient temperature, is obtained for the lowest water temperature at the deaerator outlet (Operating regime 1).
- Decrease in the ambient temperature resulted with an increase in deaerator exergy destruction for all observed operating regimes. Change in the ambient temperature has the highest influence on deaerator exergy destruction in Operating regime 1 where the water temperature at the deaerator outlet is the highest.
- Decrease in the ambient temperature resulted with an increase in deaerator exergy efficiency in all observed operating regimes.
- The highest deaerator exergy efficiencies (between 41.41 % and 45.94 %) are obtained for the highest water temperature at the deaerator outlet (Operating regime 1), while the lowest deaerator exergy efficiencies (between 13.82 % and 21.03 %) are obtained for the lowest water temperature at the deaerator outlet (Operating regime 3).
- Analyzed deaerator Operating regimes 1 and 3 are the best example of how energy and exergy analysis (from the efficiency aspect) can result with diametrically opposed results. In Operating regime 1 deaerator has the lowest energy and the highest exergy efficiency, while in Operating regime 3 deaerator has the highest energy and the lowest exergy efficiency.

7. Acknowledgment

This research has been supported by the Croatian Science Foundation under the project IP-2018-01-3739, CEEPUS network III-HR-0108, European Regional Development Fund under the grant KK.01.1.1.01.0009 (DATA CROSS), University of Rijeka scientific grant uniri-tehnic-18-18-1146, University of Rijeka scientific grant uniri-tehnic-18-18-1146, and University of Rijeka grant uniri-tehnic-18-18-1146.

8. References

Abstract: Data on solar energy flux are measured and accumulated using the automatic meteorological Vantage Pro2 Plus. The solar energy flux represents the amount of energy received over a given period of time per unit area of the earth’s surface. Directly received data from the solar radiation sensor are integrated and recalculated to produce results for the accumulated solar energy. The shortest measurement period is 15 minutes. The processing of these data makes it possible to trace the change of the solar energy characteristics during the different time periods. The measurements were performed over a period of 9 years. The highest repeatability is observed for long-term periods, such as annual ones. The high repeatability of the energy characteristics makes it easy to forecasting the energy yield from the sun’s rays.

Keywords: SOLAR RADIATION, SOLAR ENERGY, MEASUREMENT OF METEOROLOGICAL PARAMETERS

1. Введение.

Известно е, че слънчевата радиация представлява плътност на лъчестен енергийен поток излъчван от слънцето, измерван на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическа единица във вакуум на разстояние една астрономическата станция Vantage Pro2 Plus, която е локализирана в регион Стара Загора. Тя измерва и събира данни за всеки период от 15 минути [1]. В работата са използвани данни през периода на наблюденията от юли 2011 г. до февруари 2020 г., включително. Метеостанциите от типа на Vantage Pro, са снабдени с допълнителни сензори за измерване на слънчевата радиация и слънчевото ултравиолетово излъчване, което се съдържа в по-нататъшна обработка. Автоматичната измервателна станция Vantage Pro 2 Plus предоставя на своите потребители освен данни за слънчевата радиация, така и данни за слънчевата енергия (Solar Energy). Известно е, че съществува зависимост между слънчевата радиация и слънчевата енергия. От тази зависимост, данни за слънчевата енергия се получават в специфичната единица Langley:

1 Langley = 11.622 Wh/m2

2. Теоретични данни за слънчевата радиация и слънчевата енергия падаща върху единица земна площ.

Известно е, че слънчевата радиация зависи от много фактори и съсем логично е да се очаква, че добитък на енергия за различните региони може да е съвсем различен. Това се дължи на факта, че само част от слънчевата енергия достига до земната повърхност. Една част от падащата слънчева радиация върху земната атмосфера се ретрактирва директно обратно в космоса, а друга част се аборбира в стратосферата и тропосферата. Общо около 19% от слънчевата енергия не достига долите слоеве на земната повърхност [4].

Интерфейсът на слънчевата радиация намалява главно поради поглъщането й от водните пари в инфрачервената област на спектъра, озоновото поглъщане в ултравиолетовата област и разсейването от частиците прах във въздуха. Такива компоненти като вълнеления двуокис и някои други газове, които се съдържат в по-малки количества в атмосферата, поглъщат част от топлинната радиация, излъчена от земната повърхност. Следователно добитък на енергия за различните региони може да е съвсем различен в зависимост от техните особености.

3. Изследване на дневния ход на слънчевото греене.

Директно получените данни от метеорологичната станция се засавят във файлове за период от един месец, като за всеки 15 минути е направено едно измерване. Общият обем на информацията за период от 105 месеца съдържа около 310 000 измервания. След това данните в [Langley] се преобразуват във [W*h/m2], съгласно т. 1. Получените резултати за всеки час, за всеки ден и за всеки месец са показани в графичен и табличен вид.

На фиг. 1 се показва измерената слънчева енергия за различни дни за да се види как се изменя слънчевата енергия за един и същи ден, за един и същи месец през съответната година.
Съществуваща същност на въздуха и съдържанието на влага в атмосферата, така и от облачността. Различните части на нейния спектър, а освен това зависи както от фиг. 1 тук е показана средно измерената стойност за всеки ден от месец Юли в продължение на 8 години. Измерената слънчева енергия за различните дни от месец Юли значително се различава, както отбелязахме по-горе, но в случая е важно каква част от енергията достига до повърхността на земята.

4. Изследване на месечния ход на слънчевото греене.

На фиг. 3 са показани стойностите на слънчевата енергия измерена за всеки месец в продължение на повече от 8 години. За всеки ден значително се различава, както отбелязахме по-горе, но в случай е важно каква част от енергията достига до повърхността на земята.

От графика ясно се вижда сезонния характер в изменението на слънчевото греене. То е най-голямо през месеците Юли и Юлии и най-малко през месеците Януари и Декември. Най-интересен е фактът, че динамиката в изменение на стойностите за едногодишните месеци през годините показани на фиг. 3, е много по-малко отколкото тази на едноименните месеци през годините показани на фиг. 2 и фиг. 1.

На фиг. 4 е показана средно измерената слънчева енергия за всеки ден в продължение на повече от 8 години, за разлика от фиг. 3, където са показани действителните стойности на месеците. С оранжеви ленти е показана средната месечна стойност, а с червени линии е отбелязано минималното и максималното отклонение от средната стойност за всеки ден.

Фиг. 2 Средно измерена слънчева енергия за всеки ден от месец Юли през периода на наблюдението.

Същността на въздуха и съдържанието на влага в атмосферата, както и облачността, зависи както от фиг. 1 тук е показана средно измерената стойност за всеки ден от месец Юли през годините. Измерената слънчева енергия за различните дни от месец Юли значително се различава, както отбелязахме по-горе, но в случай е важно каква част от енергията достига до повърхността на земята.

Фиг. 3 Съпоставяне на стойностите на слънчевата енергия за всеки ден от месец Юли през периода на наблюдението.

Същността на въздуха и съдържанието на влага в атмосферата, както и облачността, зависи както от фиг. 1 тук е показана средно измерената стойност за всеки ден от месец Юли през годините. Измерената слънчева енергия за различните дни от месец Юли значително се различава, както отбелязахме по-горе, но в случай е важно каква част от енергията достига до повърхността на земята.
Фиг. 4 Средно измерена слънчева енергия за всеки месец през периода на наблюденията.

На фиг. 5 е показано месечното разпределение на слънчевата енергия през периода на наблюденията, заедно с центрирана аритметична средна с период 12 месеца в продължение на около 9 години. С жълти ленти е отбелязана стойността на измерената енергия за всеки месец, а с червена линия стойността на центрирана аритметична средна. От графиката се вижда, че стойността на центрираната аритметична средна е почти постоянна, т.е. годишното отклонение е по-малко от месечното. Този факт потвърждава извода направен по-горе, че колкото периодът на усредняване е по-голям, толкова прогнозите за стойността на слънчевото греене стават по-точни.

Фиг. 5 Плъзгаща се центрирана математическа средна на слънчева енергия по 12 месеца

В таблица 1 са показани измерените и средните стойности за всички месеци през периода на наблюденията. В графа „Максимална разлика“ е изчислената разлика между максималната и минималната стойност за едноименни месеци за този период.

От таблица 1 се вижда, че максималната разлика между стойностите на средната слънчева енергия от 58 kWh/m^2 се получават през месец юли вероятно защото слънчевите и облачните дни често се сменят. Теоретичната слънчева енергия от фиг. 1 за месец Юли съгласно формула 1 е 348 kWh/m^2

\[ E_{\text{teor}} = \frac{9.1 \times 31}{0.81} = 348 \text{ kWh/m}^2 \]

Където:
9.1 – средната дневна енергия (фиг 1),
0.81 - коригиращ коефициент, съгласно т. 2.
31 – броя на дните в месец юли.

От друга страна, средно измерената слънчева енергия за месец Юли от таблица 1 е 189 kWh/m^2. От тук получаваме, че реализните стойности на измерената слънчева енергия за региона Стара Загора в следствие на облачността през летните месеци е 54,3 % (189/348) от теоретично максималната енергия, което доказва съществуването с тревогата.

Освен, разпределението на слънчевата енергия по месеци, в таблица 1 са показани и средната стойност, стандартното отклонение и относителният спад. От таблицата се вижда, че стандартното отклонение и относителният спад сравнено за месеците през различните сезони на осемте години се различават значително. Това е показателно, че факторите, които влияят на слънчевата енергия като облаци, прах и други, имат случайен характер, но с течение на времето по-лъжи периоди взаимно се компенсират и осредняват. От таблица 1 се вижда, че най-големите отклонения в стандартното отклонение в стандартното отклонение са през пролетните месеци съответно за месец април са 15,0 и май 17,7. За летните месеци отклоненията леко намалят – Август 5,4 и Юли 6,8.

Най-големата абсолютна разлика е през месец юли – 58 kWh/m^2.

Друг интересен извод, който може да се направи, е, че измерената средно годишна слънчева енергия за периода от около 9 години е почти една и съща. Резултатите от тези разчети са дадени в табл. 2.

Табл. 2 Разпределение на слънчевата енергия по години.

Изчислената средна годишна енергия от тази таблица е 1334 kWh/m^2. Максималната разлика Еразл е между 1416 kWh/m^2 за 2012г. и 1250 kWh/m^2 за 2014г. и е равна на:

\[ E_{\text{разл}} = 1416 - 1250 = 166 \text{ kWh/m}^2 \]

В проценти:

\[ E_{\%} = \frac{166}{1334} = 12.4\% \]

Където:
1334 kWh/m^2 е средна годишна енергия
166 kWh/m^2 е максималната разлика.
От друга страна, ако направим същите изчисления за месечните отклонения с данни за месец Юли, таъка 1, ще получим следните резултати:

\[
E_{\text{разл}}\% = \frac{58}{189} = 30.5\%.
\]

Където:
189 kWh/m² kWh/m² е средната стойност за месец Юли
58 kWh/m² kWh/m² е максималното отклонение за месец Юли

От сравнение на резултатите във формула (3) и формула (4) се вижда, че месечните отклонения са по-големи от годишните. От по-горе в текста също установихме, че месечните отклонения са по-големи от годишните. Следователно отново се налага извода, че колкото е по-голям периодът на усредняване, толкова разликите и прогнозите са по-точни.

От фиг. 5 виждаме, че средната стойност на центрираната движеща средна е 110 kWh/m². От тук изчисляваме средната годишна стойност Eср. год.:

\[
E_{\text{сс}}\text{год.} = 110 \times 12 = 1320 \frac{kWh}{m^2}.
\]

Където:
110 е средната стойност на центрираната движеща средна,
12 броя на месеците.

С данни от таблица (2) изчислихме, че годишната средна стойност на енергията е 1360 kWh/m², а от формула (5) 1320 kWh/m². Тъй като тези 2 числа са много близки се налага извода, че центрираната движеща средна върху месечните данни може успешно да се използва за намиране на средните годишни стойности на слънчевата енергия.

5. Заключение.

В сайта EMDE Solar (www.emde-solar.com) е посочена стойност за слънчев добив на енергия от минимум 1314 kWh/m² до максимум 1510 kWh/m² като годишна база в регион Стара Загора или средно 1412 kWh/m². Разликата е 196 kWh/m².

Този диапазон сравнително точно съвпада с получените от нас резултати – с минимум 1250 kWh/m² до и максимум 1515 kWh/m² или средно 1360 kWh/m² (таб. 2). Разликата е 265 kWh/m².

От теоретична гледна точка споменахме много фактори, които оказват съществено влияние върху потока на слънчева радиация, респективно върху количеството слънчева енергия, която достига до земята. Това се потвърждава и от краткосрочните измервания с помощта на метеорологичната станция. При по-дългосрочните измервания, обаче се наблюдава едно усредняване и подтисване на разликата, особено на годишна база. Това се дължи на факта, че тези изменения във времето са с различен знак, както положителни така и отрицателни при тяхното сумиране за по-дълъг период от време те взаимно се компенсират и осредняват.

Затрупанията данни са все още сравнително мала за да се направят категорични начини заключения, но се надяваме, че бъдещите изследвания ще потвърдят направените в този доклад първоначални констатации. Резултатите от това изследване могат да послужат като важен ориентир, за да се изчисли предварително очакваната енергия от фотovoltaичните преобразователи в определени географски регион.

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Some approaches to the non-destructive control of composite materials used in the aerospace industry

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Abstract: One of the priority areas for the use of composite materials is the aerospace industry. A number of evaluations have shown that their use in the manufacture of modern aircraft and helicopters lead to a reduction in weight of the respective parts with 20–30% compared to the same manufactured from conventional materials. In this case, an increase in the resistance of the respective part to external influences is usually achieved, and in many cases a decrease in its production cost.

The increasing use of composite materials in the aerospace industry requires analyzing options for their diagnosis and non-destructive examination of their quality, taking into account their specific features. Because of the enormous diversity and complexity composition for composite materials, various methods of diagnosis have different efficiencies for different types of composites. In many cases, composites contain highly porous or fibrous layers, which results in a strong attenuation of the acoustic waves and render the acoustic method inapplicable to their non-destructive control. In these and other cases, the use of emerging methods for their non-destructive ultra-high frequency (microwave) diagnostics is of interest.

Keywords: COMPOSITE MATERIALS; NON DESTRUCTIVE CONTROL

1. Introduction

Composite materials are known to consist of two or more materials with different physical or chemical properties, which together form a composite with properties other than their own. In most cases, composites are created to give them better opportunities for use in various mechanical impacts (friction, shock, vibration, acceleration, loading, etc.), the temperature characteristics of the environment in which they function (extreme or rapidly changing over a wide range of temperatures), chemical and electromagnetic parameters of the environment in which they function (salinity, acidity, radiation, etc.), as well as to achieve certain physicochemical parameters at less weight or with smaller production costs and [1-4].

One of the priority areas for the use of composite materials is the aerospace industry. A number of evaluations have shown that their use in the manufacture of modern aircraft and helicopters lead to a reduction in weight of the respective parts with 20–30% compared to the same manufactured from conventional materials. In this case, an increase in the resistance of the respective part to external influences is usually achieved, and in many cases a decrease in its production cost.

2. Composite materials

In the aerospace industry, composites have been used mainly in the military aircraft industry, but have recently become more widely used in the development of commercial aircraft. The advantages of using composites over traditional aluminum alloys are many, which is why they are more widely used. For the most part, the composite materials used in the aerospace industry are made of two major fiber and matrix components. Fibers or reinforcement provide high strength and hardness, while the matrix is used to bind the fibers together.

Another approach in the construction of composite structures is the layered structures (laminates), which can be made of different types of fiber composites oriented in different directions for optimum strength and rigidity.

An important type of laminated composite is the sandwich composite (a very lightweight but still robust composite laminate), which consists of a lightweight base panel with thin sheets of solid material bonded to the two faces of the core.

The increasing use of composite materials in the aerospace industry imposes the requirement to analyze the possibilities for their diagnosis and non-destructive examination of their quality, taking into account their specific features. Because of the huge variety and complex composition of composite materials, various methods of diagnosis have different efficiencies for different types of composites [5-7].

In many cases, composites contain highly porous or fibrous layers, which results in a strong attenuation of the acoustic waves and render the acoustic method inapplicable to their non-destructive control.

The most famous example of the relevance and significance of this problem is the space shuttle crash of Space Shuttle Columbia in 2003. According to NASA experts, published in the authoritative edition of Aviation Week & Space Technology, one of the reasons that led to the crash were defects in the thermal insulation of the outer fuel container of the spacecraft. This insulation layer is a polyurethane foam with a thickness of 2.5-5.0 cm, applied onto the outer surface of the container to reduce the boiling point of the cryogenic components of the fuel (liquid hydrogen and oxygen) on the launch pad.

During the preparation for the start, which lasted several days, the moisture from the air penetrated the crevices of the coating and due to the difference in temperatures condensed therein. According to one hypothesis, as the shuttle took off, as the flight altitude increased, the external pressure decreased rapidly, causing the water to boil explosively, creating increased pressure. This resulted in the removal of a layer of thermal insulation coating which was rejected from the air stream and caused damage to the leading part of the wing of the space vehicle. Upon landing, at the stage of entering the Earth's atmosphere, plasma penetrates the openings, causing complete destruction of the apparatus and causing the death of the entire crew. Several other similar incidents have been reported, both in the aerospace and energy fields, which fortunately did not lead to such distressful consequences.

Therefore, the non-destructive diagnostics of composite materials of this type requires the development of new technologies, one of which could be the proposed technology of radar ultra-high frequency radiation in the GHz range. In these and other cases, the use of emerging methods for their non-destructive ultra-high frequency (microwave) diagnostics is of interest.
In general, the objectives of microwave diagnostics can be classified as superficial diagnosis - for the presence of superficial heterogeneities and / or defects, sub-superficial diagnostics - for heterogeneities and / or defects within the composite material itself, and superficial diagnostics and for non-uniform defects. Material behind the composite material or behind a certain layer of composite material.

3. Diagnosis methods

Depending on the method of diagnosis, it is appropriate that it be classified as a diagnosis on the basis of reflection (reflective diagnosis) or diagnosis on the basis of transition in the material (transient diagnosis).

Reflective diagnosis is more commonly used and is performed with the ultra-high frequency transmitter and receiver located on the same side of the material. In this case, the heterogeneity and / or the defect are recorded on the basis of the change in the signal received by it. Basically reflective surface diagnosis is applicable to all types of composite materials.

In the transient diagnosis, the transmitter and the receiver of the ultra-high frequency oscillation are located on both sides of the composite material, and inhomogeneities and / or defects are recorded based on the change of the signal passed through them.

In the case of composite materials whose surfaces are electrically conductive, a basic reflective ultra-high-frequency diagnosis is possible for the presence of surface inhomogeneities and / or defects. In some cases, when the electrically conductive surface layer is twice less than the penetration depth, a reflective diagnosis of the interior of the material is possible, and when this layer is less than the penetration depth, a transient diagnosis is also possible.

For matrix composite materials whose matrices are of electrically conductive material, but their reinforcement is of non-electrically conductive material, the possibilities for subsurface and subsurface ultra-high frequency diagnostics depend on the size and density of the matrix components. If the dimensions of the matrix component are significantly smaller than the depth of penetration of radiation into it, or if the distance between the individual individual components exceeds 0.25 - 0.5 of the length of radiation, it may be possible to perform sub-surface and even sub-surface reflective or transient diagnostics.

If the matrix and its reinforcement are not composed of conductive material, then it is possible to perform sub-surface and sub-surface ultra-high frequency reflective and transient diagnostics.

If the matrix is not composed of electrically conductive material but its reinforcement is of electrically conductive material, then in principle the possibilities of performing sub-surface and sub-surface ultra-high frequency diagnostics are extremely limited.

If the composite material is multilayered and the individual layers are not composed of conductive material, then there are possibilities for under-surface and sub-surface reflection and transient high-frequency diagnostics. If the composite material is multilayer, but only part of the individual layers (including the surface material) are not composed of conductive material, then there is a possibility to perform sub-surface ultra-high-frequency reflective diagnostics only up to the first layer, made of conductive material.

For multilayer composite materials and the use of the reflection diagnostic method, the effect of the summation of the direct ultra-high frequency signal and its reflection from surfaces with different electromagnetic characteristics should be taken into account. If the reflected and direct signals are dephased by about 90 degrees (due to the distance between the sheets in proportion to about 0.5 of the wavelength of the signal), they will compensate for each other. This effect can be avoided both by selecting the appropriate frequency of radiation for the particular type of composite material and by displacing the transmitter and receiver and providing a definite angle between the transmitted and the received signal.

4. Non-destructive testing of composite materials by holographic subsurface radar

Non-destructive testing - Definition

Non-destructive testing (NDT) is a testing and analysis technique used by industry to evaluate the properties of a material, component, structure or system for characteristic differences or welding defects and discontinuities without causing damage to the original part. [8]

NDT also known as non-destructive examination (NDE), non-destructive inspection (NDI) and non-destructive evaluation (NDE).

Holographic subsurface radars (HSR) are not often used, probably due to the fact that high attenuation of electromagnetic waves will not allow sufficient depth of penetration. It is true that the fundamental physics of HSR prevents the possibility of changing the receiver gain over time (i.e. depth) to adapt to a lost environment (as possible with impulsive subsurface radar (ISR)).

However, the use of HSR to investigate shallow subsurface objects, defects or inhomogeneity is an increasingly proven field of application.

In this case, HSR can record higher resolution images than is possible for ISR images.

Holographic subsurface radar is characterized by the requirement for routine surface scanning to record holograms. In this sense, HSR is an analogue of the optical hologram technology proposed and implemented by D. Gabor in 1948 [9]. The method proposed by Gabor can simply be illustrated with an example of recording a hologram in a point object. Axially symmetric hologram of an object point can be recorded on a flat plate such as an interference pattern between a coherent plane wave with constant phase perpendicular to the plate, and the waves that are scattered from a point object. A schematic representation of the Gabor optical hologram method for a point object is shown in fig. 1[10].

Fig. 1: Optical hologram recording (a) and reconstruction (b) [10]

The plate that records the interference pattern of waves is called a hologram. Unlike optical imaging, a microwave hologram could record not only the intensity of the waves scattered by the object, but also information about the phase of these waves. When the optical hologram is illuminated by coherent light of the same wavelength used for recording, a virtual three-dimensional image of the object is projected across the screen. In the case of a point object, the hologram is a Fresnel lens and the projected or reconstructed object is simply the point itself [9].
The Gabor method for recording holograms has many drawbacks in terms of the quality of the hologram and the convenience of its application. A new step in the development of holography was made by E.N. Leith and J. Upatnieks after the invention of the laser [9].

A method using a coherent beam of light at an angle to the recording plate is proposed. A diagram of this type of holography is presented in fig. 2. Subsequent innovations in optical holography include the use of various combinations of mirrors and light. Nevertheless, holographic technology is of great use in radar. For example, holographic radars were designed to detect weapons concealed on human bodies at airports.

![Fig. 2: Optical hologram with inclined light beam][9]

Radar holography in the atmosphere or outer space also has many features in common with optical holography, due to the lack or very low level of attenuation and dispersion of electromagnetic waves in these environments.

Holographic subsurface radars are designed to investigate heterogeneous environments with relatively high attenuation rates and sometimes high dispersion. This property can have a great influence on the recording of multifaceted holograms.

All these factors impair the quality of microwave holograms and, in many cases, make the recording of holograms impossible. The theoretical explanations for the influence of the properties of the sources on the quality of the subsurface holograms were discussed recently by N. Chubinski [11]. Surface attenuation and surface heterogeneities limit the maximum effective penetration depth for HSR. It is important to emphasize that the ISR has a clear advantage over the HSR in terms of effective penetration depth because of the possibility of applying a variable time gain to a strobe beam for selectively amplifying deeper reflections that have a longer “time-of-flight” (a method of measuring the distance between a sensor and an object based on the time difference between the signal being transmitted and returning to the sensor after being reflected by an object). Since time-of-flight is irrelevant to HSR, the main application of HSR is related to shallow depths.

At shallow depths, where applicable, the main advantage of HSR is the ability to record higher resolution images in the search plane than the ISR. High resolution at shallow depths is crucial for many applications, including the diagnosis of composite materials.

The catastrophic loss of the US space shuttle Columbia has forced researchers to find new possible methods and devices for non-destructive testing and evaluation of the space shuttle's thermal protection system, as well as the insulation foam of an external fuel tank. Such diagnostic methods can be useful not only for current spacecraft, but also for promising spacecraft such as the Orion manned spacecraft [10].

The basic problem with non-destructive testing of space vehicles thermal protection systems is that the task requires examination of a layer of dielectric material, applied directly on the metal support shell. If such composite structures were investigated by means of pulsed subsurface radar, the absorption of a radiated pulse between the metal surface and the radar antenna would significantly complicate the detection of heterogeneities and defects in the dielectric heat-shielding material. Holographic subsurface radars do not contain this disadvantage since the signal reflected by the metal surface parallel to the surface of the radiation shielding material has a constant phase and does not affect the quality of the recorded radar images.

5. Status of research on the problem

New ultra-high-frequency non-destructive testing technologies can be based on the technology used to create so-called holographic subsurface radars, developed at Bauman Moscow State Technical University and found widely applied in the diagnosis of building structures.

Preliminary experiments conducted jointly with State Space Corporation ROSCOSMOS and Vikram Sarabhai Space Center, Indian Space Research Organization, Kerala, India on presented specimens of various composite materials containing porous and elastic components, including specimens of thermal insulation coatings for space new generation rocket launchers have shown the promise of this direction.

The analysis of the reports presented at the International Conference on Non-Destructive Control in the Aerospace Industry [9,10] shows that the methods of ultra-high frequency diagnostics were presented only in the report of the Bauman Moscow State Technical University [10]. It is known that NASA, USA, a few years studies have been conducted on ultra-high frequency diagnosis of insulating coatings of rocket containers, but probably due to the use of other methods of information processing are not achieved good results and these studies have not received development in the US [10,11].

The holographic subsurface radars [7] developed at the Bauman Moscow State Technical University have a working frequency range of 1.6 to 6.8 GHz and are commercially available and are used for the diagnosis of building structures both in Russia and in other countries. The authors of the project have received a government award in science and technology for their development. At the same time, it is necessary to continue the studies related to the reflection of electromagnetic waves from the internal structure of the given materials, as well as to carry out a number of studies in order to develop new technologies for ultra-high frequency diagnostics, including in other frequency ranges. Due to the use in the aerospace industry of a number of low-attenuation dielectric coatings, such as fiberglass, polyurethane, quartz, ceramics, non-metallic nanoclusters, etc., one direction in this direction is related to the use of a 24 GHz frequency band leading to quality improvement the image and the possibility of recording minor defects in the components manufactured. To evaluate this possibility, it is necessary to evaluate the specific vibration damping at a frequency of 24 GHz for some composite materials using them.

6. Conclusion

A summary of the theory, technology and applications of holographic subsurface radar is presented in this paper. The main advantages and limitations of commonly used pulse radars are also considered. In many practically important cases the depth of penetration is insufficient and the quality of recorded images does not allow reliable identification of detected objects. However, the proper choice of the type of sounding signal and its frequency range can lead to useful results that cannot be achieved by other non-destructive diagnostic methods. A typical area of application for holographic subsurface radar is the study of opaque shallow-depth objects where high resolution is desired. In these cases, it is possible to define the shape and dimensions of the targets and elementary objects with sufficient accuracy and to formulate reasonable assumptions about their nature for developing image-based classification pictures.
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Automated testing framework with browserstack integration

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Abstract: Nowadays ensuring high-quality software product requires a lot of testing efforts. Automated tests in the 21st century are a must. Whether it’s code peer-review, unit, integration, system or exploratory user testing – it all has to be done with given insurance and expertise! Therefore, we look to automate our testing where is conceivable. Most applications today have the equivalent of Web and Mobile versions for the same functionality, but different platforms of action in order to facilitate the users. Therefore, parallel testing of both subtypes is required to provide smooth maintenance and rapidity. Running as many builds as possible, including tests to ensure quality is essential when comes up to reliable software product and agile development. With the implementation of Continuous Integration and Continuous Delivery tools, we guarantee a better way to deploy automated tests across multiple instances and execute them against those environments. BrowserStack is one common cloud solution to these requirements. It is a very powerful tool, which can be attached to our development process. This article explores detailed approach on the automation of cross-browser, device and compatibility testing in BrowserStack platform, using a custom extended automation framework to provide direct configuration output to this environment and give ease in the future Web and Mobile development.

Keywords: AUTOMATION, FRAMEWORK, TESTING, QUALITY, ASSURANCE, BROWSERSTACK

1. Introduction

There are many cloud-based applications available today that help with software development, regardless of the area we want to use or improve. It is especially important to keep in mind that when it comes to software quality assurance it is almost mandatory to take most of the automated tests on cloud infrastructure, such as: Amazon Web Service (AWS), BrowserStack, SourceLabs and etc. All of these platforms have similar functionalities and are easy to use.

The problem area of the current scientific work is focused on that in order to be able to take advantage of all the features and functionalities, we need to have a well-defined and extended automated testing framework that programmatically interacts and communicates with the above-mentioned cloud-based systems, because they all provide own rules of operation and configuration, resulting in obstacles and delays in the transformation from on-premises development to cloud-based. In this study, we will track the extension of an automated software framework geared toward connecting to a cloud-based cross-browser testing platform and utilizing all the benefits of this approach.

2. BrowserStack introduction

BrowserStack is one of the world’s most trusted platforms for cross-browser testing. It allows interactively testing and debugging websites across thousands of browsers and real mobile device browsers to ensure that applications are working flawlessly. In real-time, it is difficult to test an application in different browsers using multiple operating systems, with varying versions.

It will cost a lot to buy many computer machines to install different operating systems. It is even more difficult to buy all the Android and iOS mobile devices that are available in the market today. Due to this reason, it is not practical to buy and set up all the devices. Thus, we go with the BrowserStack to avoid the complexity of switching between the operating systems, browsers, and different versions.

When it comes to mobile application testing, we can avoid buying all the mobile devices that are available today, Browser Stack is very flexible and scalable. We can test anywhere and anytime with the help of Browser Stack.

We can use Browser Stack as a remote lab and can use this as Real Desktop Browsers. It gives us free Javascript unit tests and supports 750 configurations. There is no set up required for using BrowserStack. We can use it directly on any independent machine by using the Browser Stack URL and its login credentials. [1]

Features of BrowserStack

• Cross-browser testing with different browsers on different operating systems;
• Native app testing on mobile;
• Hybrid application testing;
• Automate web and mobile applications.

3. Automated testing framework

The benefit of creating an automation framework is to use it as a template for every new project, offering us the leverage to avoid all of the known problems. When automated tests are created, the first thing we do is to interact with the browser. This can include navigating to a page, clicking a button, or filling in a login form and many different actions. After that, we need to verify and report the actual versus the expected results. While we have many different tests at our disposal, how and when we use them is dependent on the scenario. In some cases, we will execute several tests in a specified order. In others, only execute specific tests. In order to achieve all of this, testers usually need to implement different frameworks or libraries along with the Selenium Web driver. As we said most projects have common user actions that need to be accomplished in an automated flow. These interactions are developed and implemented in the framework itself and the testers can use them right away without wasting time to write or re-write them again from the start. [2]

With the advantages of the framework, there is no need to waste time developing this functionality since it is already done generally. Along with all positives, this development is integrated and extended from Selenium and Appium. This gives us the flexibility to easily choose which tests we want to execute: whole test suite / scenario, or only smoke, sanity tests and etc. also other perspectives or a specific set of tests. It supports data-driven behavior testing and flexible configuration setup.

Another benefit of creating an automated software framework is the ability to prepare ready-made configured classes and packages for the use of many external sources such as: cloud-based tools, external media, servers or resources. The use of the ready-made techniques in the automated framework saves us time, prevents additional effort and facilitates understanding of the business logic.

In Figure 1 we can see a detailed graphical representation and collaboration of all tools and libraries of the software testing framework architecture and the benefits of using BrowserStack cloud platform.
As we said BrowserStack is a wide open platform, it is distributed under the following architecture: SaaS (Software as a service), which means that this is a cloud-based solution in a set of functionalities under certain rules. In order to facilitate the usage, we will go through these requirements and take advantage of all its benefits, we should also stick to those rules and set of desired capabilities, which BrowserStack expects from us.

The architecture is based on ‘Hubs’ and ‘Nodes’. The Hub is the central point that will receive all the requests along with information on which browser, platform (i.e. Windows or Linux) and which device the test should be run on. Based on the request received, it will distribute them to the registered nodes. Nodes are where the corresponding tests will run. Each node is a machine (physical/virtual machine) or a real mobile device that is registered with the hub. When we register a node, the hub has the information of the node and it will display the browser and configuration details of the nodes.

The prerequisites required to set up BrowserStack are the Capabilities object and Remote WebDriver. The capabilities object would help to configure the desired properties and platform for the tests, and Remote WebDriver is used to hit the BrowserStack API.

Based on the preferences set in the desired capabilities instance, the Hub will point the tests to a node that matches the preferences.

In the following chapter, we will review how BrowserStack API works.

4. BrowserStack Architecture

Here is a sample code snippet in Java that sets the capability to point the required node to the respective hub:

```java
final String USERNAME = "";
final String AUTOMATE_KEY = "";
final String URL = "https://" + USERNAME + "::" + AUTOMATE_KEY + "@hub-cloud.BrowserStack.com/wd/hub";

DesiredCapabilities caps = new DesiredCapabilities();
caps.setCapability("browser", "browser");
caps.setCapability("browser_version", "browser_version");
caps.setCapability("os", "os");
caps.setCapability("os_version", "os_version");
caps.setCapability("resolution", "resolution");
caps.setCapability("project", "Project-1");
caps.setCapability("build", "1.0");
caps.setCapability("BrowserStack.debug", "true");
caps.setCapability("BrowserStack.Type.ACCEPT_SSL.CERTS", true);
driver = new RemoteWebDriver(new URL(URL),caps);
}
catch(MalformedURLException e) {
    e.getMessage();
}
```

In this example, the TestNG annotation parameters have been used to get the value of the corresponding parameters and feed it to the capabilities object:

```java
@org.testng.annotations.Parameters(value={"browser", "browser_version", "os", "os_version", "resolution"})
```

Now we can run the desired test automation suite on BrowserStack. Each test run has a unique session ID associated with it. Based on the session ID, all the details required for test execution will be fetched. Each test execution has bug logs generated, for example: a test log that gives a textual representation of each process running in the background. There is also a visual log that shows screenshots of the test being executed. [3]

Methods in DesiredCapabilities for Selenium configuration:

Now let’s have a look at all the methods available in the DesiredCapabilities Class.

1. getCapability();
   - This method helps in retrieving the capabilities of the current system on which the tests are being performed.
   ```java
   public java.lang.Object getCapability(java.lang.String capabilityName)
   ```

2. setCapability();
   - The setCapability() method is used to declare the properties of test environments like device name, operating system name, operating system versions, browser, and browser versions.
   ```java
   public void setCapability(java.lang.String capabilityName, java.lang.String value)
   ```

3. getBrowserName();
   - This method helps in retrieving the browser name of the current system.
   ```java
   public java.lang.String getBrowserName()
   ```

4. getBrowserName();
   - This method is used to set the name of the browser on which tests are to be executed.
   ```java
   public void setBrowserName(java.lang.String browserName)
   ```

5. getVersion();
   - This method helps in retrieving the version of the browser or the operating system of the current system used for running the tests.
   ```java
   public java.lang.String getVersion()
   ```

6. setVersion();
   - This method helps in defining the version of the browser or the operating system for running the tests.
   ```java
   public void setVersion(java.lang.String version)
   ```

7. getPlatform();
   - This method helps in retrieving the details of the operating system.
   ```java
   public Platform getPlatform()
   ```

8. setPlatform();
   - This method helps in defining the desired operating system to be used.
   ```java
   public void setPlatform(Platform platform)
   ```

Infrastructure model for interaction from our local machine and BrowserStack cloud platform:

1. BrowserStack Local makes a REST call using the user’s access key to BrowserStack.com.
2. BrowserStack.com chooses a repeater to establish a secure connection for Local Testing.
3. The repeater exists within the BrowserStack cloud infrastructure.
3. BrowserStack.com supplies BrowserStack Local with the information necessary to establish a connection with the repeater.

4. BrowserStack Local initiates a connection to the repeater on port 443, using our custom SSL-encrypted protocol.

Note: The repeater cannot directly initiate a connection to BrowserStack Local.

5. A secure, bi-directional, and persistent connection is established between the end user machine and the repeater. We use Secure WebSockets as part of our communication framework. If your enterprise firewall blocks the WebSocket protocol, we fall back to a legacy protocol which is also SSL encrypted, but much slower than WebSockets. For best results, we recommend that outgoing WebSocket connections be allowed in your firewall.

Note: The secure connection is only established up to the user’s machine.

5. Extended Framework Architecture

As we said, in the beginning, our case study is focused on expanding the core software test framework, in this chapter we will follow the overall development of the framework targeting Mobile and Web configurations used and envisioned in BrowserStack.

To be able to use and connect our tests to BrowserStack platform and run it as well, we should extend our automation framework to meet the given rules from BrowserStack architecture. We extended our custom automation framework based on Selenium WebDriver and TestNG, written in the programming language Java.

We have two types of tests in our testing framework, Web and Mobile tests. Web tests are concentrated to run on different browsers, versions, resolutions, projects and builds. Mobile tests, on the other hand, are supposed to run on different devices and operating systems (OS), including Android and iOS. For this purpose, we created the following packages: Device Manager to handle device metrics, prerequisites and configurations, Mobile Capabilities to get the given mobile resources and Web Capabilities.

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We have two types of tests in our testing framework, Web and Mobile tests. Web tests are concentrated to run on different browsers, versions, resolutions, projects and builds. Mobile tests, on the other hand, are supposed to run on different devices and operating systems (OS), including Android and iOS. For this purpose, we created the following packages: Device Manager to handle device metrics, prerequisites and configurations, Mobile Capabilities to get the given mobile resources and Web Capabilities.

Device Manager holds the functionality to create a specific Mobile device object, Operation system, Install and Uninstall actions on the app. In this approach, we can gain more abstraction on the written code and easily. From the given perspective we now have our device held approach and can proceed to the next programming package which contains the logic for the current device set and managed options.

Figure 2. Device Manager Interface Class Diagram

Device Manager holds the functionality to create a specific Mobile device object, Operation system, Install and Uninstall actions on the app. In this approach, we can gain more abstraction on the written code and easily. From the given perspective we now have our device held approach and can proceed to the next programming package which contains the logic for the current device set and managed options.

Figure 3. Device Class Diagram

In Device Class diagram is the whole logic for device capabilities, which we described in BrowserStack architecture, with the given code:

```java
public abstract class MobileCapability extends AbstractCapability {
    private String capabilityName;

    MobileCapability(final DesiredCapabilities capabilities, final String
    capabilityName) {
```

When objects are locally set up we can proceed to transfer them via BrowserStack cloud base platform to handle the given capabilities, for Mobile and Web testing approach.

For Mobile testing purpose, we created the following file: MobileCapability.java which is the main class to get the options from iOS and Android Capabilities instances, such as OS type and given versions. We also have BrowserStackMobileCapability which will transfer objects directly to BrowserStack Cloud platform.

```java
public abstract class MobileCapability extends AbstractCapability {
    private String capabilityName;
    MobileCapability(final DesiredCapabilities capabilities, final String
    capabilityName) {
```

We can manipulate the whole device settings and configurations and also parse it through the testing framework for further explorations.

When objects are locally set up we can proceed to transfer them via BrowserStack cloud base platform to handle the given capabilities, for Mobile and Web testing approach.

For Mobile testing purpose, we created the following file: MobileCapability.java which is the main class to get the options from iOS and Android Capabilities instances, such as OS type and given versions. We also have BrowserStackMobileCapability which will transfer objects directly to BrowserStack Cloud platform.

```java
public class MobileCapability extends AbstractCapability {
    private String capabilityName;
    MobileCapability(final DesiredCapabilities capabilities, final String
    capabilityName) {
```
super(capabilities);
   this.capabilityName = capabilityName;
}

@Override
public DesiredCapabilities get() {
   new CapabilityPreferences(this.capability, this.readCapabilities());
   return this.capability;
}

Figure 4. Mobile Capability Class Diagram

For Web testing, we created WebCapability.java to inherit different capabilities: depending on browsers, versions, resolutions, projects and builds.

Figure 5. BrowserStack Web Capability Class Diagram

From Web perspective, we are allowed to use all of the BrowserStack functionalities for different browser testing approach and versions, such as: Google Chrome, Mozilla Firefox, Internet Explorer, MS Edge and Safari. In the given class diagram there is a provided solution on every capability to be parsed from the automation testing framework through BrowserStack platform. We also can manage to choose from a list of supported browser versions.

6. Conclusion

In this paper, we have proposed creation of an automated testing framework with BrowserStack integration. Using this approach provide several benefits such as code re-usage, higher portability, easy maintainability, reduced script maintenance, low cost and “ready-go” configuration to use it directly with BrowserStack cloud platform. Automating most of the actions according to the guidelines reduces manual operations. Since maximum coverage is already in-built and achieved at the initial stage, there is very little or no intervention required by individuals to run the automation tests. Parameters can be parsed automatically from the local machine through BrowserStack, everything is set, only the subscription key is needed to activate the whole process between our development and BrowserStack platform. This article explores a detailed approach on the automation of cross-browser, device and compatibility testing in BrowserStack platform, using a custom extended automation framework to provide direct configuration output to this environment and give ease in the future Web and Mobile development.

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Abstract: Collaborative robots, or cobots, are increasingly being taken out from behind the cages and being used alongside human beings to automate a variety of tasks, including quality inspection, pick-and-place. Collaborative industrial robots are harmless to the human worker, affordable, and easy to use and program. This paper studies applications of collaborative industrial robots in industry.

Keywords: collaborative robots, cobots, industrial robots

1. Introduction

The term “collaborative robot” is often a misnomer. Although a collaborative robot is designed to work alongside humans, the device itself is not necessarily forced limited. This means that the robotic cell is monitored, is safe for human co-workers, and relies on at least one of the 4 collaborative modes. The term “collaborative robot” is unique in that it describes the fact that humans and robots work with each other, not whether the robots are force limited.

“Cobot” is a slang term used to describe a collaborative robot. Cobots are designed to be used within a defined collaborative workspace with human workers, and typically have some built-in safety mechanisms to support this use. Cobots typically fulfill repetitive or injury-prone tasks such as machine tending or palletizing while the human worker performs higher-value upstream or downstream manual tasks. Cobots mimic human actions and carry out tasks at similar or slower speeds, with payload and reach that is also similar to a human’s.

The International Federation of Robotics defines two types of robots designed for collaborative use. One group covers robots designed for collaborative use that comply with the International Organization for Standards norm 10218-1 which specifies requirements and guidelines for the inherent safe design, protective measures, and information for use of industrial robots. The other group covers robots designed for collaborative use that do not satisfy the requirements of ISO 10218-1. This does not imply that these robots are unsafe. They may follow different safety standards, for example, national or in-house standards.

Human-industrial robot collaboration can range from a shared workspace with no direct human-robot contact or task synchronization, to a robot that adjusts its motion in real-time to the motion of an individual human worker (Fig. 1).

Applications in which the robot responds in real-time to the motion of a worker (altering the angle of the gripper to match the angle at which a worker presents an object, for example) are the most technically challenging. Since the robot needs to adjust to the motion of the worker, its movements are not completely predictable and therefore the end-user must be sure that the full parameters of its potential scope of motion meet safety requirements. Examples of responsive collaboration in industrial settings are unlikely to appear soon in most manufacturing sectors, which rely on precision and repeatability to achieve productivity gains.

2. Applications of collaborative robots

Over the last few years, automation has gained immense popularity in various industries. And the manufacturing industry sits on the cutting edge of automation technology, ahead of other industries. With automation, manufacturing companies have revolutionized the way activities were once performed. With autonomous systems coming into the picture, human participation and involvement have reduced significantly. As a result, work gets done faster and more importantly, with greater precision.

Though automation changes the nature of employment, it has brought in huge profit opportunities to the manufacturing industry. One of the most extensively used types of automation machines is a collaborative robot. Robots programmed to operate 24x7 in almost any situation to help manufacturing companies achieve greater productivity, higher throughput, and greater revenue gains. Besides, robots in manufacturing now have the cognitive abilities to take decisions independently. As the underlying technologies mature, collaborative robots in manufacturing can be made more versatile to take up more creative tasks.

Areas of application collaborative robots in manufacturing are:

- Picking, packing and palletizing,
- Welding,
- Assembling items,
- Handling materials,
- Inspecting products for quality

2.1. Picking, packing, and palletizing

Picking, packing, and palletizing are activities that need to be accurately performed. Manually performing these tasks can be mind-numbing, labor-intensive, and also time-consuming. Expecting humans to work with endless energy levels is unreasonable. Besides, humans can make errors while performing tasks. Collaborative robots (cobots), programmed to work alongside and share the human workload, have a very interesting role to play in a manufacturing company. One of the most important advantages of deploying collaborative robots is speed. Having the potential to function around the clock, these robots can work for long hours and even days (unlike humans). Robots can pick different items (which are required in constructing a product), pack them in different cartons, and palletize them. With the advantage of speed, manufacturing companies can achieve their production goals at a faster rate. Besides, there will be no room for error with collaborative robots. As a result, the time taken for the completion of manufacturing processes will be saved tremendously [2].
Bin picking comes in many shapes and sizes, from high payload automotive and heavy equipment manufacturing applications, to pick and drop e-commerce order fulfillment and part sortation applications (Fig. 2).

![Fig. 2 Bin-picking cobot](image)

The packaging is a wonderful application for collaborative robots. First, it's a vital but non-value-added task—perfect for cobots (Fig. 3). Moreover, today's industries have an ever-increasing need for packaging. Nine out of ten packaging companies are now using robots. According to one report, the cobot market has an estimated 57 percent Compound Annual Growth Rate (CAGR) between now and 2023.

![Fig. 3 Packing cobot](image)

Using manual palletizers can take a toll on the workers and the rate of production. They are slow, they need constant monitoring and their payload is not much. Introducing cobot palletizers improves the working conditions of the workers as they can leave most of the heavy duties to the cobots and attend to other easier tasks (see Fig. 4). Cobots do not require too much monitoring and as long as their sensors and programs are in place, then they carry out their tasks effectively. They can also handle heavier payloads with better speeds per minute.

![Fig. 4 Palletizing cobot](image)

Cobot palletizers come with an easy to use technology that does not require a permanent trained robotic expert to keep monitoring it. This saves you the costs of hiring technicians and operators.

2.2. Welding

Manufacturing companies try to produce goods according to customer expectations while keeping the prices low. In their quest to accomplish these goals, these companies leverage new-age technologies. And collaborative robots can be one of these technologies. One of the most cumbersome tasks in a manufacturing plant is welding and soldering (Fig. 5). Humans can definitely perform these activities, but for how long? It is no surprise that workers can’t be expected to work all day long. Sensors and computer vision systems increase collaborative robot sensing capabilities. With this potential, robots can sense catastrophic environments and notify workers about the same. This way, collaborative robots can work alongside humans, preventing accidents and loss of lives too [3].

![Fig. 5 Welding cobot](image)

With collaborative robots, manufacturing companies will see: an increased rate in their production rate, no errors that are otherwise seen in their human counterparts, and improved work quality with high-level uniformity, and a reduction in wastage.

2.3. Assembling items

Assembly tasks are becoming more and more automated. With the introduction of robots that can work alongside workers, human-robot collaboration is truly a step up. It is now easier, less risky, and a lot faster to use a robot for your assembly line [4]. A collaborative robot general term used to describe the power and force limited robots, robots that can be used without safety guarding or that has incorporated other safety features. This means it can be put
beside a machine or a person and set to perform a certain task without needing to be fenced off from the surrounding environment. That being said, to introduce a cobot to an assembly line and program it to load and unload parts is not as simple as it sounds (Fig. 6).

**Fig. 6 Assembly cobot**

Advantages of collaborative robots for assembly applications
- Increased quality, consistency, and production speed
- Easy programming for fast redeployment to new assembly configurations
- Space-saving, lightweight design for exceptional manufacturing flexibility
- Ability to adapt assembly output to meet peak seasons and changing consumer demands
- Fast payback with none of the traditional robotic costs for programming, set-up, and dedicated work cells

2.5. Handling

Moving materials inside a manufacturing unit, around a factory floor, is a tedious process for humans. To ensure that production meets customer expectations, companies have to automate repetitive tasks like material handling. One of the best ways to deal with this concern is by bringing collaborative robots to the factory aisle. Collaborative robots can easily understand work requirements and move materials to the desired location at faster speeds. Besides, collaborative robots can help in providing a hazard-free work environment by taking care of harmful raw materials automatically.

**Fig. 7 Handling cobot**

By using collaborative robots for material handling, manufacturing companies can witness:
- Increased worker health and safety,
- Reduced costs,
- Faster production cycles, and
- Reduced downtime.

2.6. Inspecting products for quality

Making quality inspection quick and easy with the help of a collaborative robot arm ensures that you have the flexibility to automate almost any manual task. This is especially useful when dealing with small batches or having to switch quickly from task to task. A cobot can reuse programs for repetitive tasks [5].

Quality inspection is a suitable task for the cobot. If you use a vision system together with a cobot, it is possible to check products for quality and immediately remove defective products from the production line. With the camera, you can identify and remove defective parts before they are packaged or shipped.

Precision and consistency are the qualifications of a cobot that are most important for quality inspection. A robot arm consistently and repeatedly follows precise processes with minimal deviations; much more precise than a human.

Examples of quality inspection by the cobot
- Inspecting aircraft engines
- Inspecting car doors
- Inspecting central heating boilers
- Inspecting parts of X-ray equipment
- Inspecting welds
- Checking the correct shape/dimensions of fruit and vegetables
- Repeatedly opening and closing drawers with a specific force set

**Fig. 8 Inspecting cobot**

Benefits of quality inspection by the cobot
- Prevent employees from getting injured (or bored) due to repetitive work during quality inspection
• Reduce operating costs
• Consistent quality

3. Conclusion

The market for collaborative robots is still in its infancy. End-users and systems integrators are still gaining experience in what works and don’t in the design and implementation of collaborative applications. Technology developments in sensors and grippers hold promise for expanding the range of actions that the robot end-effector can perform. Programming interfaces will continue to become more intuitive, not just for cobots, but also for traditional industrial robots.

4. References

Methodology for static tuning of the HEV fuel flow measuring system

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Abstract: The modern automobiles are subject of more stringent requirements \cite{1} corresponding to power, torque, fuel economy and ecology legislations, which is led to designing of new power sources and constructions, such as the hybrid electric vehicles (HEV). They are moving by the energy \cite{2}, which is ensured by the internal combustion engine (ICE) and the battery. The main factor in this area is the HEV fuel system, which is controlled by the electronic control unit (ECU) \cite{1}. The electronic control of the Spark Ignition Engines (SI engines), as well as the Direct Ignition Engines (DI engines) is based on the certain sensors signals, program maps and management algorithms. The result in this electronic control is the management of the fuel injectors. The management of the fuel injectors consists in the start of injection, injection duration, number of injection events, injection advance, injection pressure etc. Moreover, the fuel consumption and fuel efficiency are the main factors, which are determining the HEV advances. The learning and measuring the HEV fuel consumption, as well as, the conventional automobiles, is the ground for achievement of quality results in the education of the automotive engineers, as well as for obtaining of scientific researching for developments and innovations. Significant meaning in this concept has the real, live and practical performance with the help of testing equipment and test-benches. This paper renders the methodology of static tuning the Fuel Flow Measuring System EFMS100 on the test bench SAV-1 with the support of controller Matrix MIAC MI0245 and Flowcode 7 software.

Keywords: HEV, FUEL FLOW, METERING, METHODOLOGY

1. Introduction

The hybrid electric vehicles or simply hybrid vehicles use both electric motors and an SI engine for delivering the propulsion power \cite{3}; these vehicles have lower emissions compared to a similarly sized conventional vehicle, resulting in less environmental pollution. The ICE used in a HEV is, of course, downsized compared to an equivalent vehicle engines. The SI engine in combination with the electric motor and an energy storage unit battery provide an extended range for HEV and bring down pollution. The HEV serves as a compromise for the environmental pollution problem and the limited range capability of today’s purely electric vehicle (EV). The HEV energy efficiency is the main factor for its advantage and evaluating. This efficiency depends directly from the HEV fuel consumption. It is very important to measure the fuel consumption in correct manner and with suitable equipment to obtain the correct results. Meanwhile, the fuel consumption metering equipment must be calibrated and adapted to the current tests.

2. Structure

The fuel consumption metering equipment is specialized set of fuel sensors, metering units and display units. In accordance with the fuel to use there is different kind of sensors and metering techniques. In this case the EFMS100 \cite{4} metering system is used. It consists from two sets of fuel sensors, metering units and display units (fig.1).

Fig.1 EFMS fuel flow metering system \cite{4}: 1-metering unit; 2-display unit; 3-fuel flow sensor

The fuel metering system must be calibrated according to the amount of the fuel flow in the current application. In the case of metering the HEV fuel consumption it is very useful to apply test benches, which can adjust and calibrate the equipment according to the flow range. Such test bench is the test bench SAV-1 \cite{5} for automated management of the automotive gasoline fuel injectors SAV-1 (fig.2). The test-bench can be programmed and managed by the Flowcode 7 software \cite{6}, which ensures adjustment to the real work mode of the fuel injectors in the modern automobiles and HEVs.

Fig. 2 Common view of the test bench SAV-1 for automated management of the automotive gasoline fuel injectors: a) 1-control panel; 2-controller MI0245; 3-fuses; 4-fuel pump relay; 5-main relay; 6-fuel pump; 7-fuel filter; 8-fuel tank; 9-pump line; 10-return line b) 1-base plate; 2-fuel rail bar; 3-fuel rail; 4-fuel injector; 5-ignition key; 6-metering glass; 7-manometer

3. Methodology

The EFMS100 equipment is connected to the test bench SAV-1. The fuel sensors 3 (fig.1) are connected to the pump line 9 and return line 10 (fig.2a). The fuel to use is gasoline, which is in the fuel tank 9. The gasoline is pumped by the fuel pump 6 and is pressurized in the fuel rail 3 (fig.2b). The gasoline pressure is maintained by the fuel pressure regulator in limits of 3-4 bar. The gauge 7 measures the pressure. The controller MI0245 2 (fig.2a) manages the fuel injectors 4 (fig.2b). The Flowcode 7 software develops the management program.

The management program determines the opening and closing time of the injectors, i.e. the injection duration and injection advance.

The metering program is used to measure the fuel sprayed from the injectors. The metering glasses are an A class according to the DIN 12680. The quantity of sprayed fuel in the metering glasses is compared to the quantity registered by the EFMS100 system. The whole equipment is powered form the 12V battery or by an adaptor from the electric set.

The two fuel sensors are metering the fuel flow in the pump line and the return line. The measured values of the sensors are registered in the metering units and displayed on the display units. The difference between measured values is the real fuel quantity which is essential for the calibration. The static tuning, or calibration is carried on by the values from the pump line fuel sensor. In this case the test bench is set to pump mode, i.e. the regulator does not permit the fuel to the return line. The dynamic
tuning is carried on by the values from the two sensors, i.e. by the differential value of the sensors. The results from this tuning is object of another researching.

The static calibration is performed in the four modes, which have main automotive application. These modes are:

1) Continuous – all injectors are activated and produce continuous spraying;
2) Simultaneous – all injectors are pulse activated and produce pulse spraying;
3) Semi-sequential – the injectors are pulse activated in groups and produce group pulse spraying;
4) Sequential – the injectors are individual pulse activated and produce individual pulse spraying.

The pulse has three parameters:
1) $ON_{\text{time}}$ – the time in which the injector is opened;
2) $OFF_{\text{time}}$ – the time in which the injector is closed;
3) Duty cycle D:

$$D = \frac{ON_{\text{time}}}{ON_{\text{time}} + OFF_{\text{time}}} \times 100\%$$

The timing of the $ON_{\text{time}}$ and $OFF_{\text{time}}$ are varying from 5 to 45 ms at the step of 5 ms, and D is varying from 10 to 90%. There are the following combinations, which are represented on the Table 1. These values are corresponding to the real injection automotive processes.

<table>
<thead>
<tr>
<th>$ON_{\text{time}}$, ms</th>
<th>$OFF_{\text{time}}$, ms</th>
<th>D, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>45</td>
<td>10</td>
</tr>
<tr>
<td>10</td>
<td>40</td>
<td>20</td>
</tr>
<tr>
<td>15</td>
<td>35</td>
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<td>10</td>
<td>80</td>
</tr>
<tr>
<td>45</td>
<td>5</td>
<td>90</td>
</tr>
</tbody>
</table>

The quantity of fuel sprayed in the metering glasses is set to be 100 ml. After that, the test bench SAV-1 is paused and is performing the comparison between the sprayed and registered fuel quantity. Then is performed the EFMS100 adjustment if required. The adjustment is made by the EFMS100 menu, which gave the access to the parameter PVR – pulse/volume ratio. This parameter is calculated the by formulae:

$$PVR = \frac{FPC}{Q_f}$$

where $FPC$ is the fuel flow pulse count, which is the number of revolutions of the flow sensor turbine to the measured fuel quantity; $Q_f$ – the measured fuel quantity.

Then the calculated PVR is set in the EFMS100 menu.

4. Results

After the performed experiments is obtained the following results, which are displayed in graphic diagrams. The fig.3 displays the fuel metering results during the Continuous mode. In this case the fuel injectors are spraying continuously. The characteristic shows equal dependence between metering glasses and calibrated EFMS100 system. The deviation of the experiment 3 is because of fuel flow fluctuations, which has chance character.

The remaining combinations are the same with the second combination 10 to 40 ms.

The Semi-sequential mode is displayed on the fig.5. The timing of the $ON_{\text{time}}$ and $OFF_{\text{time}}$ is the same as previous Simultaneous mode. All the combination shows equal characteristic and are layered one above other.

As can be seen, all the fuel flow characteristic has approximate dependence, which is essential to the static tuning, i.e. static calibration of the calibrated system.
5. Calibration

During the experiments at the previous point can be seen that the main difference is rendered at the little quantities of injected fuel, i.e. at the $ON_{\text{on}}$ timing of 5 to 10 ms. To achieve the comparative characteristic of the calibration or calibration characteristic it is important to compare the FPC values with the fuel quantity values during the four modes. The values for the Continuous and Simultaneous mode is represented in the Table 2.

Table 2: Comparative value for the Continuous and Simultaneous mode.

<table>
<thead>
<tr>
<th>Continuous</th>
<th>Simultaneous</th>
</tr>
</thead>
<tbody>
<tr>
<td>fuel, L</td>
<td>FPC</td>
</tr>
<tr>
<td>0.04</td>
<td>636</td>
</tr>
<tr>
<td>0.08</td>
<td>1153</td>
</tr>
<tr>
<td>0.12</td>
<td>1770</td>
</tr>
<tr>
<td>0.16</td>
<td>2545</td>
</tr>
<tr>
<td>0.20</td>
<td>3134</td>
</tr>
<tr>
<td>0.24</td>
<td>3781</td>
</tr>
<tr>
<td>0.28</td>
<td>4425</td>
</tr>
<tr>
<td>0.32</td>
<td>5079</td>
</tr>
<tr>
<td>0.36</td>
<td>5656</td>
</tr>
<tr>
<td>0.40</td>
<td>6152</td>
</tr>
</tbody>
</table>

The values in the table and the remain values are represented on the fig.7. As was mentioned above the range of little fuel quantities is critical for the adjustment and calibration.

Fig.7 Calibration characteristic at Continuous and Simultaneous mode

The values for the Semi-sequential and Sequential mode is represented in the Table 3.

Table 3: Comparative value for the Semi-sequential and Sequential mode.

<table>
<thead>
<tr>
<th>Semi-sequential</th>
<th>Sequential</th>
</tr>
</thead>
<tbody>
<tr>
<td>ON5ms, OFF45ms</td>
<td>ON10ms, OFF40ms</td>
</tr>
<tr>
<td>fuel, L</td>
<td>FPC</td>
</tr>
<tr>
<td>0.04</td>
<td>2055</td>
</tr>
<tr>
<td>0.08</td>
<td>4163</td>
</tr>
<tr>
<td>0.18</td>
<td>9241</td>
</tr>
<tr>
<td>0.30</td>
<td>15736</td>
</tr>
<tr>
<td>0.20</td>
<td>7663</td>
</tr>
</tbody>
</table>

The values in the table and the remain values are represented on the fig.8.

As it is shown on the fig.7 and fig.8, there is critical area in the range of little fuel quantities, i.e. at the little $ON_{\text{on}}$ values. This area is more likely to be the reason for incorrect fuel flow measurements. So, the static calibration must be performed in this area.

Fig.8 Calibration characteristic at Semi-sequential and Sequential mode

The correct calibration consists the following:

1) Setting up the timing to the minimal $ON_{\text{on}}$ values (for example 5 ms)
2) Defining the control fuel quantity $Q_c$ (for example 200 ml)
3) Performing the experiment
4) Comparing the values of sprayed fuel quantity $Q_f$ by the metering glasses and by the display of calibrating system
5) If there is difference between the readings the parameter PVR must be update, according to below
6) Reading the values of sprayed fuel quantity $Q_f$ by the metering glasses and the values of the parameter FPC.
7) Calculating the PVR parameter by the (2)
8) Setting up the updated PVR value in the menu of the calibrated system
9) Repeating the experiment and comparing the readings

After the correct calibration, the fuel metering system can be attached to the real HEV and can be made experiments to determine its fuel consumption during different driving modes in different areas. This will give the accurate evaluation of the HEV fuel efficiency.

Conclusion

The experimental calibration of the fuel metering system for the HEV fuel consumption is needful and important factor for the correct fuel metering.

Static tuning or calibration must made in the little fuel flow quantity modes to achieve the accurate tuning of calibrated system. Thus, the fuel consumption during idle mode of the HEV will be accurately define, moreover the idle mode is very common during the city traffic conditions.

Literature


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Crowdtesting as part of quality management method in a mobile development

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Abstract: The influence of crowdtesting on the development of mobile applications is the aim of this work. Based on the study, changes in the value of the mobile application for stakeholders interested in ensuring the quality of the mobile application are revealed.

KEYWORDS: MOBILE APPLICATION, SOFTWARE PRODUCT LIFE CYCLE, SOFTWARE TESTING, RESCUERS, MONITORING.

Introduction

The quality and success of software is one of the pressing topics of IT development. According to a study by Standish Group, since 1994 the share of successful IT-projects has not changed significantly and amounts to about 30%. Quality is inextricably linked to the expectations of consumers and stakeholders. The article discusses the experience of improving quality through crowdtesting technologies.

Preconditions and means for resolving the problem

The research describes a testing method that involves the involvement of users in the development, tested by different stages of the development of the “Help Is Nearby” mobile application of the Scientific Research Institute of Emergency Situations and Emergencies. In order to improve the quality of the application, as well as to take into account the opinions of end users, crowdtesting technologies were used in the development with the involvement of a wide range of users (both professional rescuers and ordinary users of the application). Free distribution of the application on PlayMarket and AppleStore suggests that the data from users is relatively homogeneous, unlike commercial products, where paid subscription data significantly affects the final metrics.

Attraction of rescuers and volunteers for testing the application is carried out throughout its life cycle. The basis for the development of technical specifications for modify and evolve the mobile application became a testing the “Report a Problem” functionality. The technical tasks were based on ideas, rational proposals and feedback received from the specialists planning to use the application in their interests. Android App’s section “Report a Problem” was open to all users and to representatives of rescue groups in 2017-2019. Also, after the release of the IOS, QA and 12 testers were involved in testing.

Functionality is a complex multi-user system: only at the testing stage 731 users with 13 types of roles were added to the Users directory, 152 structural units, 41 maps were created. Android's application was tested throw the Google developer console. The closed group beta-version was chosen: ordinary users installed software from PlayMarket. Stakeholders installed test-file also through the organization’s network resources. Beta-testers quantity ranged from 27 to 500 people at different stages. The list included volunteers, stakeholders, representatives from the development team. 11 thousand messages were sent from users by the functionality of sending messages as with or without photos from various devices. 42 errors were found: from minor to two critical. 18 proposals were received from stakeholders, 14 of it were deemed appropriate for further development and formed the basis for the future technical specification. Improvement options were formed by test results, including changes in the project architecture, classification of messages and users entered, graphic marking of messages and participants, automatic notification of messages and the ability to add comments to it and a number of others. There was a modular separation of functionality by ordinary users and specialists of rescuer's service.

Regression testing was carried out after improvements. 80% of user interface improvement suggestions were deemed appropriate. By the way, the answer was received from real devices. Diversity of modern systems makes us look at modern crowdsourcing technologies as a tool to improve the quality of software products.

So if it comes to mobile devices list of supported devices announced thousands versions. For ex. for app “Help Is Nearby” list of supported devices are announced in 14,336 on the Play a mobile application. It gives maximum accuracy of results and a model of user behavior with interruptions, an unstable network, and a weak battery.

Testing by community provides easy access to various devices and platforms. A globally distributed team can test software in different places and in different network conditions with different localization and see problems that users may encounter. Crowdtesting can become effective for solving several problems at once because of diversity user's versions of operating systems and the assembly of mobile phones, smartphones and tablets. Rely only on custom testing is not the best way of course. But crowdtesting should be an integral part of full testing of a software product. Load tests, boundary point tests, verification and validation should remain with professional QA with technical knowledge and experience.

Conclusion

Experiment of the attracting users to the development of the application hits to goal of the recommendations to foundations of the Iron Triangle in such parameters as time, resources and quality of the mobile application ultimately. In order, it helps to get into the percentage successfully completed projects. In addition, method allows receiving feedback from potential users in the shortest possible time and improve the quickly iterative software product in a short time.

References

Studies of the efficiency of plain bearings used in microturbines

Исследования эффективности подшипников скольжения, применяемых в микротурбинах.

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Abstract: The article assesses the possibility of using plain bearings (using the example of radial bearings) in high-speed microturbines (up to 60,000 rpm). The results of mathematical modeling of the thermal state of bearings and the oil layer between the shaft and the bearing surface are presented. A detailed description of the stand, designed to analyze the effectiveness of radial and thrust composite plain bearings, is given. The test bench allows testing of radial, thrust and rolling bearings, taking into account the deformation of the shaft from the weight of the turbine and compressor wheels of the microturbine. The results of an experimental study demonstrate high accuracy of calculations.

KEYWORDS: PLAIN BEARING, MICROTURBINE, TEST BENCH, FLUID BEARING, OIL WEDGE

1. Introduction

High-speed (up to 60,000 rpm) microturbines are a perceptive type of engine, providing high specific power, low vibrations, low fuel requirements [1, 2, 3]. However, at the same time, the efficiency (efficiency) of such engines is often lower than that of piston engines. One of the possible ways to increase the efficiency is the use of plain bearings in the design of microturbines [4, 5]. The main advantages of such bearings are vibration resistance, low noise level during operation, compact radial dimensions [6].

2. Mathematical modeling of fluid bearings

Friction losses in sliding bearings depend on the sliding speed and the area of wetted surfaces [7]. With a constant bearing diameter, the only way to reduce the bearing area is to reduce its length. However, it is necessary to take into account the distortion of the shaft under the influence of the load. Therefore, when calculating the bearing, the clearance should provide not only the displacement of the shaft axis to create an oil wedge, but also the minimum thickness of the oil layer even with a strong skew of the shaft.

An important issue is the determination of the required radial clearance in the bearing. The minimum possible clearance between the rotor and the bearing stator (critical oil layer thickness) should not be less than the total height of the microroughness, multiplied by a safety factor of 2 [8].

One of the key parameters is the coefficient pv [9, 10], which determines the indestructibility of the oil film with a lack of lubrication. The calculated bearing must meet these parameters [11, 12].

In the course of work, a variant of a radial plain bearing was considered. Based on the calculations, the skew of the shaft reaches 0.045 mm.

The pressure distribution with a diametral clearance of 0.1 mm is shown in Fig. 2.1 and Fig. 2.2.

![Fig.2.1 - Bearing pressure without skew shaft](image1)

![Fig.2.2 - Bearing pressure with skew shaft](image2)

The ratio of the bearing force created under such conditions to the required one as $K_{pv}$. If $K_{pv}$ is more than 100% - this means that the created lifting force is sufficient for bearingless operation. The calculation results are shown in table 2.1.

<table>
<thead>
<tr>
<th>Shaft position</th>
<th>$\delta$, mm</th>
<th>$e$, mm</th>
<th>$h_{min}$, mm</th>
<th>$N_{fr}$, kW</th>
<th>$K_{pv}$, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without skew</td>
<td>0.05</td>
<td>0.023</td>
<td>0.026</td>
<td>0.76</td>
<td>190</td>
</tr>
<tr>
<td>With skew</td>
<td>0.05</td>
<td>0.021</td>
<td>0.007</td>
<td>0.81</td>
<td>35</td>
</tr>
</tbody>
</table>

, $\delta$ - radial clearance, $e$ - eccentricity, $h_{min}$ - minimum thickness of the oil layer, $N_{fr}$ - friction loss power.

3. Calculation of the thermal state of the bearings

According to the results of mathematical modeling, the maximum power of the generated heat reaches 0.81 kW. In this calculation, we neglect the heat from the bearing to the environment and bearings, assuming that in the steady state all heat is removed by oil.

Oil consumption $Q$ will be equal (1).

\[
Q = \frac{A}{\rho \cdot c \cdot (t_{out} - t_{in})}
\]

, where $A$ - amount of heat; $\rho$ - oil density; $c$ - specific heat of oil; $t_{out}$ - oil temperature at the outlet of the bearing; $t_{in}$ - oil temperature at the inlet to the bearing.

Substituting the characteristics of the oil, and given a temperature difference of not more than 20 degrees, we obtain $Q=21.2$ cm$^3$/s.

4. Test bench for microturbine bearing prototypes.

The test bench was designed and manufactured for bench testing of bearings designed for use in a microturbine. The stand is...
designed to test radial and thrust bearings with a shaft speed of up to 60,000 rpm.

The design of the stand provides the following types of tests of microturbine bearings:
- measurement of temperature indicators of the tested bearings;
- measurement of shaft rotation frequency;
- measurement of the moment of resistance of the tested bearings.

The developed design of the test bench allows you to simulate the loads that arise during the operation of a typical design of a microturbine with cantilevered wheels. The general view of the test bench is shown in Fig. 4.1.

Fig. 4.1 - General view of the stand for testing bearings

The electric motor (1) is a drive device for the shaft (2) passing through the bearing housing (3), which is mounted on the mounting table (4) through the bearing assembly (5). The movable housing design allows measuring the moment of rolling resistance that occurs in composite bearings.

The electric motor allows you to accurately control the shaft speed, as well as measure the relative torque. The electric motor is equipped with a bellows coupling to compensate for misalignment of the bearing housing shaft relative to the motor shaft.

The shaft of the test bench (Fig. 4.2) is made stepped, which allows you to test different models and types of plain bearings on this bench without changing the shaft.

Fig. 4.2 - Shaft of the test bench

On the lower edge of the bearing housing (Figure 4.3) there are five threaded holes designed to drain the oil. Adapters are screwed into each of these holes. They are equipped with temperature sensors used to assess the temperature of the drained oil. The drain line allows you to combine all the exits from the bearing housing, and bring the drained oil back to the oil station. The hoses used in the drain line have low bending resistance, which allows us to neglect the forces arising from the deformation of the hoses to determine the torque in the tested bearings.

An threaded hole is made in the side of the housing for installing the rod, designed to be moved to the load cell (Fig. 4.4). In addition, the bar provides space for the installation of balancing weights. On the other side of the housing, a threaded hole is also provided for installing the rod with balancing weights, which is necessary to minimize the imbalance of the entire assembly.

Fig. 4.3 - The lower edge of the bearing housing

Fig. 4.4 – Load cell installation

The supply line is mounted on a mounting frame, which allows you to transfer the center of rotation of the inlet fitting of the line to the axis of rotation of the housing and thereby minimize the measurement error. The supply line is equipped with three turbine type liquid flow meters, as well as taps that allow you to adjust the oil flow depending on the type of bearing being tested. A protective cover closes the shaft exit from the bearing housing (Fig. 4.5). This casing is necessary as an element of protection in case of failure of the investigated bearings and possible uncontrolled movement of the shaft of the bench with a simulation mass having high kinetic energy.

Fig. 4.5 - Protective cover mounted on a stand

An oil hydraulic station is used as a device for injecting and maintaining the temperature of the lubricant into the tested plain bearings. Technical characteristics of the stand are shown in table 4.1.
5. The results of the experiment.

In the framework of this article, one type of test is considered that corresponds to the conditions of the mathematical modeling. The conditions of the experiment:

- Shaft rotation speed 60,000 rpm;
- Initial oil temperature 24°C;
- Oil consumption: 21.2 cm³/s.

A graph of the temperature of the oil at the outlet of the test bearing relative to is shown in Figure 5.1.

![Graph of oil temperature](image)

**Fig. 5.1 - Graph of oil temperature**

As you can see from the graph, the difference between the calculated and experimentally obtained values is less than 1.5°C, which is less than 5%.

5. Conclusion

In this article, a mathematical model was developed for calculating the distribution of oil and temperature in a liquid radial bearing. The model provides high accuracy of calculations, and also allows you to take into account the speed of rotation of the shaft and its skew.

A bench was also designed for testing the sliding bearings of a microturbine with a shaft rotation speed of not more than 60,000 rpm. The design of the stand allows you to analyze information about the temperature state of plain bearings under various conditions of oil supply. In addition, the design of the stand is made in such a way that it is possible to measure the moment of resistance that occurs in the bearings with minimal errors.

6. Acknowledgments

The paper was prepared under the agreement # 075-11-2018-233 with the Ministry of science and higher education of the Russian Federation (unique project identifier RFMEFI62518X0045).

### Table 4.1 - Technical characteristics of the test rig for testing bearings

<table>
<thead>
<tr>
<th>Characteristic</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Range of measurement of frequency of rotation of the electric motor, min⁻¹</td>
<td>0...60000</td>
</tr>
<tr>
<td>Range of measurement of torque on the shaft of an electric machine, N·m</td>
<td>0...1</td>
</tr>
<tr>
<td>The accuracy of measuring the relative torque on the shaft of the electric machine, %</td>
<td>5</td>
</tr>
<tr>
<td>The accuracy of measuring the speed, %</td>
<td>5</td>
</tr>
<tr>
<td>Class precision load cell</td>
<td>C3</td>
</tr>
<tr>
<td>Weight, kg</td>
<td>243</td>
</tr>
<tr>
<td>Overall dimensions, mm</td>
<td>2334x617x1626</td>
</tr>
</tbody>
</table>

7. References

Building personal virtual private networks in public cloud platforms

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Abstract: Virtual Private Networks (VPN) enable usage of the public Internet infrastructure to build secure and reliable connections providing functionally of private corporate IT networks. Back in 90s VPN were created to mainly allow access to corporate resources for employees who work remotely and/or travel. Today, VPN can be used to gain access to geographically isolated and highly protected Internet resources like websites, interactive platforms and more. Such VPN are good for protecting Internet users’ privacy and enhance their security especially when using public free Wi-Fi networks. Indeed, now VPN are used more and more and gain popularity for exactly those reasons - provide almost universal access and protect privacy of millions Internet users. This paper reviews building blocks and procedure to build our own VPN. This way power users are in full control of their privacy and security when using public Internet infrastructure while also gain access to otherwise restricted online resources.

Keywords: AWS, VPN, PRIVACY, SECURITY, CLOUD COMPUTING

1. Introduction

There are many VPN providers which offer paid VPN service for Windows, macOS, iOS and Android devices. Using freely available resources like AWS Free Tier and Open-VPN private and personal VPN can be deployed, configured and used for even higher level of protection and control for user data and privacy.

2. Deploying Virtual Machine in AWS Free Tier

First step in creating private and personal VPN is to register in Amazon for AWS free tier (1). Registration is straightforward as shown in Figure 1:

![Fig. 1 Registering for AWS Free Tier](image)

Once registration process is completed next steps is to login in Amazon console and deploy Amazon Elastic Computing Cloud (EC2) virtual machine (Figure 2) using proper Amazon Machine Image (AMI) as show in (Figure 3):

![Fig. 2 Selecting Free-Tier EC2 instance](image)

![Fig. 3 Selecting proper public AMI image](image)

3. OpenVPN Access Server Configuration

Once the AMI image is deployed and started it is time to configure OpenVPN Server. This can be done with graphical user interface wizard using associated elastic public IP for the AWS free tier instance visiting https://xxx.xxx.xxx.xxx/admin where xxx.xxx.xxx.xxx is public elastic AWS IP of the server. The process is completed by choosing password and then OpenVPN is started and accessible using same elastic IP as show in Figure 4:

![Fig. 4 OpenVPN Access Server Admin Console](image)

Additional fine tuning can be done using SSH (ssh keypair is created for access in AWS console) by connecting to the elastic public IP over SSH protocol as shown in Figure 5:
One of the most advanced SSH clients is MobaXterm client (3) which is also a free tool. Good SSH clients are also PuTTY (4) and mRemoteNG (5) and any default Linux native ssh client usually part of OpenSSH package (6). On Table 1 is provided comparison between the respective SSH clients.

Table 1: Comparison of commonly used SSH clients

<table>
<thead>
<tr>
<th>N.</th>
<th>SSH Client</th>
<th>Pros</th>
<th>Cons</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>MobaXTerm</td>
<td>Fast and reliable Many handy features Stored sessions</td>
<td>Windows only Closed source Paid for non-academic use</td>
</tr>
<tr>
<td>2</td>
<td>PuTTY</td>
<td>Fast and reliable Small footprint Stored sessions</td>
<td>Windows only Closed source</td>
</tr>
<tr>
<td>3</td>
<td>mRemoteNG</td>
<td>Fast and reliable Open source Stored sessions</td>
<td>Windows only</td>
</tr>
<tr>
<td>4</td>
<td>OpenSSH</td>
<td>Multiplatform Open source</td>
<td>Command Line Interface (CLI) only</td>
</tr>
</tbody>
</table>

Final step is to create new user in the VPN server and test with windows and Android clients. Creating user is done by using OpenVPN server GUI as shown in Figure 6:

Windows OpenVPN client can be downloaded from OpenVPN website (2) and respective mobile clients from Google PlayStore for Android (6) and Apple AppStore for iOS (7). Once those clients are installed and configured to access OpenVPN server instance in AWS cloud (by using public elastic IP) users can start their surfing in protected and secured environment as shown in Figure 7.

3. Conclusion

By using freely available resources from Amazon cloud and OpenVPN community along with applications for major mobile platforms like iOS and Android in conjunction with couple of solid SSH clients provides means of quick, based on author's experience in matter of 1-2 hours, deployment, configuration and ready to use personal VPN server. This is is extremely helpful for access to otherwise protected and locked Internet resources. What is more such VPN help protecting user traffic from surveillance and keeping users privacy and blocking potential hackers hijacking public free Wi-Fi networks.

4. References

Study on the possibilities for the industrial water purification from heavy metal ions

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Abstract: Among the various methods for water purification and treatment from contaminated industrial pollutants, one of the most used is the adsorption methods based on activated carbons. The purpose of our study is to investigate the correlation between the porous texture and chemical nature of the surface and sorption capacity of the activated carbon, obtained based on lignite coal. The object of the study is also to determine its effectiveness as a sorbent for Cd-ions purification of contaminated industrial water. The obtained data from the conducted investigation show that the adsorbent based on such kind of activated carbon has good qualities for water purification from various pollutants and heavy metals.

Keywords: ACTIVATED CARBON, ADSORPTION, PURIFICATION, INDUSTRIAL WATER

1. Introduction

Nowadays the industrial water purification from heavy metals is of the basic importance due to their toxic nature and risk of potential accumulation in the food chain. This requires applying the appropriated methods of reducing the heavy metals ions concentration to the acceptable levels. By using a very promising cost-efficient technology for purifying of industrial water can be applied various adsorption methods based on carbonaceous materials, i.e. activated carbon. The activated carbons (AC) represent one of the most effective approaches to ecosystem remediation [1-7]. The most common material used for AC preparation are different carbonaceous materials like wood, peat, coal, coconut shells, wasted biomass from cellulose industry and etc. The activated carbons are widely used in water filtering system due to its excellent adsorption capacity. They are the best way for remediation of industrial contaminated water. The ability of AC to trap and absorb various contaminations is well known but the scientists look for and develops new methods and materials for this purpose [8-10].

Uses of the AC as a sorbent is determined by its low cost and the best combination of physicochemical properties such as: developed specific surface, porous structure and presence of functional groups on the surface, as well as the high adsorption capacity to different substances. An additional requirement for AC is weak interaction of the hydrophobic carbon surface to the water molecule and good to the organic substances; well developed mesoporosity, providing good access to micro and super micropores; high selectivity and ability to be regenerated. Adsorption properties of the activated carbons can be explained by the transport pores and adsorption pores. However different AC has different surface area and porosity, depending of the kind of source of carbon and the activation process. The main parameters, allowing the specific application are the texture parameters: specific surface area, meso- and micropores volumes, their ratio and micro and mesoporous distribution. AC are defined as microporous materials, but more often as a micro-/mesoporous or as a meso-microporous material. It is established that the high sorption capacity of AC to the metal ions in an aqueous medium is mainly related to the presence of oxygen functional groups on their surface [11]. Activated carbons typically contain chemically bound oxygen, which depends on the method and conditions of the production, and form the basic or acidic surface compounds [12]. The explanation of the AC adsorption capacity to the metal ions is based predominantly to the role of the surface oxygen groups, and can be given by the theory model of Grou-Chapman-Stein-Grahame (G.C.S.G) [13], the theory of ion exchange [14] and the theory of formation of surface complexes [15]. The amount and pore distribution will affect the efficiency and the adsorption capacity of the AC. The purpose of our study is to estimate the influence of the porous texture and chemical surface nature of the activated carbon, based on lignite coal and determine its sorption capacity, its effectiveness as a sorbent of Cd-ions purification of the contaminated industrial water.

2. Experimental

For the purpose of our investigation was used activated carbon, obtained by water vapor pyrolysis of lignite coal [16]. The ash content of the activated carbon was determined by slowly treating the sample in a muffle furnace at 1073 ± 50K and glowing of the ash residue to a constant mass. [17].

pH of the AC was performed using „Hanna instruments – 211“meter, Germany. The carbon isoelectric point was determined by Noch-Schwartz method [18]. The acidic and basic surface oxygen groups was determined by Böhm neutralization method [19].

IR analysis of the AC sample was done using a Bruker IFS 25 FTIR spectrometer in the range 3000 - 4000 cm⁻¹, giving an additional information for the type of surface oxygen groups.

The characterization of the texture parameters and the specific surface area of AC were performed by low- temperature nitrogen adsorption (at 77.4 K) using conventional volumetric apparatus. Specific surface of the samples (Å²) was determined by BET method from the low temperature data of N₂ (77 K) in p/p₀ = 0.05 - 0.35 relative pressure range [20]. Determining of the sample volume: total pore volume (Vₜ₀) in accordance with the Gurvich rule at relative pressure p/p₀ = 0.95 [21]. The volume of mesopores (Vₘₑₐ) was calculated by the formula: Vₘₑₐ = V₁ - W₀, where W₀ (the limit volume of the sorption space, calculated using the simplified Dubinin - Radushkevich equation [22,23,24]. W₀ was determined from the N₂ isotherms in the relative pressure range <0.1. The micropore volume (Vₘₐ) was determined by the t/F method [24]. The volume of super micropores (Vₘₑₐ) was determined by the equation: Vₘₑₐ = W₀ - Vₘₑₐ. The size distribution of micropores was done using (Simplified Equation-SE) [25]. The size distribution of mesopores was carried out by the Pierce method [26].

3. Results and Discussion

Table 1 presents the ash content and results of the elemental analysis (wt.%) of the sample of ACVM.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Ash content (%)</th>
<th>C (%)</th>
<th>H (%)</th>
<th>N (%)</th>
<th>S (%)</th>
<th>O (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>ACVM</td>
<td>10.1</td>
<td>91.8</td>
<td>1.63</td>
<td>0.78</td>
<td>0.66</td>
<td>5.13</td>
</tr>
</tbody>
</table>

Table 1 shows that the ash content of the activated carbon is 10.1 wt.%, similar to the ash content of activated carbon based on such coal type. The elemental composition of the activated carbon is characterized by a high carbon content (91.8 wt.%) and a sulfur content in carbon of 0.66 wt. %, but it does not affect the adsorption process of the studied ions. The values of pH, IEP and the results from the Boehm neutralization method for ACVM activated carbon are presented in table 2.
Table 2. pH, IEP and functional group content according to Boehm neutralization method for ACVM

<table>
<thead>
<tr>
<th>pH</th>
<th>IEP</th>
<th>NaOH</th>
<th>NaCO₃</th>
<th>Na₂CO₃</th>
<th>HCl</th>
</tr>
</thead>
<tbody>
<tr>
<td>7.8</td>
<td>7.5</td>
<td>10.35</td>
<td>0.95</td>
<td>0.90</td>
<td>0.8</td>
</tr>
</tbody>
</table>

From the results obtained for pH, IEP and functional groups content, according to the Boehm neutralization method, their values are close (7.8 and 7.5). According to the results from the Böhm neutralization method, it is obvious also, that the acidic oxygen groups prevail on the carbon surface, which is characteristic for activated carbon, obtained by vapor-gas activation. Based on the Böhm neutralization method and the results obtained for pH and IEP may be assumed that the activated carbon will adsorb metal ions which hydroxides are less basic and their salts are hydrolyzed during the experiment.

The FTIR spectrum of the studied sample is presented on figure 1. It cannot be clearly identified vibrations of acidic oxide surface groups, except in the range 1600-1545 cm⁻¹, which according to [27] is characteristic of the enol form of the dicarbonyl groups.

**Fig.1** FTIR spectra of the sample of ACVM

The adsorption-desorption isotherm of the ACVM sample

The adsorption-desorption isotherm of the studied activated carbon, determined by nitrogen, is shown in figure 2, and its adsorption-texture parameters calculated on its basis are given in table 3. It is evident from the figure that the isotherm of the sample refers to mixed type (I and IV), and has well-defined hysteresis loop of type H3, according to the IUPAC classification this is characteristic for the materials containing flat parallel pores.

**Fig.2** Adsorption-desorption isotherm of the ACVM sample

<table>
<thead>
<tr>
<th>Xₐ (nm)</th>
<th>X₁ (nm)</th>
<th>X₂ (nm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0.36</td>
<td>0.04</td>
<td>0.13</td>
</tr>
</tbody>
</table>

It can be seen from the texture parameter data (table 3), that AC is characterized with not so developed specific surface area (ANET = 388 m².g⁻¹), and slightly developed micropores volume (Vₘₐ = 0.04 ml.g⁻¹), opposing to those of super micropores (Vₘs = 0.13) and well developed mesoporous transport texture, with ratio Vₘₑ/Vₘᵢ = 1.4

Based on the results obtained, it can be concluded that in the microporous texture of the AC super micropores dominate, and the volume of the typical micropores is four times smaller than the super micropores. All this confirm the fact that the sample ACVM is obtained by high degree of activation.

The analysis of the textural parameters of the sample AC based on the lignite coals, shows that it is suitable adsorbent for organic and inorganic substances (contaminants) from aqueous medium.

As a result of meso-microporous texture developing of the sample during the activation process and the obtained favorable Vₘₑ/Vₘᵢ ratio, it can be concluded that the adsorption process is facilitated for the contaminated substances to the sorption centers on the surface and in the porous texture of the AC.

3.1. Study of the adsorption capacity of the obtained ACVM for Cd²⁺ ions contaminated aqueous solution

The adsorption of metal ions from aqueous solution depends on many factors, but the most important are ionic radius, ionic potential, q/r (q ionic charge, r ionic radius), pH, chemical properties, hydrolysis and etc.

Cd²⁺ has relatively larger hydration radius (compared to the radius of Cu, Zn, Pb ions) and hence has significantly greater access to the carbon surface area. His ionic potential is smaller than the potential of the other mentioned heavy metals ions. Therefore, the interaction forces between AC - Cd²⁺ will be relatively weak, which means that Cd²⁺ ions are retained only on the center of hydrocarbon surface, with a higher negative charge.

The effect of pH of the solution on the adsorption value (x, μmol.g⁻¹) to Cd²⁺ is given on fig. 4. At constant temperature, ion concentration, time contact and stirring rate, pH of the adsorption medium has the important influence on the adsorption process. From the presented adsorption isotherm it can be seen a sharp increase of the adsorption of Cd²⁺ ions in region 3.2≤pH≤4.2, which reaches constant values for pH: 5~7.

The sharp rise of pH in the range 3.2~4.2 of X=f (pH) (fig.4) for the Cd²⁺ ions adsorption associated with the surface charge of the activated carbon, which is extremely dependent from the solution pH value. [28]. The IEP value of the AC is 7.8 (table 2). At low value of pH, as a result of protonization of the surface oxygen groups, the electrostatic repulsion forces of Cd²⁺ ions from the positively charged carbon surface occur, so a lower degree of adsorption is observed. The increased pH solution value leads to the amount of the protonized surface functional groups decreasing (respectively the strength of the hydrogen bonds between hydrogen cations and these groups also decreases). As a result Cd²⁺ ions will easily displace H⁺ from the surface oxygen groups and the adsorption of Cd²⁺ will increase.

The results obtained show that the adsorption of Cd²⁺ of the obtained activated carbon depends on the texture parameters (their hydration radius) and adsorption-desorption characteristics. The adsorption of Cd²⁺ is low at low pH values (pH<3) and increases significantly in the pH range from 3.2 - 4.2, reaching constant values at pH>5.
Conclusion

The Cd\textsuperscript{2+} ions are serious environmental problem of waste water and contaminated groundwater. The obtained adsorption-texture parameters of the investigated activated carbon derived from the lignite coal show that it is a suitable adsorbent for organic and inorganic substances (contaminants) from a liquid medium.

The results obtained by studying the adsorption capacity on the obtained ACVM by static method of Cd\textsuperscript{2+} ions from aqueous solution show that the adsorption of these ions depends on both the adsorption-texture parameters and the chemical nature of the carbon (in particular IEP) and as well as from the pH of the solution. The adsorption of Cd\textsuperscript{2+} is low at low pH values (pH<3) and increases significantly in the pH range from 3.2 - 4.2, reaching constant values at pH>5.

However, its practical use for the purification of contaminated industrial water from Cd\textsuperscript{2+} ion needs of an additional investigation on the so-called dynamic carbon adsorption capacity and on the possibility of regeneration of the sorbent.

ACKNOWLEDGMENT

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References

The protective mesh coatings on facade scaffold system – an effective protection and a part of the urban view

Abstract: The variants of the protective scaffold system, their purpose and the regulations to which they must comply are briefly described. An analysis of the different types of trauma is made. The wide application of facade scaffold system with protective mesh coatings is justified. Various options based on modern materials and techniques for large format printing on different materials are considered. Examples of construction sites (new or under reconstruction) with good fit in the urban view are given. Examples from all over the world of facade scaffold system with protective mesh coatings with a "photo" of the hidden object are shown.

Keywords: FACADE SCAFFOLD SYSTEM WITH PROTECTIVE MESH COATINGS, HEALTH AND SAFETY, DESIGN, EXECUTION

1. Увод

Строителното скеле е преместваемо съоръжение с конструкция, отнасяща се към групата на тези с временно предназначение. Основната им задача е, да осигурят фронт във височина за работниците, оборудването и материалите при строителство, монтаж, експлоатация, ремонт и разрушаване (вкл. при строителни процеси като почистване, реставриране, канализиране, реконструкция, и други) на сгради и съоръжения.

Фасадните скелета са временните конструкции, които спадат към групата на работните скелета. С тях се обезпечава изпълнението на строително-монтажните и ремонтно-възстановителните дейности „на ниво по височина“ [1, 26].

2. Предназначение

2.1. Основни функции в строителния процес

Съобразно предназначението им, фасадните скелета съвместяват две основни функции — осигуряване на безопасен достъп до фасадните повърхности по височина на конструкциите и гарантиране на комфортен микроклимат при изпълнение на строителните и монтажните работи. По същество това са строителни площадки развити във вертикална работа равнина на сградите и съоръженията. Респективно при тях са в сила регламентите в Наредба № 2 от 22 март 2004 г. за минималните изисквания за здравословни и безопасни условия на труд при извършване на строителни и монтажни работи, за извършване на СМР [2] и тези в Наредба № 7 от 23.09.1999 г. за минималните изисквания за здравословни и безопасни условия на труд на работните места и при използване на работното оборудване [3].

2.2. Трудове травматизма

Статистиката по отношение на трудовия травматизм налага обезпечение на минимално необходимо ниво на сигурност на строителната площадка, извън която е регистрирано настъпване на редица злополуки, с последици от ниво на леки наранявания до тежки контузии и/или терминален край.

Инцидентите в зоната на дейностите, извършвани по височина са със значителен принос в общата бройка за местостроителството. Това се потвърждава и от проведените изследвания в САЩ, при които е отчетено, че около 43.9% от инцидентите са в резултат на падане от височина, а 25.7% са причинени от удар от предмет в движение [4]. В България ситуацията е даже по-усердена за сектор „Строителство“. Публикуваните данни от проверки на Главна инспекция по труда на строителни площадки през 2016 г., показват аналогична неблагоприятна тенденция. Според данните най-честата причина за тежките трудови злополуки в сектора е падането от височина [5]. Отново в [5] се цитира, че през 2016 година от всички 1290 нарушения, свързани с безопасна работа на височина, 1023 броя са установени на строителни площадки.

Посочената година е от съществено значение за статистиката, защото е в активния период по програмата за енергийна ефективност и саниране на сградния фонд.
предпазва от прах, шум и атмосферни въздействия в различни степени.

3. Урбанистични практики при строителните обекти

В 21 век пространствата, в които се извършва строителство и ремонт изисква планиране на градската среда с интегриране на елементите на строителната площадка. Това включва и нов модернистичен подход при системите скелета, особено в случаите, когато времето за изпълнение на строително монтажните или ремонтните дейности е с голема продължителност, както е при значителни инвестиционни проекти и такива, които касаят реновиране на паметници на културата.

Фасадните скелета са пространства, които претърпяват сериозно развитие в екстериорното им вписване на населените места, защото предоставят много възможности за декориране и брандиране на предлаганите мрежи. Високотехнологичните процедури на принтиране и печат, съчетани с покритията, които гарантират длъготрайност на атмосферни влияния, намалена чувствителност на ультравиолетови лъчи и при необходимост защита от пожарни въздействия съгласно [7], предлагат продължително решение на проблема с обектите, при които замърсени и повредени предпазни мрежи загрозяваха градската пространствена среда – фиг. 2.

Фиг. 2. Стандартни решения с предпазни мрежи на строителни обекти в гр. София с недобър външен вид на строителната площадка

В редица държави лошата визия на покритите скелета е само спомен от миналото. Мрежите и покривалата са превърнати в красива рекламна площ, реализирана с високо качествен печат и дълготрайни мастила, която конкурира графицата на банерите и на билбордове – фиг. 3.

Фиг. 3. Рекламно брандиране върху предпазна платница - Antwerp-Giant-Teniersbuilding 66 и „Мадрид Плаза” [8] и такива с допълнителни триизмерни ефекти на обект в Мюнхен / Rosenstraße и Мадрид 3D Puerta del Sol [9] - фирма blowUP media

3.1. В помощ на историческите градове и културното наследство

Мащабните възможности на съвременния пънноцветен печат с растерна графика, скоростта на принтиране и пространствата, които могат да бъдат покрити, развива предлаганите покрития в реплики на фасади – фиг. 4а.

Фиг. 4а. Проектиране и широкоформатно пънноцветно отпечатване върху PVC мрежа от 320gsm на фирма Imagegroup. Сграда на HSBC Bsink – Sunderland [11]

Съществено предимство е, че фирмите, производители на рекламните материали предлагат монтаж и поддръжка на покривалата и мрежите, за да гарантират доброто ниво на изглаждане на повърхността и геометричната пропорция на изображенията [10]. Това е особено приоритетно в градове, които са представители на световното архитектурно наследство на Европа и по света, защото предоставят вписване в урбанистичната среда на съответния исторически период, при извършването на реставрация на фасадите на паметници на културата.

Пример за постиженията в съвременните методи за комфорт при строителството по височина – фиг.4б, 4в и 4г.

Фиг. 4б. Проектиране и широкоформатно пънноцветно отпечатване върху PVC мрежа от 320gsm на фирма Imagegroup. Сграда на HSBC Bsink – Sunderland [11]

Фиг. 4в. Музеят Магрит в Брюксел - покритието е с размери 21 на 75 метра широчина [12]; Реплика на фасадата на Старата Опера във Франкфурт по време на ремонта й [9].

Фиг. 4г. Реплика на фасадата по време на реставрация и ремонтни дейности по конструкцията на храма Rintoji в гр. Никко, Япония – 2015 г.

3.2. „Пространствени художествени инсталации“

Широкоформатните визуализации достигат много добро ниво на естетика и пространствен реализъм при значителна скорост на принтирането в големи по обем проекти. Това позволява някои обекти да се покрият изцяло, което ги прави практически „опаковани” с изображения на всичките си
фасади. Да „облечеш“ сграда в пространството и да композиращ формата и обем вече е нормално проектно решение в съвременитите практики за безопасност и здраве в строителството – фиг. 5.


Това предимство е от голямо значение при сгради, които са станали обект на опожаряване или в следствие на сейсмични въздействия са получили множество частични разрушения по всичките фасадни площи и при реконструкция на паметници, емблеми на градове и държави.

3.3. Фасада-реплика-фасада
Съвремените проекти успешно се справят с предизвикателствата като частичното заскеляване. Това гарантира, че сгради в експлоатация ще останат атрактивни за посещения и в същност вкл. и за реконструкция на паметници, емблеми на градове и държави.


3.4. „Обемни“ фасади и допълнителни ефекти в градския екстериор
Допълнителни предимства на дигиталните фасадни покрития са възможности за имитиране на черупкови повърхнини, орнаменти, детайлиране (фиг. 7) и въвеждане на осветление, с което да се коригира възприемането на изображението в съответствие със светлата или тъмната част от денонощието – фиг. 8.

Фиг. 7. Катедралата „Сейнт Пол“, което е покрита, за да се скрие скелета при реставрационни работи през лятото на 2006 г. - [17]. Реставрация на покрива част – Китай - [18]

Разбира се, има и спазване на добри практики при пълноцветното отпечатване и при местомонтажа на получените елементи на покритието. Такъв добър пример е на частичното фасадно затваряне на строителните скелета при извършване на довършителния работи на сграда при Южния парк в гр. София – фиг. 10.

Фиг. 8. Сградата Millbank в Уестминстер – върху PVC платната е инсталирано осветление на определени нива, за да се постигне реализъм на възприемането на експлоация на сградата през светлата и тъмната части на денъното [19]

4. Добри и не до там добри практически решения в България
У нас все още не съществуват традиции в проектирането и изпълнението, които да обезпечават чистотата на строителството в средата на градския екстериор. Положително развитие има при единични обекти, чито собственици подлежат на контрол от общинската администрация, такива с национално значение и тези, собственост на държавни институции.

Фиг. 9. Принтирани предпазни покривала при реставриране, финансирано от „Метрополис груп“ [21] и проекта на БЛЕК ПЪРЛ ЕООД [22]

Фиг. 10. Принтирани фасади: върху мрежа при изграждането на гаров хотел Пловдив и върху винил при строителството на жилищна сграда в гр. София, 2019 г.
5. Заключение и препоръки

През 1968 година Христо Явашев и Жан Клод (Christo and Jeanne-Claude) опаковат сградата на галерията в Берн, като илюстрират формата на изкуство, при което строителните инженери стават част от творческия процес. Около 45 години по-късно идеята за „обличането“ на сгради и съоръжения по време на изпълнението, ремонта или реставрацията се превръща в модел на проектантски решения, които преобразяват строителните площадки във височина в естетична компонента на урбанистичната среда в градовете.

Въвеждането на практиките за по-зелено, по-чisto, визуално по-приемливо изпълнение на строителното при високи нива безопасност и комфорт на работещите в частта си фасадни скелета, минава през осъвременяване на защитните покрития на временните съоръжения за строителство.

Добър идея е, да се търси приложимост за временно визуализиране при ремонт и рехабилитацията на съоръжения като камиони, мостове, порти на тунели и други специализирани съоръжения, особено при такива от историческо значение.

Това от своя страна, отправя заявка към проектантите, които ще изчисляват скелетата за допълнителните и/или по-високи стойности на въздействията от собствено тегло и вътрешно на вятъра при затваряне им с материали, които позволяват печат на сложни изображения. Пример от практиката за възникване на такава необходимост е представена в [27]. Тази препоръка трябва да стане задължителна предпоставка на проектирането, защото по-същност скелета са временни ретежни конструктивни системи, при които се наблюдават форми на разрушение от загуба на устойчивост в зависимост от ветровото налягане, в зависимост от вида решетъчност на покритието (пропускливостта на мрежата).

Теоретичната постановка, която третира изчисляването на покрити скелета в следствие на ветрово въздействие, е записана в БДС EN 12811-1 [1] и БДС EN 12810. В [1] проектният параметър, който отчита въздействието на резултатната сила на натоварването от вятър за „равномерната площ на покритието“, е аеродинамичният коефициент за сила на покритие „\( c_{w,i} \)“. В приложение „A“ на [1] влиянието на типа покритие при покривала (плътни коефициент за сила за покритие „сравнителната площ на покритието“, е аеродинамичният коефициент и процент на пропускливост. Това е предпоставка за редица затруднения при спазването на препоръките в [1] по отношение проектирането на скелета клас В.

Решение на проблема с липсата на бази с данни у нас, може да се търси, ако научните изследвания в областта се фокусират върху влиянието на пропускливостта на предизвиканите покрития като елемент за оценка на завишено ветрово натоварване при покрити фасадни скелета. По този начин може да се определят стойности на коефициентите, необходими за основни поставяне в изчислителните ситуации за съответните гранични условия.

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Optimization of the parameters of the energy absorbing element of the armored combat vehicle's seat in the conditions of explosive loading

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Abstract: The principle of operation of the energy absorbing element, which consists in the conversion of kinetic energy acquired as a result of explosion, into the energy of plastic deformation of a material is considered. To evaluate and select an element, a typical algorithm for optimizing it is developed. This allows using qualitative criteria with the known value of the explosive load to choose the rational parameters of the design and material of the element that will be optimal for a particular armored combat vehicle.

Keywords: EXPLOSIVE LOADING, ENERGY ABSORBING ELEMENT, SEAT, ARMORED COMBAT VEHICLE

1. Introduction

Currently, researches in the field of a hull strength of armored combat vehicles (ACV) have made significant progress. Technical solutions, such as the V-shaped and energy-absorbent bottom structure, the power frame of the armored hull, the antimine screen, etc., allow to ensure the integrity of the ACV's hull in the event of an explosion. Then, the so-called "throwing effect", caused by the high acceleration of the ACV, which can reach up to 600g in the seat, remains the main impact factor on the crew. This load can be countered with the help of the energy-absorbing seats of crew (EAS) (Fig. 1) [1-3].

![Fig. 1 EAS of ACV: a) 1 - a geometric model of the EAS, 2 - place of installation of the EAE, 3 - the seat attachment; b) installation of the EAE.](image1)

The objective function of the EAS at blasting of the ACV is to reduce the acceleration to the allowable values of the human injury criteria [4]. The main role here isn’t the design of the EAS, but the installation of the energy-absorbing elements (EAE) into the places of the seat attachment that will absorb the energy of the explosion and will transform it into the work of plastic deformation of the material [1].

2. Physical, numerical and theoretical researches

As the EPE is selected crashboxes, which absorb a large part of the impact energy in a stepwise change in the size of its diameter. To determine the optimal parameters of EPE, the blast loading value should be used for a specific sample ACV. For this purpose, a numerical experiment was conducted in the LS-Dyna software complex, based on the finite element method, which was verified by a full-scale experiment (Fig. 2, Fig. 3) [5].

![Fig. 2. Full-scale experiment (right) and numerical simulation (left) of the explosion of the ACV by the explosive charge 6 kg TNT (according to STANAG 4569).](image2)

The error between the maximum values of the accelerations obtained during the physical and numerical experiments is 8.5%. This confirms the adequacy of the model for determining the explosive load on the EAS of the ACV for further investigation of the ways of adaptation of the EAE for specific loading conditions.

Progressive deformation of EAE can have different character: axisymmetric; non-asymmetric; mixed and global bending [6-9]. Obviously, much more energy is absorbed in the axisymmetric deformation mode than in the global bending mode, because in such conditions more material is subjected to plastic deformation [8]. The step of the plastic deformation zone also depends on the geometry of the profile (Fig. 3).

![Fig. 3 Modes of deformation and plastic deformation zones of different EAE profiles: a - octagonal; b - cylindrical; c - rectangular; d - ellipse.](image3)

Optimization of EAE is carried out by a number of qualitative criteria: energy intensity; average and peak load of operation;
specific absorbed energy; absorbed energy per unit length; effective triggering force and optimal working stroke [6,10-13].

The main criterion for evaluating the efficiency of EAE is the amount of energy absorbed $E_A$:

$$E_A(\delta) = \frac{1}{\rho} P_0(\delta)d\delta,$$

where, $P_0$ is the initial destructive load, $\delta$ is the course of EAE (length of plastic deformed part), and $\delta_{\text{max}}$ is the maximal working stroke of EAE (the initial length of EAE).

The EAE must have the optimum triggering force, since the high force will lead to the failure to activate or not to use the entire working stroke of the EAE (Fig. 4a), and at low force there will be a breakdown of the EAE (actuation of the entire working body of the EAE) (Fig. 4d).

The EAE can be defined as the load to which it is necessary to initiate the onset of its deformation, because the ideal condition for absorption is to achieve the force of the actuation and keep it constant throughout the entire working stroke. So, the amount of energy absorbed during blasting is proportional to the force of the actuation of the EAE $P_0$ and its working stroke $\delta_{\text{max}}$ (Fig. 4, shaded sections).

The average load for the axisymmetric deformation $P_{av}$ is defined as the ratio of the total absorbed energy $E_A$ to the total deformation, $d$:

$$P_{av} = \frac{E_A}{d},$$

In this case, $P_0$ and $P_{av}$ are the priority parameters for evaluating the effectiveness of the EAE. Therefore, in order to prevent injury to crew in the event of a blowout of the ACV, the value should not exceed the limit values of the injury criteria 14.5g, which corresponds to the permissible value of the injury criterion DRI≤17.7 (Dynamic Response Index) [4].

The effectiveness of the triggering force is a qualitative criterion for the uniformity of deformation and is determined by the ratio of peak load $P_0$ to average $P_{av}$:

$$\eta_{ff} = \frac{P_0}{P_{av}},$$

For the ideal energy absorption, the optimum triggering force should result in almost 100% activation of the EAE stroke.

Equally important characteristic of EAE is the specific absorbed energy $E_{SA}$, which is determined by the ratio of absorbed energy $E_A$ per unit mass.

$$E_{SA} = \frac{E_A}{m},$$

The value $E_{SA}$ is the most common parameter for evaluating the efficiency of an EAE in terms of its energy intensity, especially when overall dimensions are important.

In addition, this parameter is usually used as an indicator of the efficiency of the selected material for the EAE, depending on its density, and the mass [8,9].

During the deformation process, not all of the EAE stroke can be used to absorb the kinetic impact energy. The efficiency of EPE stroke is defined as:

$$\eta_{ws} = \frac{\delta}{L},$$

where $L$ is the initial length of the EAE.

With $\eta_{ws}$, we can determine the maximum allowable working stroke of EAE. Ideally, the initial length of the EAE $L$ should be equal to the working stroke of the EAE $\delta$, but in practice, the stroke efficiency is always less than one $\eta_{ws} < 1$.

Considering the above, the algorithm of optimization and estimation of EAE is constructed [13]. Using the developed algorithm, on the example of a numerical model of the blasting of the ACV, the choice of rational parameters of the EAS was made (Fig. 5).

Fig. 4 Typical cases of EAE working with different characteristics: a - high $P_0$, the element doesn't work; b - quite high $P_0$, not all stroke is used; c - optimal $P_0$, sufficiently used working stroke; d - low $P_0$, the breakdown of EAE.

Fig. 5 The acceleration values for seats in the standard version (a) and in the EAS with the EAE (b). The results of the comparison of the upgraded EAS with the regular seat showed that the use of the first one can reduce the load on the crew from 62g to 12g, i.e., into five times, which minimizes the probability of injury.

3. Conclusion

The built optimization algorithm of EAE is typical because it can be used in the development and research of different MRAP vehicle and can significantly assist in the evaluation and comparison of different EAE variants. Its application makes it possible to compare and evaluate EAE of EAS of ACV in the design phase, identify weaknesses, make appropriate design decisions, and thus ensure their effective.
4. Literature


Size and speed of data generated by Fleet Management Software

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Abstract: The paper looks at the relation between the number of transport domains (cars, trucks, buses, ship, etc.) and the size of data, generated in fleet management software. Nowadays, such software is stored and run on a cloud and users do not need to care about the size limitation, just for the price. If using a solution on premises, the cost includes creating and supporting infrastructure and licences. Software developers should care for the scalability of the application time and also managing bottlenecks, that are likely to appear in data flow due to the size of the management program.

Keywords: CLOUD, ON PREMISES, FLEET MANAGEMENT, AUTOMOTIVE, SAE J1939

1. Introduction

In present life, goods are manufactured all over the globe and are transported to customers in their respective countries. Internet trade increases the demand for fast and reliable end-to-end transportation of goods. Within a company, the task of efficiently managing the utilization of different transportation means is delegated to a fleet management system (FMS). This is software, used in enterprises, responsible for acquiring, maintaining, planning and generating profit, related to transportation company activities. Such software is part of company’s tools, used to maximize profit and reduce cost. FMS tool tracks all available transportation means and classifies them depending on type and usage. It assigns to the elements of the fleet various parameters depending from business needs. Planning maintenance with cost and time, predicting supplies and spare parts are part of the requirements to the system.

2. Structure of Software for Fleet Management

Fleet management software might consist of several logical parts - Figure 1. These are telematic system, service provider, and central authority system (order & fleet management).

The telematic system is the part, responsible for collecting data. It is placed on the vehicle and is unique for each item in the fleet. Its main requirements are to inform driver for changes in the environment and to transmit data to the information storage.

The service provider is responsible to feed fleet management system with information that is needed to work properly but is not part of telematic system. Data provided by this system might be relatively static as geo data or dynamic as weather conditions or traffic conditions.

The order & fleet management is the “brain” of the system. Data received from telematic system and service provider is stored and processed in this unit of FMS. This is the unit, where transportation requests are made, reports for different needs are generated and visualized. Users interact with FMS trough this part of the package to post requests related to management of transportation means. Based on algorithms, defined in this logical unit, dispatchers can generate messages and interact with drives trough telematic system. Order & fleet management system is typically interacting with other systems in the enterprise like ERP, cost and performance analysis, planning systems, etc. [1].

3. Strategy for software hosting

Every enterprise has its own strategy and dedicated teams to manage software infrastructure, with common goals - reduce cost and increase efficiency. When integrating a new package in the corporate software environment a decision must be whether this software will run on premises, or be hosted on a cloud. In the past, each organization has its own hardware infrastructure and dedicated teams to manage their software products and such solutions are called on premises. Nowadays there are data centers, where an organization can outsource the software management - clouds. There are some features for both approaches that must be considered, when a strategy for a new software is drawn. The key difference between the two approaches is who is responsible for what and who is responsible for the risks. Cloud-based solutions require the organizations to pay a subscription fee to the provider, in order to use the software. The software is usually accessed online through a server owned by the software provider.

Under cloud solutions, the software vendor is responsible for the server infrastructure data integrity, updates, backups, and security measures. Still company must have wideband and reliable internet connection trough data canter of the software provider. Organization relies on service level agreements (SLA) and ability of software provider to manage a possible crisis, related to system malfunctioning. Updates of software are regularly received, liked or not. It is not possible to have dedicated features and customizations, common to all users of a package.

On-premise software requires the organization to pay the cost of the software, upfront. In exchange, they receive a product with full licensing, capable of being used on the company’s server. Organizations are thus required to manage and maintain their physical computer servers internally, primarily when backups and upgrades are being performed. As data is stored in house all concerns about management and security are internal for the organization. It is possible software owner to provide custom feature or allow organization to build them self as organization has a higher degree of control when implementing the system [2].
During operation time of the package, there is certain cost for transferring data from telematic system to order management past of the system. The amount of this data depends of how much information system is logging form one unit, how often this information is collected and how many unites are managed by the fleet management system.

4. Data Generated by Transportation Means

Data from the vehicle reaches the data storage system, after passing through several levels. First is the physical - transformed into electrical signal. Physical data values are temperature, speed, humidity, fluid level, pressure, etc. At the second stage - the electrical signal is digitally coded, so that can be processed further. Then data must be transmitted from the mobile unit to the stationary ground network. From there it is the network, that transfers data to the storage and also for processing by the fleet management system.

There is various of environmental parameters that must be monitored to assure smooth and effective work of a vehicle. Some are related to engine itself, that allows them to operate and to monitor if it is in working conditions. Others are monitoring for hazardous situation and provide feedback to manage such situations. Such data is handled and managed by the systems of the vehicle. In respect to fleet management, this information is not so valuable unless it leads to conditions, where the vehicle is not operating normally. Other types of environmental parameters that do not have direct impact of transportation means but are valuable for the fleet management system are the position of the vehicles, its speed, and its destination. On top of them, the fleet management system must be interested by the driver who is operating the unit, the cargo’s conditions if applicable for the unit, energy stored in the vehicle (level of gas tank or battery charge) and currently consumed energy. In modern system all this data is collected and proceed by Electronic Control Unit ECU. To reduce cost and make some components interchangeable, as well to ease the maintenance of the transportation means, manufacturers follow data exchange standards. Data between sensors and ECU could be analog signal or digital. The most popular standard is Controller Area Network (CAN bus) [3]. This is a robust vehicle bus standard designed to allow microcontrollers and devices to communicate with each other’s applications without a host computer. It is a message-based protocol, designed originally for multiplex electrical wiring within automobiles to save on copper, but can also be used in many other contexts. For each device, the data in a frame is transmitted sequentially but in such a way that if more than one device transmits at the same time the highest priority device can continue while the others back off. Frames are received by all devices, including by the transmitting device. As the CAN standard does not include tasks of application layer protocols, such as flow control, device addressing, and transportation of data blocks larger than one message, and above all, application data, many implementations of higher layer protocols were created. Several are standardized for a business area, although all can be extended by each manufacturer. Among these implementations are SAE J1939 in-vehicle network for buses and trucks and SAE J2284 respectively for passenger cars [4].

SAE J1939 is a high-level communications protocol, which operates on a CAN bus. SAE J1939 specifies exactly how information (e.g. engine RPM) is exchanged between electronic control units (ECUs) on a vehicle. Information is exchanged in data frames consists of header or datalink, actual data or message and several control bits. Datalink is encoded into the 29-bit CAN identifier and contains bites for: Priority, Extended Data Page, Data Page, Protocol Format, Protocol Specific, and Source Address - Figure 2.

Figure 2. Data frame in SAE J1939.

A message is in one or more CAN data frame and contains information exchanged between devices on the datalink. J1939 has three different allowed message sizes, they are: 3 bytes, 8 bytes, and variable length. Most messages in J1939 are 8 bytes in length. This allows for a more efficient use of the network bandwidth by maximizing the amount of data on the network by reducing the number of messages. Variable length messages are messages with a length from 9 to 1,785 bytes. These messages are too large to fit in a single CAN data frame and must be fragmented by the transmitter and reassembled by the receiver. This process is defined by J1939’s transport protocol which is specified by J1939-21. The size of one data frame all together is estimated at 16 bytes.

5. Data Exchanged Between Mobile Unit and Stationary Systems

Following registration of environmental parameters and conversion into electrical signals is to send the information form vehicle to stationary network and fleet management system. Nowadays under stationary network is understandable Internet, assuming FMS is connected to internet. Data exchange could be done online or offline. Offline is when data is stored in memory of the unit and then uploaded to internet on occasionally on time basis. Examples when vehicle is stationary at depot connected to local network via Bluetooth, Wi-Fi, etc. or information is transferred from device memory card. Online transmission is continuous process of transferring information for status of the unit. Most widely used mediums is cellular or satellite network. In addition, other means of exchange data dedicated to transportation exists such as TETRA (TErrestrial Trunked Radio) a European standard for modern digital trunked radio. For civil systems in Europe the frequency bands 385-390 MHz, 395-399.9 MHz, 410-430 MHz, 450-470 MHz, 780-960 MHz, and 915-921 MHz, have been allocated for TETRA by ERC Decision (96)043. Data transfer with TETRA is at 7.2 kbps. Dedicated Short Range Communication Dedicated Short Range Communications (DSRC) is a short to medium range wireless communication technique specifically designed for automotive use, i.e. vehicle-to-vehicle and vehicle-to-infrastructure communication. Due to the short range of the signals, DSRC is useful to provide location-based services. Today, the main application of DSRC is Electronic Toll Collection (ETC). DSRC systems use infrared or the radio spectrum, particularly microwaves in the frequency bands 5.795-5.805 GHz and 5.805-5.815 GHz [5].

6. Use Case, Results and Discussion

To do some calculation, we assume that an organization manages a fleet of 50 units (the number is chosen to be relatively small compare to fleet of rental vehicles and could be used as base for future calculation in relation to number of unites) and is concerned to have information for each unit at real time and reasonable price. To reduce the data exchanged between telematic system and central authority system of FMS, some data will be transmitted less frequently from the other and some conditions will be present to send data or not. For FMS resolution of 1 sec is considered as acceptable for time critical events. Resolution of 10 secs will be used for dynamic events and 60 sec for non-critical parameters.
According to data in Table 1, there are \(3 \times 60 + 5 \times 10 + 3 = 266\) messages per minute or 3.88 per second. As it is stated earlier, one message contains more than one value of interest.

Next, let’s make some computation on the resources in the cloud. Basic FMS must monitor for errors and potentially hazardous situations as much as close to real time. Assuming every 10 secs and those checks will take no longer than 100ms. This is part of automation of the system that monitors each unit in real time and reports/take actions according programming logic.

On the other hand, we have users interacting with the program giving new orders new destinations, generating reports working with collected data. Those are relatively big request compare to the one that are monitoring units. Users will do large request lasting 10 secs every 10 minutes, as there will be 10 users connected during working hours. These are average assumptions. On a monthly basis 269760 request with average length of 961ms and 2GB of memory:

- RoundUp (900) = 900 Duration rounded to nearest 100 ms
- 269,760 requests x 900 ms x 0.001 ms to sec conversion factor = 242,784.00 total compute (seconds)
- 2 GB x 242,784.00 seconds = 485,568.00 total compute (GB-s)
- 485,568.00 GB-s - 400000 free tier GB-s = 85,568.00 GB-s
- Max (85568.00 GB-s, 0) = 85,568.00 total billable GB-s
- 85,568.00 GB-s x 0.0000166667 USD = 1.43 USD (monthly compute charges)
- 269,760 requests - 100000 free tier requests = -730,240 monthly billable requests
- Max (-730240 monthly billable requests, 0 ) = 0.00 total monthly billable requests
- Lambda costs - With Free Tier (monthly): 1.43 USD
- Time for which Provisioned Concurrency is enabled: 8 hours = 28800 seconds

Pricing calculations:

- 10 concurrency x 28,800 seconds x 2 GB x 0.000050147 USD = 2.89 USD (Provisioned Concurrency charges)
- RoundUp (10000) = 10000 Duration rounded to nearest 100ms
- 10,000 requests x 10,000 ms x 0.001 ms to sec conversion factor = 100,000.00 total compute (seconds)
- 2 GB x 100,000.00 seconds = 200,000.00 total compute (GB-s)
- 200,000.00 GB-s x 0.0000117011 USD = 2.34 USD (monthly compute charges)
- 10,000 requests x 0.000002 USD = 0.00 USD (monthly request charges)
- 2.89 USD + 2.34 USD + 0.00 USD = 5.23 USD
- Lambda costs for Provisioned Concurrency (monthly): 5.23 USD

Estimated cost of data storage and manipulation on the cloud is shown in Figure 3.
7. Conclusions

It must be found a balance between requirement to have data in real time and the quantity of data transferred between telematic system and stationary part of FMS. Data generated by vehicle is continuous (analogue). For the size of the data transferred between mobile units and stationary system is important to select the frequency of reported data based on priority and based on events that are detected on the unit itself. Calculation for the size of data done for one vehicle are proportionally to number of unites present in the system from one type. In case of variety of unit types, they must be classified and calculation to be done depending of vehicle class. As the size of the data increases with number of units this could be a key factor to go on cloud or stay on premises.

Larger enterprises can invest significant capital in on-premise FMS solutions, but smaller – can’t. For medium and small businesses have limitations on their budget, so cloud FMS software alternatives are the only answer. They simply save time and money.

Whichever the case, every successful business requires a healthy and dynamic data ecosystem. Having a reliable and scalable infrastructure in place which can support end-to-end visibility of data flows, fast and secure file transfers, data transformation, and storage is integral to success.

8. References

Estimation of modal split parameters – a case study

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Abstract: Choosing a mode or type of transportation is certainly one of the most important steps in a classic transportation model, given that it has a significant impact on the traffic planning and transport policy of a city. The choice of transport mode (e.g. passenger car, public transport, bicycle, walking) depends on the availability of transport modes and the generalized cost of transportation by transport mode from origin to destination. The choice of mode of transportation is also significantly influenced by the trip purpose. The most commonly used model for determining the modal split is the logit model. Parameters of utility function for each mode were estimated based on a household travel survey in Slavonski Brod, Croatia using the Biogeme program. The generalized cost and impedance towards using each transport mode is expressed by the utility function. This paper presents a methodology for determining the utility function for each transport mode using the Biogeme program.

KEYWORDS: MODE CHOICE, LOGIT MODEL, UTILITY FUNCTION, BIOGEME

1. Introduction

The modal choice of transport is the third step in a four-step modeling process and is one of the most important steps. It has a significant impact on the traffic planning and traffic policy of the city. The transport mode choice (e.g. car, public transport, bicycle, walking) depends on the availability of transport modes (especially passenger car) and the travel cost for each mode from origin to destination. Factors influencing the mode choice can be divided into three groups of characteristics (1) passenger characteristics (car ownership; possession of a driver’s license; household structure (youth, couple with children, pensioners, singles, etc.); income; (2) characteristics of travel: trip purpose - trip to work is usually more difficult to do by public transport due to its regularity, part of the day when traveling - eg night travel is more difficult to achieve by public transport, whether traveling alone or with other passengers (3) features of the transport system: travel time components: in-vehicle time, waiting time and walking time to each transport mode, monetary cost components (transport ticket, tolls, fuel costs and other operating costs), availability and parking costs, reliability of travel time and regularity of service; comfort and convenience; driving safety and protection while driving; driving skills requirements; opportunities to carry out other activities while driving (telephoning, reading, etc.) [1].

The basic problem of discrete mode choice analysis is the modeling of choices between a set of different alternatives. Utility maximization is taken as the solution. The decision maker selects the alternatives with the greatest utility over the time period. The operational model consists of a parameterized utility function consisting of independent variables and unknown parameters estimated from the sample. The probability of selecting an alternative is defined as the probability that has the greatest utility among all possible alternative solutions [2].

The choice of alternative can be observed because of a multi-stage decision-making process:

1. definition of the choice problem,
2. generation of alternatives,
3. evaluation of attributes of the alternatives,
4. choice of alternative,
5. implementation.

Choice theory is a set of procedures consisting of the following elements: (i) decision maker, (ii) alternatives, (iii) attributes of alternatives, (iv) decision rule. Not every choice behavior of individuals is described by such a decision-making process. An individual may choose a mode of transportation according to a habit, intuition, or imitation of someone else who is considered as an expert or leader. This behavior is presented as a decision-making process in which the decision maker generates only one alternative.

The modal distribution is determined using discrete choice models, ie Logit models. The most widely used discrete choice models are multinomial (MNL) and nested (NL) logit model. Multinomial logit models imply a larger set of alternatives in the final data set (eg alternatives can be car - driver, carpooling, taxi, bicycle, walking, bus, tram, train), while nested models consist of a group of similar alternatives grouped in a nest, in which each alternative belongs to only one nest. A multinomial logit model was used in this study:

\[ P_n(i) = \frac{e^{\mu V_{in}}}{\sum_{j \in C_n} e^{\mu V_{jn}}} \]

\( P_n(i) \) = probability of choosing an alternative \( i \),
\( \mu \) = calibration parameter,
\( V_{in} \) = utility of mode \( i \).

The aim of this paper is to estimate the parameters of the utility function for each mode of transport using the Biogeme program based on a household survey. Generalized cost and resistance to a mode of transport are expressed using the utility function. This paper presents a methodology for determining the utility function for each mode of transport using the Biogeme program.

2. Modal split in Croatia by National Transport Model

The National Transport Model for the Republic of Croatia was completed in June 2016, and the model represents the second phase of the development of the Transport Development Strategy of the Republic of Croatia 2017 – 2030 [3]. The reference year for the analysis of the current state of the transport sector in the National Transport Model is 2013, since it is the only year for which all data were available. As part of the research for the needs of developing the National Transport Model in the Republic of Croatia, a travel behavior survey was conducted.

Figure 1. presents the proportion of all trips taken by different modes of transport. The most used transport mode was car with about 51% of all trips (40.8% as a driver and 10.4% as a passenger). Walking was the second most used travelling mode with the proportion of 30% of all trips. The bus was the most often used public transport mode with a share of 7.1%, while overall around 12% of all trips were made by public transport (bus, tram, train, and ferry). About 5% of all trips were made by bicycle [3].
According to National Transport Model Croatia is divided into two NUTS regions: Continental Croatia and Adriatic Croatia. Figure 2 shows a map of NUTS-2 regions in Croatia.

Other results indicate that about 5% of all trips were made by bicycle. Compared to Continental Croatia, citizens from Adriatic Croatia made almost 40% more car trips, 60% more walking trips, 32% fewer public transport trips, and 65% fewer bicycle trips.

3. Case study – Slavonski Brod, Croatia

The household survey was conducted as part of the development of the Sustainable Urban Mobility Plan of the Urban Area of the city of Slavonski Brod (Croatia). Slavonski Brod is in Brod-Posavina County, which is part of Continental Croatia according to the NUTS-2 division. The survey was conducted on a random sample of households, by direct interview, on representative days, in October and November 2019. A total of 5% of the total number of households in the study area were surveyed. The survey was conducted in the household where trained interviewers asked questions related to general household data and data on all trips of each household member that occurred the previous day (origin and destination of trips, travel time, trip purpose, mode choice). A total of 752 household surveys were collected in 36 residential zones.

The parameters of the utility function for each transport mode were determined by the PandasBiogeme program code. Four types of transport modes were considered: car, bicycle, walking and public transport. The package Biogeme [5] is designed to estimate the parameters of various models using maximum likelihood estimation (MLE). It is particularly designed for discrete choice models. Biogeme is available in three versions.

- BisonBiogeme is designed to estimate the parameters of a list of predetermined discrete choice models such as logit, binary probit, nested logit, cross-nested logit, multivariate extreme value models, discrete and continuous mixtures of multivariate extreme value models, models with nonlinear utility functions, models designed for panel data, and heteroscedastic models. It is based on a formal and simple language for model specification.
- PythonBiogeme is designed for general purpose parametric models. The specification of the model and of the likelihood function is based on an extension of the Python programming language. A series of discrete choice models are precoded for an easy use. The package is written in C++ and is standalone.
- PandasBiogeme is a Python package, that must be imported in a Python code. It relies on the Pandas package for the data manipulation. This is the standard mode of operations of more and more data scientists. The syntax for model specification is almost the same as PythonBiogeme.

The data table from household survey must contain information about trips, travel time for each transport mode and the respondents choice of the transport mode. Each column corresponds to a specific variable, and the row corresponds to a value.

<table>
<thead>
<tr>
<th>Trip_ID</th>
<th>TT_CAR</th>
<th>TT_BIKE</th>
<th>TT_PUT</th>
<th>TT_PED</th>
<th>CHOICE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>11</td>
<td>24</td>
<td>68</td>
<td>106</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>8</td>
<td>16</td>
<td>40</td>
<td>61</td>
<td>1</td>
</tr>
<tr>
<td>3</td>
<td>8</td>
<td>4</td>
<td>29</td>
<td>61</td>
<td>1</td>
</tr>
<tr>
<td>4</td>
<td>8</td>
<td>16</td>
<td>28</td>
<td>58</td>
<td>3</td>
</tr>
<tr>
<td>5</td>
<td>8</td>
<td>16</td>
<td>20</td>
<td>59</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>3</td>
<td>94</td>
<td>19</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>7</td>
<td>3</td>
<td>18</td>
<td>20</td>
<td>2</td>
<td>4</td>
</tr>
<tr>
<td>8</td>
<td>7</td>
<td>82</td>
<td>31</td>
<td>69</td>
<td>1</td>
</tr>
<tr>
<td>9</td>
<td>7</td>
<td>17</td>
<td>37</td>
<td>68</td>
<td>1</td>
</tr>
<tr>
<td>10</td>
<td>6</td>
<td>14</td>
<td>32</td>
<td>55</td>
<td>1</td>
</tr>
</tbody>
</table>
The variables defined in the program code were:
- Trip_ID = trip ID,
- TT_CAR = travel time by car [min],
- TT_BIKE = travel time by bicycle [min],
- TT_PUT = travel time by public transport - bus [min],
- TT_PED = travel time by walking [min],
- CHOICE = choice of transport mode.

The parameters that need to be evaluated to define the logit function are:
- ASC_CAR (alternative specific constant_car),
- ASC_BIKE (alternative specific constant_bike),
- ASC_PUT (alternative specific constant_put),
- ASC_PED (alternative specific constant_ped).

The utility function is defined for each transport mode where the travel time of each transport means is considered:
- \( V_1 = \text{ASC\_CAR} + B\_\text{TIME} * \text{TT\_CAR\_SCALED} \),
- \( V_2 = \text{ASC\_BIKE} + B\_\text{TIME} * \text{TT\_BIKE\_SCALED} \),
- \( V_3 = \text{ASC\_PUT} + B\_\text{TIME} * \text{TT\_PUT\_SCALED} \),
- \( V_4 = \text{ASC\_PED} + B\_\text{TIME} * \text{TT\_PED\_SCALED} \).

Each utility function must be associated with the number or identifier of each alternative using numbering as in the data table (table 1).

\[ V = \{1: V_1, 2: V_2, 3: V_3, 4: V_4\} \]

After defining the utility function, it is necessary to assign each function to a specific transport mode using numbering as in the data table. The following numbering was used:
- CAR = 1,
- BIKE (cycling) = 2,
- PUT (public transport) = 3,
- PED (pedestrian/walking) = 4.

Next, the choice model is defined. The function bioLogLogit provides the logarithm of the choice probability of the logit model. It takes three arguments:

1. the dictionary describing the utility functions (V),
2. the dictionary describing the availability conditions (av),
3. the alternative for which the probability must be calculated (CHOICE).

\[ \text{logprob} = \text{bioLogLogit} (V, \text{av}, \text{CHOICE}) \]

The results of the estimated parameters for each mode of transport are shown in Table 2. It is concluded that the p-value of the analyzed parameters is less than 0.05, which means that the results are statistically significant.

<table>
<thead>
<tr>
<th>Name</th>
<th>Value</th>
<th>Std err</th>
<th>t-test</th>
<th>p-value</th>
<th>Rob. Std err</th>
<th>Rob. t-test</th>
<th>Rob. p-value</th>
</tr>
</thead>
<tbody>
<tr>
<td>ASC_BIKE</td>
<td>-0.29</td>
<td>0.04</td>
<td>-6.74</td>
<td>0.00</td>
<td>0.04</td>
<td>-6.81</td>
<td>9.82e-12</td>
</tr>
<tr>
<td>ASC_CAR</td>
<td>1.41</td>
<td>0.03</td>
<td>43.80</td>
<td>0.00</td>
<td>0.03</td>
<td>45.50</td>
<td>0.00</td>
</tr>
<tr>
<td>ASC_PED</td>
<td>0.65</td>
<td>0.04</td>
<td>18.40</td>
<td>0.00</td>
<td>0.03</td>
<td>18.70</td>
<td>0.00</td>
</tr>
<tr>
<td>ASC_PUT</td>
<td>-1.77</td>
<td>0.08</td>
<td>23.20</td>
<td>0.00</td>
<td>0.07</td>
<td>24.20</td>
<td>0.00</td>
</tr>
<tr>
<td>B_TIME</td>
<td>5.06e-05</td>
<td>2.33e-05</td>
<td>-2.18</td>
<td>0.0295</td>
<td>2.63e-05</td>
<td>-1.92</td>
<td>0.05</td>
</tr>
</tbody>
</table>

The values of the utility function parameters obtained by the computer program PandasBiogeme were used for development of a multimodal transport model of the urban area of Slavonski Brod. The multimodal transport model was developed in the computer program PTV VISUM [6].

Data validation was made by comparing the data obtained by the multimodal transport model and the data collected by the household survey. Figure 4 shows a comparison of the modal distribution obtained by the household travel survey in Slavonski Brod, the multimodal transport model of Slavonski Brod and National Transport Model (Continental Croatia (NUTS-2 region)).

It is concluded that the difference of the parameters obtained by Slavonski Brod model from the household survey for transport modes is as follows: for public transport (PuT) the difference is 0.2%, for bicycle (BIKE) 0.3%, for walking (PED) 0.8% and for car (CAR) 0.1%.

Comparing the results from the National Transport Model (Continental Croatia) and the results from the Slavonski Brod model, the modal distribution for public transport (PuT) differs by 11.7%, for bicycles (BIKE) 3.8%, walking (PED) 0.3% and cars (CAR) 9.4%.

Figure 4. Comparison of Modal Split of Household Survey, Model and NTM

4. Conclusion

The modal distribution is the third step in the classic four-step model. The choice of transport mode is influenced by certain factors that can be divided into passenger characteristics, travel characteristics and transport system characteristics.

The application of discrete choice models determines the modal distribution. The most widely used discrete choice models are the multinomial logit model (MNL) and the Nested logit (NL) model.

The aim of this paper was to estimate the parameters of the utility functions for each observed transport mode using the PandasBiogeme program. The estimation of the parameters is based on a household survey conducted in the city of Slavonski Brod (Croatia). Slavonski Brod is part of Continental Croatia according to the NUTS-2 division.

The estimated utility functions parameters were implemented in the multimodal transport model. The data were analyzed and compared with the conducted household survey in Slavonski Brod and the modal distribution obtained by the National Transport Model.

The difference between the estimated modal distribution of the household survey and the multimodal transport model is less than 1% for all modes of transport. The difference between the estimated parameters of the Slavonski Brod model and the National Transport Model is a bit larger, but not significantly. However, it must be considered that in the National Transport Model all cities of Republic of Croatia were analyzed in 2013.

5. References
Humint factor as an open source of information

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Abstract: The improvement of modern information technologies has undoubtedly increased the opportunities for gathering and processing of information and created a favorable environment for increasing the number of open sources, which in a way increased the interest of society and science in them. Among the various types and categories of open sources, human as a factor undoubtedly stands out. The use of the human intelligence as an open source of information is a topic that is most often the subject of discussion for intelligence professionals. A human's role is expressed not only in his relationship with other people, but also in the relationship between him and the methods he uses to gather information. On the one hand, these methods depend on the intellectual capacity, individual knowledge, qualities and experience of the person, and on the other hand - on the technical means he uses.

Keywords: information, open sources, human intelligence, intelligence.

I. Увод

Краят на миналия век с и същевременно началото на един нов период от човешкото развитие, който окаzia продължително въздействие върху обществата. Този период, или т.н. „информатизация”, се характеризира с масовата трансформация на цялото обществ, което пряко засяга и обхваща всички сфери на човешката дейност и задача тяхната посока на развитие, или по-точно ти предопределя прогреса на съвременната информационна цивилизация. Този прогрес се базира основно на отношението на обществото към информацията и неговото участие в развитието на информационните и комуникационните технологии, на ред с еволюцията на Интернет. Само за малко повече от 15 години, от масовото навлизане на Интернет в обществената практика, тази технология, този истиначен феномен на съвременната цивилизация, намери място във всяка страна и във всяка социална система, включително и в най-малката – семейната; пременени по редицата начин обхванато между хората; направи обично и леснодостъпна огромни информационни ресурси; осигури глобализирането на не само на икономиката, но и на всички области на социалната практика.[1]

Признанието за тези промени в глобален масштаб и зараждането на новата цивилизация [6], са били съвсем логични в дорулия възраст и въобще време. Така например, известните американски учени Алин и Хайди Тофлър въз основа на познанията, опита и наблюдението им в обективно съществуващата среда, успяха да предвидят промените и характерните особености, които формират съвремения информационен свят. Общото между двете понятия информационно общество и съвременен информационен свят е информационата, която се явява ресурсът, благодарение на който се заражда и развива новата цивилизация. Това се потвърждава и в изследванията на българските учени Стоян Денчев и Иrena Петева, насочени към публични достъп до информация, където яро се посочва, че основен принцип на информационното общество е, че достъпът до информация е осново човешко право, а информационните и комуникационните технологии създават предпоставки за свободното му упражняване.[1]

Промените, които настъпват в обективно съществуващата среда, намерили влияние и върху развитието на съвременното информационно общество. Това предопределя и посоката на развитие на информационното пространство [5], което представя голяма и сложна система, обединяваща както циркулиращата и постоянно преобразуваща се информация, така и специфични обекти, събития и не на последно място регулаторна рамка, уреждаща отношенията в тази сфера. Концептуално разбиране за информационното пространство се използва най-често при осъществяването и изграждането на държавна политика в информационната сфера за усъвършенстване на нейното право, методически, научно-технически и организационно гарантирани и за разработване на целеви програми в тази област. То е организационна и процедурна основа за стратегическото ръководство на въръзките си и отбраната в националното информационно пространство. На тази основа са разработени концепции за водене на информационни операции и се формираат изискванията към системата от по-горно ехирхично равнище, т.е. към системата за менеджъмът на националната сигурност и стратегическото ръководство на системата за национална сигурност. Съгласно общоприетата класификация информацията, което циркулира в информационното пространство се групира в четири основни класа: сигнали, данни, знания и култура [5]. В тази класификация данните се определят като кодирани сигнали. Съответно, знанията са интерпретирани данни, а културата се разглежда на работно ниво като организационна култура. Въвеждането на тези определения позволява да се получи обща концепция за процеса по „извличане“ на знания, които напълно е представена във вид на т.н. „познавателна (когнитивна) иерархия“.[5]

От всичко казано до момента става ясно, че с всеки последен етап от развитието на информационното
пораждането на определени проблеми, свързани с Big Data. Акцентите върху тези три особености, които предизвикат скорост и сложни, за да бъдат обработвани с наличните инструменти за обработка на тези данни. Това създава предпоставки за възникване на Big Data, като основен ресурс в системата на информационното пространство и от друга страна – самия процес по обработката, съхраняването и разпространяването на информацията.

Свидетели сме как в края на ХХ и началото на XXI век резултатите от дейността на обществата в различни области на човешката дейност създаха предпоставки за генериране и натрупване на огромни по своите мащаби количества информация, което наложи и наяви на информационно-аналитичната дейност огромното количество натрупана обектива и субъектива информация може да бъде фиксирани, съхранено и предадено на други хора. Получаващият в готов вид информацията, човекът успява да достигне по-бързо своите цели и да се стреми да поставя нови, както и да научава нови начини за постигането им. С други думи, информацията разкрива нови възможности и предизвиква нови информационни потребности.[3]

Така, към днешна дата всяка съзнателна и целенасочена човешка дейност е свързана със създаването, обработката и използването на значителна по обем информация. Този вид естествени процеси обикновено остават незабелязани като част от ежедневния ни дейност, но с развитието и внедряването на инструментите за обработка на данните, техническата база на изчислителните системи и специализирани софтуери, те придобиват все по-голямо значение. В този смисъл, източниците на данни са изключително разнообразни:

- Бизнес - Интернет, електронна търговия, транзакции, фондова борса, публикувани официални счетоводни и финансови отчети и др.
- Наука - Remote sensing, bioinformatics, scientific simulation
- Общество и индивид - новини, развлечения, многомедийна продукция, социални мрежи и др. [2]

Поради динамичния ръст на обема на данните, които биват генерирани всекидневно в следствие от човешката дейност, все по-често възникват негативни ситуации, които поставят предизвикателства свързани със съхраняването, поддържането и обработката на тези данни. Това създава предпоставки много често днес и съвременните компютърни технологии и различни програмни инструменти да не са в състояние да се справят ефективно и в разумни срокове с тях.

Big Data („големи данни”) е термин, който е свързан с използването на големи маси от данни. Big Data представлява съвкупност (набор) от данни, твърде големи и сложни, за да бъдат обработвани с наличните инструменти за управление на бази от данни. Като предизвикателство те включват събиране, съхранение, търсене, споделяне, анализ и визуализация.[2]

Трите основни характеристики на Big Data са обем, скорост и разнообразие (volume, velocity и variety) или V3. Акцентите върху тези три особености, които предизвикат пораждането на определени проблеми, свързани с Big Data, маркират зараждането на т.нар. метод Data Mining.

Натрупването на огромни обеми от организирани по различен начин първични данни създава предпоставки за по-задълбоченото им аналитично изследване и обобщаване, за прилагане на специфични аналитични техники с оглед разкриването на явления, процеси, вътрешни връзки и зависимости, които обикновено не могат да се установят дори и от подготвен анализатор.

Съвременните средства за интелигентен анализ на данни обикновено се обозначават чрез термина Data Mining, който много често се употребява без еквивалент превод дори и от различни от англоезичните източници [2].

Data Mining се появява през 1978 г. и придава голема популярност в съвременната ня синтеграция през първата половина на 90-те години на миналия век. До този момент обработката на данните извършва с конвенционални средства, основаващи се на класическата статистика, като се прилагат преди всичко към неголеми бази от данни. Терминът Data Mining получава своето наименование в следствие от идеята за търсене и откриване на полезни и ценни информация, съдържаща се в големи бази (Big Data) или хра нилища за данни (Data Warehouse). Тази идея се заражда от метафоричното разбиране на някои автори, свързана с минната дейност за търсене и откриване на ценни полезни изкопаеми. Аналогията идва най-вече от факта, че и в двата случая ценният добив идва в резултат на обработката на значително количество суров изходен материал. В тази връзка, 90% от наличните данни в света са създадени през последните пет години, като повече от 80% от тези данни са неструктурирани, достъпни от открити източници на информация. Неструктурираните данни са в различни формати като текст, аудио, видео, сигнали от устройства и сензори, повечето от които се поддават в реално време, които традиционните системи за управление на бази от данни или складовете от данни не могат да обработят директно. Това налага използване на други подходи, методологии и инструменти за обработка на тези данни. [4]

2. Изложение

Една от най-важните категории открити източници на информация е човекът. Необходимо е да отбеляжим, че във всеки един информационен процес (от създаването на информацията, до нейното събиране, обработка и повторно разпространение), несъмнено човешкият фактор има особено важно значение. Неговата роля в този процес има двойствен характер – той може да бъде източник или резултант на информация. Подобна е и гледната точка на двамата известни български учени Стоян Дечев и Димитър Христозов, които определят двойствената роля на човека като източник и получател на информация. Източникът изпраща (съобщава, комуникира) знание, което той притежава, на получателя, който го получава (възприема, усвои я) и като резултат намалява несигурността (получателят е получил ново знание – знае повече) при определяне на поведението си [7].

Ролята на човека се изразява не само във връзката му с други лица, но и във връзката между него и способите, които използва за събирането на информация. От една страна тези способи зависят от интелектуалния капацитет, индивидуалните познания, качества и опит на човека, а от друга страна – от техническите средства които използва. Техническите са пряко свързани със съответните информационни технологии и фондове. От социална гледна точка интерактивният диалог представлява един своеобразен феномен, отразявайки както нивото на развитие на съответната научна, технологична и техническа база, така и нивото на развитието на интелектуалните способности, мирогледа и социалната ангажираност на отделния индивид на обществото [7].

Използването на човешкия фактор като открит източник на информация е тема, която най-често е обект на дискусиия за специалистите по разузнаване (Human Intelligence). В този смисъл, открит източник е лице, което предоставя на
добиващ орган важна за целите на разузнаването информация. Този вид открити източници на информация могат да бъдат разделени в следните две категории:

- лица от местното население;
- граждани на държава или на страна по пребиваване, които имат актуална информация за определен обект.

Таки категории открити източници на информация могат да бъдат и експерти или специалисти от определена област на човешката дейност като например журналисти, бизнесмени, пилоти, шофьори, служители на структурите на министерствата, на международни правителствени и неправителствени организации, научни работници и др.

Изявяването на информация от човешки фактор като открит източник е специфична дейност, която изисква предварителна подготовка както по отношение на специфичните културни блики, свързани с произхода на източника, така и притежаването на умения за психологичното му профилиране. Според двамата български учени в областта на науката при лицето, представляващо интерес за разузнаването информация за индивидуална психологична типология на лицето, представляващо интерес за резултатите от този процес.

Важно е т.е. откритите източници на информация са представители от различни социални и етнически групи, жители на определен регион, които имат непосредствена информация, или са признати за експерти в дадена област (директори на водещи културни институции, научни работници, библиотекари, представители от различни социални и етнически групи, учители на структурите на министерствата, на международни правителствени и неправителствени организации, научни работници и др.).

Подобно на разузнаването, в процеса на добиване на информация от човешки фактор като открит източник, се изисква предварителна подготовка и познаване на историята, фолклора, традициите, бита, народопсихологията и дори специфичните културни блezи, свързани с произхода на източника, и притежаването на умения за психологичното му профилиране.

Откритост и прозрачност на рецепента, което гарантира успеха на научното изследване.

В този смисъл, открити източници на информация са съществуват две категории открити източници на информация за определени събития, процеси или обекти.

1. Резултати и дискусия

1. Независимо от различните разработки и възможности за търсене, събиране, обработка, съхранение и разпространение на информацията – критичен за правилното й използване е човешкият фактор.

2. Човешкият фактор има двупосочно действие – той може да бъде източник/подател и реципиент/получател на информация. В случая на информация от открити източници, доминират потребителските функции, при което липсва регулираща обратна връзка (от потребител към източника). Това има пряко влияние върху качеството на резултатите, получени от информационния процес.

3. При използване на открити източници, критичен за ефективността на информиранието е оперативността на информацията (особено на постъпващата от аудио-визуални медии и Интернет).

4. Заключение

Несъмнено, към днесна дата темата за откритите източници на информация е особено актуална, тъй като поставя важни въпроси за естеството и потреблението на информацията като основен ресурс в системата на информационното общество. Усъвършенстването на съвременните информационни технологии увеличи и възможностите за събирането и обработването на информацията и създава благоприятна среда за нарастване броя на откритите източници. Технологичният напредък доведе до иновации в сферата на технологиите и наложи използването на по-модерни компютърни системи за търсене и разпространение на информация. Това позволява на потребителите в системата на информационното общество бързо и почти безпроблемно от една страна да създават различен вид съдържание като текстове, снимки, видео и др., а от друга да споделят това съдържание от всички части на света, чрез използването на Интернет и в частност чрез социалните мрежи и др. Въпреки това, една от най-важните категории открити източници на информация е човекът и неговата роля именно в това информационно пространство.

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Laser marking on plastic surfaces with minimal changes in material structure and maximum contrast

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Abstract: It is possible to do laser marking on plastic surfaces by using lasers. Coding of information is very popular in last years because of its ability to convert information in one symbol. But there are lot of small sized parts where it is hard to do laser marking or physical impact on material is so big, that this code would be readable. On the other side contrast of marked area must be good enough so camera used in experiment would be capable read it. Goal of research is to find laser parameters that would be good enough to do laser marking on plastic surfaces so that physical impact would be made on that surface. There is used two-dimensional code- QR code. Target is to find parameters which would allow to do 3.5mm big square.

KEYWORDS: ABS PLASTIC, QR CODE, SURFACE ROUGHNESS, LASER MARKING

1. Introduction

Different kind of companies are more and more interested in doing laser marking on them products. Laser marking is done in different methods of laser marking, some materials could be marked only by marking or engraving without special requirements and difficulty, while for other materials one can choose the concrete method about the kind of material, marking type, and the specific needs of the production process and the geometry of detail [1]. In this case authors must concentrate on method where is minimal physical impact on surface- it is marking, where beam is making termycal impact on surface, so the surface is change colour for human eyes. For each material must be researched new laser marking parameters [2] because of specific of material.

Fig.1. QR code marked on E2000/APC fiber optic connector

As a sample of such small size laser marking could be mentioned fiber optic connectors, where is laser marking, for marking on connectors surface QR code with different parameters.[3] look Fig.1.

It is necessary to distinguish between the concept of the diameter of the laser beam and the zone of influence of the laser beam on the material, this zone depends on the power density, the higher the power density, the wider the heat-affected zone. Ideally, it is necessary to select the value of the power density of the laser radiation so that the affected area, as close as possible, corresponds to the size of the laser beam in focus. This condition allows you to ensure the clearest contours when marking with a laser beam. Clear marking borders and high contrast allow the camera to recognize smaller objects. This is important for recognizing the QR code.

For the various mechanisms of modelling can be displayed on the normalized overview chart shown in Fig. 2. The process parameters are normalized with the thermal properties of the materials. Diagram showing contours for the onset of surface melting and vaporization constructed from a surface heat flow model (solid lines); experimental data for various mechanisms of marking cluster into regions bounded by broken lines.[5]

Values can be calculated using the following formulas [5]:

- normalized traverse rate,
  \[
  \frac{v r_B}{\alpha}
  \]
  where:
  - \(v\) - Beam traverse rate ms\(^{-1}\)
  - \(r_B\) - Beam radius defined where \(q=q_{\text{max}}/e\), or beam half-width \(m\)
  - \(\alpha\) - Thermal diffusivity, \(\lambda/(pc)\) \(\text{m}^2\text{s}^{-1}\)

- and normalized beam power,
  \[
  \frac{A q}{T_B \lambda (T_m - T_0)}
  \]
  where:
  - \(A\) - Absorptivity
  - \(q\) - Beam power Js\(^{-1}\)
  - \(r_B\) - Beam radius defined where \(q=q_{\text{max}}/e\), or beam half-width \(m\)
  - \(\lambda\) - Thermal conductivity Js\(^{-1}\)m\(^{-1}\)K\(^{-1}\)
  - \(T_m\) - Melting temperature K
  - \(T_0\) - Initial temperature K

To ensure high-quality marking, a number of requirements for the surface of the material must be observed; it must be smooth, uniform, with good absorption of the laser beam.

2. Materials and methods

For experiments were used ABS (acrynotrile-butadiene-styrene) plastic. One of the most successful polymer composites with an unequalled variety of forms and range of applications [4].

To assess the qualitative and quantitative marking parameters, devices and specialized computer programs were used. 3D Laser Confocal Scanning Microscope OLS5000 laser microscope that can make accurate measurements of submicron level shape and surface roughness. The results were analyzed using a microscope “Dino-...
Lite Egde” and a computer program “Dino Capture”, which magnifies the image 50 times. Ocean optics HL-2000 STS VIS spectrometer was used in the experiment. Code contrast is measured on the Image color picker website. The resulting data is entered into the Contrast Ration site. The site calculates the ratio of the background color to the color of the label using the color codes you enter and outputs a contrast factor.

The Rofin PowerLine F20 Varia Laser System was used for the experiments. It is a fiber laser with a wavelength of 1064 nm. A distinctive feature of this system is that it has a wide range of adjustment of the pulse duration from 4 to 200 ns and the pulse repetition rate from 2 - 1000 kHz.

For following experiments were prepared matrix with QR codes and different parameters of them.

There were made following experiments to find best parameters:
1. Frequency (Hz)- speed (mm/s);
2. Frequency (Hz)- power (W);
3. Impulse length (ns)- speed (mm/s);
4. Impulse length (ns)- power (W);
5. Cell size (mm)- speed (mm/s).

After finishing experiments, authors were able to find optimal Frequency, speed, power, impulse length and cell size parameters.

As first experiment were done Frequency- Speed matrix (Fig.3.). In this experiment constant values were:
1. Power- 70%;
2. Pulse length- 8 ns;
3. Line step- 0.05mm.

In the next experiment were searched cell size- power (look fig.5.) parameter. Were constant values were:
1. Speed 400 mm/s;
2. Frequency 60KHz;
3. Line speed 0.05mm.

And in the last experiment were researched cell size-speed (look Fig.6.) matrix. Were constant speed were:
1. Power 70%;
2. Frequency 60KHz;
3. Line step 0.05mm.
The ability of a QR code to be read is a key criterion for the parameters of a laser-marked code to be considered acceptable. This code is scanned with the Android platform application “QR scanner”. In experiments, a “+” marks those QR codes that can be read and “−” marks those codes that cannot be read because their contrast ratio is too low or the energy level is so high that effect on the surface causes such physical transformations that the region to be marked acquires a relief on the surface, which creates problems for code recognition.

In the experiment in which the “Pulse-Speed” relationship is formed, see Table 1. In the table, a small number of readable codes is detected because too much energy is supplied (see Fig. 7), as the pulse time is very large.

Experiments have shown that a contrast factor of 3 or higher is not optimal for reading the code, because although the contrast is high, the structure of the material is damaged by physical transformations due to heat input and the surface of the material around the QR code contour begins to melt and color due to foaming effect (look Fig. 8).

<table>
<thead>
<tr>
<th>Pulse width (ns)</th>
<th>Speed mm/s</th>
</tr>
</thead>
<tbody>
<tr>
<td>4</td>
<td>50 100 150 200 250 300 350 400 450 500</td>
</tr>
<tr>
<td>8</td>
<td>1.0-1.5 1.6-2 2.1-2.5 2.6-3</td>
</tr>
<tr>
<td>14</td>
<td>2 2.1 2.2</td>
</tr>
<tr>
<td>20</td>
<td>2.2</td>
</tr>
<tr>
<td>30</td>
<td>2.3</td>
</tr>
<tr>
<td>50</td>
<td>2.4</td>
</tr>
<tr>
<td>100</td>
<td>2.5</td>
</tr>
<tr>
<td>200</td>
<td>2.6</td>
</tr>
</tbody>
</table>

3. Results

In the end of experiments were found samples where were done big physical impact on material surface (look Fig. 9). Such results were unacceptable because there were changed roughness of material surface, code was unreadable and in worst case surface was damaged.
Samples with low laser beam impact had low contrast ration, that means, that QR code were almost unreadable for came (look fig. 9.).

![Fig. 9. Marked QR code with low contrast ratio](image9)

After doing research using microscope, even well looked QR code had made physical impact on surface, because plastic material is melted around marked are (look fig. 10.).

![Fig. 10. Well looked QR code with melted area](image10)

After farther research were founded good parameters were roughness of surfaces were not changed and contrast ration was good enough to be readable (look Fig. 11.).

![Fig.11. QR code with optimal parameters (at the top the image next to the scale with a division price of 0.5 mm, at the bottom is the same image with an increase)](image11)

4. Conclusions

As optimal QR code parametrs marked on plastic surfaces with Rofin Powerline varia 20 laser are:
1. Pulse length 8ns;
2. Frequency- 60KHz;
3. Line step- 0.05mm;
4. Power- 70%;
5. Speed 400 mm/s-;
6. Cell size- 0.14mm.

Using this parametrs it is posible to get 3mm big QR code, which marking process does not make any physical impact of surface roughness changing and contrast ration is good enough to be readable.

The introduction of new technologies in the process of labeling products, especially small sizes, allows you to place more information with minimal image sizes, allows you to use automated systems in the process of further use of the product, allows you to increase the possibility of product identification.

5. References

Mineralogical characterization of different clay varieties on behalf of advanced industrial handling

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Abstract: Clay is a group of minerals that is more industrial demanded material because of the specific strengths of some components of such clays in the fulfilments of some industrial and technological needs. The chemical composition and other important properties of clays are depended on the origin, location and some other environmental factors. The industrial applications might be varied upon the mineralogy of some clay. In the existing research, three different types of clay were selected as the materials that namely as anthill clay, brick clay and roof tile clay. The selected types of clay samples were collected from three different regions in Sri Lanka. The collected clay samples were characterized using X-ray fluorescence (XRF) spectrophotometer, Fourier transform infrared (FT-IR) spectrophotometer and optical microscope. According to the investigation results, there were observed the presence of Fe as the most abundant element in all of clays at least 75%, large amounts of kaolinite in three clay types, intermediate amount of quartz and trace amounts of rutile in three clay types. In addition that it is possible to present muscovite in brick clays as a trace mineral and some trace amounts of Fe minerals such as glauconite and marcsite in three clay types. When comparing of the mineralogy of such clays mainly those clays are possible to be further developed as the adsorption materials (adsorber) for the recovering of metals from waste water and polluted air and a recovery material to remove some unnecessary components in chemical processes.

Keywords: CLAY, XRF CHARACTERIZATION, FT-IR CHARACTERIZATION, MINERALOGY, CHEMICAL COMPOSITION

1. Introduction

Clay is an industrially demanded soils species among earth resources because of the distinct properties of such clays foremost of the high porosity and less permeability although the properties and chemical compositions of such clays are varied with the origin and formations. The mineralogy of some clay plays a great role in the industrial applications quits as physico-chemical properties of such clays based on the advanced chemical behaviours of those clays most probably the process of adsorption. In the modern industrialized world, it is highly allured in the development or direct uses of natural materials for advanced industrial handling as composite materials and treated raw materials. Clay is a multi purposely applicable raw material due to the series of physico-chemical varieties and diversity in chemical compositions. Based on those features, those clays may have wide range of applications and those applications may be varied according to the physical and chemical characteristics of specified clays [1, 2, 3, 4, 5, 6]. Therefore, the investigation and analysis of common and advanced characteristics of some selected clay are essential necessity prior of the uses. In the existing research there were expected to investigate and analyze the mineralogy of three different clay species which are available in three different areas in Sri Lanka.

2. Materials and Methodology

As the scopes and objectives of the existing research, three different types of clays were selected as the materials for the study namely as follows and the collected (available) areas are shown in Fig. 1.

- Anthill clay- Using in the building of anthill by termite (A 1- Matale Area in Matale District)
- Brick clay- Using in the manufacturing of bricks (A 2- Maduragoda Area in Kurunegala District)
- Roof tile clay- Using in the manufacturing of roof tiles (A 3- Dankotuwa Area in Puttalam District)

The collected clay samples were stored carefully in non-contaminated polythene bags and some representative clay samples from their original clay bulks were separated for the different experiments and those clay samples were prepared according to the standard defined methods for each experiment.

2.1. Elemental analysis

The representative clay samples were oven dried for 24 hours under the temperature of 110°C until removal of moisture from clays and the dried clay samples were crushed using a ceramic crucible [1-9].
The final representative clay portions were selected using the coning and quartering method which is shown in the Fig. 2.

The selected representative clay samples were analyzed using X-ray fluorescence (XRF) spectrometer.

2.2. Mineralogy and functional group analysis

A selected raw clay portion was separated from each clay bulk. Each of separated clay portion was separately placed in medium size measuring cylinders and the clay potions were dissolved in distilled water while shaking the system. The shacked system was allowed to settle down after a few minutes shaking period. The status of the setting system was observed throughout about two hours and the top most clay portion of each measuring cylinder was collected using medical droppers. The collected clay portion would be the tiniest portion in of each of clay. The collected clay portions were oven-dried for 24 hours under the temperature of 110°C based on the aim of the removal of water and moisture [1-10]. The dried clay samples were crushed using a ceramic crucible to break some clogs and finally a dry clay powder was prepared from each clay type.

The prepared clay samples were analyzed using Fourier transforms infrared (FT-IR) spectrometer.

3. Results and Discussion

3.1. Elemental analysis of clays

According to the analysis of X-ray fluorescence (XRF) analysis, the elemental compositions of clays are given in the following figure and tables.

<table>
<thead>
<tr>
<th>Color of the Peak</th>
<th>Element</th>
<th>Atomic Number (amu)</th>
<th>Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (Fe)</td>
<td>26</td>
<td></td>
<td>82.08</td>
</tr>
<tr>
<td>Titanium (Ti)</td>
<td>22</td>
<td></td>
<td>4.84</td>
</tr>
<tr>
<td>Barium (Ba)</td>
<td>56</td>
<td></td>
<td>0.79</td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>19</td>
<td></td>
<td>12.28</td>
</tr>
</tbody>
</table>

Based on above results, the higher Fe content was observed with the trace elements of Ti, Ba and K from anthill clay. Usually such elements would be presented in clays as their oxides because of the reaction with water or moisture [1, 2, 4, 5, 6, 10].

In the analysis of observed results, relatively higher Fe content indicates the suitability of some advanced chemical applications such as the adsorption of other metals or catalyst since it is non-toxic [2,4,6,7]. The industrial applications of such clay can be further described with the mineralogy of anthill clay. In addition, the content of K indicates some relatively higher acidity for anthill clay and Ba is non-toxic element whereas Ba²⁺ is highly toxic in aqueous solutions. But that factor may not be considered in the existing study and further researches because the Ba content is trace in anthill clay (<1%) [1-4].
The X-ray fluorescence (XRF) results of brick clay showed the majority of Fe with other trace elements Ti, Ca and Ba. It was not found any K content in brick clay and that observation denotes that the acidity of brick clay should be relatively lower when comparing with other clays which are composed of potassium. The trace content of Ca indicates the plasticity of the clay because the CaO causes the higher plasticity for clays. The plasticity is an indicator for the resistance of such material against the heat [1-6]. Therefore, it is possible to expect some heat resistant applications from brick clays. Apart from that the brick clay may be applied in advanced chemical process which is called as ion exchange because the Ca$^{2+}$ is identified as a foremost exchangeable ion that present in clays or clayey soils.

Ion exchanging is a mechanism which is mostly used in the waste water treatments as a unit operation to remove some unnecessary/undesirable or toxic ions from waste water and the replacing of the removed ions with other necessary/ desirable or non-toxic ions. The possible exchangeable cations which are present in clays are as follows [1, 4, 6, 9, 10, 11, 12].

- Mg$^{2+}$
- Na$^+$
- K$^+$
- NH$_4^+$
- Ca$^{2+}$
- H$^+$
- Ba$^{2+}$

The ion exchange process is usually applicable in the waste water treatments based on following tasks [1-12].

- Reducing or removal of hardness (softening)
- Removal of nitrogen
- Removal of heavy metals
- Desalination of sea water

When considering the elemental composition of roof tile clay, it was composed majority of Fe as usual with Ti, Ba, Zr and K. Therefore, it is possible to expect some applications of roof tile clay in followings [1-8].

- Adsorber for some other metals (Fe content)
- Applications in catalytic purposes (porous structure and Fe content)
- Ion exchanging material (Ba$^{2+}$, Fe$^{2+}$ and K$^+$)

In the overall analysis of the elemental compositions of three different clays, some of advanced properties and related applications can be emphasized. However, the applicability of such clays on those tasks would be descriptively confirmed with the mineralogical analysis results forever.

### Table 2: Elemental composition of brick clay

<table>
<thead>
<tr>
<th>Color of the Peak</th>
<th>Element</th>
<th>Atomic Number (amu)</th>
<th>Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (Fe)</td>
<td>26</td>
<td>84.38</td>
<td></td>
</tr>
<tr>
<td>Titanium (Ti)</td>
<td>22</td>
<td>5.92</td>
<td></td>
</tr>
<tr>
<td>Calcium (Ca)</td>
<td>20</td>
<td>7.56</td>
<td></td>
</tr>
<tr>
<td>Barium (Ba)</td>
<td>56</td>
<td>2.14</td>
<td></td>
</tr>
</tbody>
</table>

### Table 3: Elemental composition of roof tile clay

<table>
<thead>
<tr>
<th>Color of the Peak</th>
<th>Element</th>
<th>Atomic Number (amu)</th>
<th>Content (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Iron (Fe)</td>
<td>26</td>
<td>75.72</td>
<td></td>
</tr>
<tr>
<td>Titanium (Ti)</td>
<td>22</td>
<td>2.95</td>
<td></td>
</tr>
<tr>
<td>Barium (Ba)</td>
<td>56</td>
<td>5.30</td>
<td></td>
</tr>
<tr>
<td>Zirconium (Zr)</td>
<td>40</td>
<td>3.36</td>
<td></td>
</tr>
<tr>
<td>Potassium (K)</td>
<td>19</td>
<td>12.67</td>
<td></td>
</tr>
</tbody>
</table>

### 3.2. Mineralogy and functional groups analysis

According to the Fourier transforms infrared (FT-IR) analysis, the FT-IR spectroscopes are shown in following graphs.
The FT-IR spectroscopy (transmittance) of anthill clay showed major peaks at some specific wave number. The descriptions of the relevant functional groups are given in the Table 4.

Table 4: Functional groups and assignments of anthill clay

<table>
<thead>
<tr>
<th>Wave Number (cm(^{-1}))</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3695</td>
<td>OH stretching of inner surface hydroxyl groups</td>
</tr>
<tr>
<td>3628</td>
<td>OH stretching of structural hydroxyl groups</td>
</tr>
<tr>
<td>999</td>
<td>Si-O stretching</td>
</tr>
<tr>
<td>910</td>
<td>OH deformations of inner hydroxyl groups</td>
</tr>
<tr>
<td>527</td>
<td>Al-O-Si deformation</td>
</tr>
<tr>
<td>460</td>
<td>Si-O-Si deformation</td>
</tr>
<tr>
<td>411</td>
<td>-</td>
</tr>
</tbody>
</table>

According to the general investigation of the major peaks of the FT-IR spectroscopy of anthill clay, it is possible to conclude that the presence of kaolinite accordingly with the peaks of wave numbers at 3695 cm\(^{-1}\), 3628 cm\(^{-1}\), 910 cm\(^{-1}\), 527 cm\(^{-1}\) and 460 cm\(^{-1}\). Apart from the major clay mineral, it is feasible to identify the mineral muscovite according to the peak of the wave number at 999 cm\(^{-1}\). The muscovite is a mineral which is belonged to the group of mica. It can be distinctively identified because of the white color of that mineral when comparing with the other available colors of minerals in mica group. The chemical formulas of kaolinite and muscovite are given in the below \[1, 2, 4, 11, 12\].

- Kaolinite - Al\(_2\)(Si\(_2\)O\(_5\)) (OH)\(_4\)
- Muscovite – KAl\(_3\) (AlSi\(_3\)O\(_10\))(OH)\(_2\)

In the further analysis of the FT-IR spectrum of anthill clay, there would be a probability to present the ferrous mineral which is named as pyrite accordingly with the peak of the wave number at 411 cm\(^{-1}\) although it is an insufficient observation to make some fixed conclusion or decision.

Therefore, the anthill clay should be a good adsorber for some other metals because of the presence of kaolinite due to the chemically activation of the functional groups such as the hydroxyl groups. The anthill clay is possible to be recommended for the waste water treatment applications such as the removal of heavy metals and pathogens as well.

The FT-IR spectroscopy of brick clay showed the presence of kaolinite because the peaks were identified with respect to the wave numbers at 3702 cm\(^{-1}\), 3629 cm\(^{-1}\), 909 cm\(^{-1}\), 530 cm\(^{-1}\) and 469 cm\(^{-1}\). The peak of the wave number at 1001 cm\(^{-1}\) indicates the present of muscovite in brick clay. Therefore, the industrial applications of brick clay would be same as the anthill clay such as the removal of heavy metals from the waste water \[2, 3, 4, 10, 11, 12\].

Those clays would be applicable in the removal of following metals from the waste water including heavy metals.

- Cobalt
- Copper
- Nickel
- Manganese
- Arsenic
• Cadmium
• Chromium
• Mercury
• Lead
• Zinc
• Uranium

The metallic contamination of water is a serious incident in the less quality of drinking water which causes some diseases for the human beings and animals. Therefore, the development of clay based treatment systems may be seen in the future.

Fig. 10. FT-IR spectroscopy (transmittance) of roof tile clay

Table 6: Functional groups and assignments of roof tile clay

<table>
<thead>
<tr>
<th>Wave Number (cm(^{-1}))</th>
<th>Assignment</th>
</tr>
</thead>
<tbody>
<tr>
<td>3696</td>
<td>OH stretching of inner surface hydroxyl groups</td>
</tr>
<tr>
<td>3623</td>
<td>OH stretching of structural hydroxyl groups</td>
</tr>
<tr>
<td>1001</td>
<td>Si-O stretching</td>
</tr>
<tr>
<td>915</td>
<td>OH deformations of inner hydroxyl groups</td>
</tr>
<tr>
<td>530</td>
<td>Al-O-Si deformation</td>
</tr>
<tr>
<td>463</td>
<td>Si-O-Si deformation</td>
</tr>
</tbody>
</table>

The presence of kaolinite was confirmed in roof tile clay because of the distributions of peaks of wave numbers at 3696 cm\(^{-1}\), 3623 cm\(^{-1}\), 915 cm\(^{-1}\), 530 cm\(^{-1}\) and 463 cm\(^{-1}\) as usual. Also the present of muscovite was confirmed referring the peak of wave number at 1001 cm\(^{-1}\). The roof tile clay would also be useful in the industrial purposes such as the treatment of waste water [1, 2, 4, 11].

As the special industrial application for the roof tile clay, it can be expected the applications in the removal of inorganic contaminations from the waste water such as the fluorides because of the presence of zirconium also with clay minerals such as kaolinite [4, 11].

In addition that the major peaks of wave numbers at ~ 450 cm\(^{-1}\) and ~1000 cm\(^{-1}\) were observed in three spectrums and that evident indicates the presence of quartz in three clay types even as a trace mineral [1, 2, 3, 4, 11].

4. Conclusion

As the results of the existing research, there were obtained at least 75% of Fe in each of clay with some of trace metals such as K, Ba, Ti, Ca and Zr in trace amounts < 13% while observing kaolinite, muscovite and quartz as the major minerals with some ferrous minerals. By considering the results and analysis of the outcomes, it seems that those clays would be some robust raw materials in the industrial applications namely as the ion exchanging material, adsorber, catalyst and heat resistant material.

5. Acknowledgement

The great efforts of the technical staff at the Department of Chemistry, University of Peradeniya would be appreciated by the authors.

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Study of electrolytic corrosion resistance in parts clean melted bases before their deposits by electrolytic alloy coatings

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Abstract: The report examined electrochemical processes are established and the influence of main technological parameters on the corrosion properties of electrolytic clean parts in a melt of alkalis.

KEY WORDS: MELT, BASES, CORROSION PROPERTIES.

1. Увод

Детайлите замърсени с гъсти консистентни смазки най-лесно се измиват с керосин [3]. Проблемно е почистването на детайлите с нагар, корозия и на детайлите със сложна геометрия и дълбоки канали.

Най-ефективно почистване на детайлите се постига при обработването им в стопилка от основи[2]. Този електролитен способ за почистване не изисква установка със сложно оборудване.

За първи път методът за почистване на детайлите от селскостопанската техника по галваничен път включва неутрализация в разтвор на фосфорна киселина с последваща обработка с 10% ексикутор (на дъното му имаше вода).

Изработването на композиционен план се прие за липса на корозионни огнища върху повърхността на обработените образци, при които се получават минимални огнища на корозия.

Таблица 1

<table>
<thead>
<tr>
<th>№</th>
<th>Напълнител за надида корозия</th>
<th>Оцена в %</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Без огнища на корозия</td>
<td>0,100</td>
</tr>
<tr>
<td>2</td>
<td>С единични петна на корозия</td>
<td>0,125</td>
</tr>
<tr>
<td>3</td>
<td>С частични петна на корозия</td>
<td>0,250</td>
</tr>
<tr>
<td>4</td>
<td>Със значителни петна на корозия</td>
<td>0,375</td>
</tr>
<tr>
<td>5</td>
<td>С единични огнища на корозия</td>
<td>0,500</td>
</tr>
<tr>
<td>6</td>
<td>С частични огнища на корозия</td>
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<td>7</td>
<td>С огнища на корозия</td>
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</tr>
<tr>
<td>8</td>
<td>Със значителни огнища на корозия</td>
<td>0,875</td>
</tr>
<tr>
<td>9</td>
<td>С повсеместна корозия</td>
<td>1,000</td>
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</tbody>
</table>

Задачата на математическото моделиране на процеса се поставя с цел да се оптимизират текущите стойности на входните фактори: - температура на алкалната стопилка; - плътност на тока; - продължителност на обработването във ваната със стопилка; - концентрация на фосфорната киселина при които се получават минимальни огнища на корозия.

Предварителните експерименти на образци от стомана 15XГНТ с размери 50х50х1 mm включват обработване във вана със стопилка от натриева основа, калиева основа и натриев нитрат с и без последваща обработка в разтвор от фосфорна киселина. Върху същите образци се извършило диаметър на корозионната устойчивост при обикновено условие (на въздух) и в атмосфера на повишена влажност, за провеждане на затворен екскатор (на дъното му имаше вода).

Установените факто е, че образците почиствени във ваната със стопилка от основи и последваща обработка с 10% разтвор на фосфорна киселина, не корозираят в атмосфера на повишена влажност за дълъг период от време (повече от месец). С по-малък устойчивост се оказват образците без последваща обработка в разтвор на фосфорна киселина след електролитното.
почистване. Най-малка устойчивост на корозия се наблюдава при детайли, подложени на пясъкоструйно почистване.

Като правило при корозионните петна настъпват 15÷20 min, а след 6 часа повърхността напълно корозира.

Въз основа на априорната информация и предварителните изследвания, нивата на променливите фактори и интервалите на вариране са дадени в таблица 2.

Таблица 2

<table>
<thead>
<tr>
<th>Променливи фактори</th>
<th>Код</th>
<th>Интервал на вариране</th>
<th>Нива на кодирания фактори</th>
</tr>
</thead>
<tbody>
<tr>
<td>Температура на стопилка - Z0, (K)</td>
<td>X0</td>
<td>Z0 = -0,5</td>
<td>-1</td>
</tr>
<tr>
<td>Плътност на тона - Z1, Дк, (кг/м3)</td>
<td>X1</td>
<td>Z1 = +0,5</td>
<td>0,4</td>
</tr>
<tr>
<td>Предимството на обработка в стопилка - Z2, (мин.)</td>
<td>X2</td>
<td>Z2 = -14</td>
<td>20</td>
</tr>
<tr>
<td>Концентрация на фосфорната киселина при концентрацията - Z3, (C%)</td>
<td>X3</td>
<td>Z3 = -6</td>
<td>4</td>
</tr>
</tbody>
</table>

Опитите съгласно плана се проведоха в полупрозводствени условия, като се използва електросъпротивителна вана с капацитет 180 dm³. Същата е снабдена с вентилационна уредба с вентилатор, който при съпротивление на системата H=78 mm воден стълб има производителност 9100 m³/h.

Съставът на солната вана включва приетите компоненти: 50% натриева основа, 25% KON и 25% NaNO₃. Захранването на почистените образци се извършва от селенов токоизправител с мощност 1500 А и напрежение 12 V. За проверка повърхността на почистените детайли, на корозионна устойчивост, се изработват образци с размери 100х50х5 mm. Образците предварително се подлагат на термична обработка при следния режим: закаляване при температура 1168 K в масло и отвръщане при температура 758 K.

При провеждане на опитите, съгласно матрицата на планиране експеримент, температурата на алкалната стопилка и плътността на тока се поддържаха автоматично. С помощта на мощни контактори се осъществява дистанционна смяна на полярността на почистваните образци. Концентрацията на фосфорната киселина се контролира периодично чрез химичен анализ.

При всеки опит образците се изпитвайки на корозионна устойчивост в атмосфера на повишена влажност и нормална температура в продължение на десет месеца.

След провеждането на експериментите съгласно плана и обработка на данните се получи следното регресионно уравнение

\[ Y = 0,475 + 0,056X₀ + 0,09X₁ - 0,28X₂ + 0,04X₃ - 0,05X₄ - 0,06X₅ \]

Коефициентите пред факторите в регресионното уравнение дават връзка между корозионната устойчивост и променливи фактори.

Статистическата оценка на регресионното уравнение и адекватността на неговите експериментални данни са представени в таблица 3:

Таблица 3

<table>
<thead>
<tr>
<th>Название</th>
<th>Величина</th>
<th>Стойност</th>
</tr>
</thead>
<tbody>
<tr>
<td>Коэффициент на множествен корелация</td>
<td>R</td>
<td>0,945</td>
</tr>
<tr>
<td>Дисперсия на остатъка</td>
<td>Sₑ²</td>
<td>0,165</td>
</tr>
<tr>
<td>Остатъчна дисперсия</td>
<td>Sₑ²</td>
<td>0,0388</td>
</tr>
<tr>
<td>Критерий на Фишер по табл. Fₚₐₜ</td>
<td>Fₚ</td>
<td>6,10</td>
</tr>
<tr>
<td>Дисперсионно отношение ( F )</td>
<td>Fₑ</td>
<td>0,205</td>
</tr>
<tr>
<td>Критерий на адекватност ( F_{Δg} )</td>
<td>Fₑ = Fₚ</td>
<td>0,205</td>
</tr>
</tbody>
</table>

Геометричното представяне на полиномния модел с помощта на двумерни сечения позволява да се получи съвкупност от изолинии, които дават информация за процентното съдържание на корозионните огнища по почистените детайли.

Зависимостта за съдържанието на корозионните огнища от аподната плътност на тока и времето за обработка в стопилката от основи при постоянни T = 610 K и C = 5 % има вида:

\[ Y = 0,5488 - 0,01X₀ + 0,1025X₁ \]

и се представя чрез криви с равни значения на фиг.1. В диапазона на изменение \( Da = 0,1÷1,2 \text{ kA/m}² \) и \( t = 6,3÷48,2 \text{ min} \) обработкените във ваната детайли имат слабо повишено на процентното съдържание на корозионните огнища (≈ 1,2÷2,2 %). Повърхностите на почистените детайли при малките стойности на \( Da \) и \( t \) имат понижено процентно съдържание на корозионните огнища, което плавно намалява с понижаване стойностите на \( Da \) и \( t \).

Фиг. 1 Изолинии за процентното съдържание на корозионните огнища по почистените детайли в зависимост от \( Da \) и \( t \) при \( T = 610 \text{ K} \) и \( C = 5 \text{ %} \).

Влиянието на времето за обработка на почистените детайли в солната вана при \( T = 608 \text{ K} \) и \( Da = 0,5 \text{ kA/m}² \) концентрацията на фосфорната киселина във ваната се описва от зависимостта:

\[ Y = 0,475 + 0,09X₀ - 0,28X₁ - 0,05X₄ - X₅ \]

и се интерпретира чрез изолиниите на фиг.2.
Фиг. 2. Изолинии за процентното съдържание на корозионните огнища по почистените детайли в зависимост от $C$ и $t$ при $T = 603$ К и $Da = 0.5$ kA/m$^2$

Колебанията на времето за обработка в диапазона 45÷70 min практически не оказва съществено влияние върху процентното съдържание на корозионните огнища. Но силно това е изразено в началния период 10÷45 min.

Съвместното влияние на концентрацията на фосфорна киселина след почистването на детайлите и анодната плътност на тока при $T = 610$ K и $t=30$ min се описва от зависимостта:

$Y_i = 0.448 - 0.28X_1 + 0.04X_1X_2$

и е изрежена графично на фиг.3

Фиг. 3. Изолинии за процентното съдържание на корозионните огнища по почистените детайли в зависимост от концентрацията и $Da$ при $T = 610$ K и $t=30$ min.

Аналитът показва, че концентрацията на фосфорна киселина в разтвора за нейтрализация на детайлите след обработка в солната вана незначително влияе върху процентното съдържание на корозионните огнища, но повишаването на плътността на тока значително увеличава процента на корозионните огнища.

Зависимостта на процентното съдържание на корозионните огнища от въздействието на температурата на стопилката и времето на обработка в солната вана при постоянна $Da= 6$ kA/m$^2$ и $C = 5\%$ има вида

$Y_i = 0.404 + 0.56X_1 + 0.102X_2 - 0.06X_2^2$

и се представя, чрез изолиниите на фиг.4

Фиг. 4. Изолинии за процентното съдържание на корозионните огнища по почистените детайли в зависимост от температурата на стопилката и времето за обработка при $Da = 0.5$ kA/m$^2$ и $C=5\%$.

Колебания в температурата в диапазона 600÷700 K практически не влияе върху процентното съдържание на корозионните огнища по електролитно почистените детайли.

Високите стойности на температурата и времето за обработка в стопилка от основи са един от основните фактори определящи процентното съдържание на корозионните огнища.

3. Заключение:

Правилното подбиране на параметрите при почистване на детайлите в стопилка от основи може да доведе до оптимално съчетаване на крайните антикорозионни характеристики предсказването им.

С помощта на получените модели зависимости при конкретно зададени антикорозионни свойства могат оптимално да се подберат и технологичните режими на процеса електролитно почистване в стопилка от основи в предварително подбрани и изследвани области.

4. Литература

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Abstract: The main factors that allow the aggregate electrochemical deposition of two or more metals and the formation of the corresponding electrolyte alloy are identified in the development. The aggregate deposition of two or more metals on the cathode has been shown to be the equality of their deposition potentials.

KEY WORDS: THEORETICAL ANALYSIS, DEPOSITION, METALS

Features of total electrolytic deferment of iron, cadmy and nickel

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1. Увод
Електролитното нанасяне на сплави за промишлени цели започва да се развива успоредно с нанасянето на монометални електролитни покрития.

Първата електролитна сплав месинг е получена през 1841г.[1,2] Въпреки този факт изучаването и прилагането на електролитните сплави намира широко приложение в последните четири на ХХ век. В сравнение с монометалните покрития, сплавните имат редица преимущества. Едно от най-важните е, че химичния и структурен състав на получената електролитна сплав може да притежава желаните от нас свойства.

2. Изложение
Главните фактори, които определят възможността за съвкупно електрохимично отлагане на два или повече метала и образуването на електролитна сплав са следните: [4]

• Катодната поляризация на всеки един от металите в електролита;
• Същност на равновесния потенциал на всеки един от металите в електролита;
• Относителната концентрация на йоните на отделните метални сплави в електролита и особено в прикатодния дифузионен слой;
• Режим на електролиза като температура, плътност на тока, разбъркване на електролита и др.
• Потенциала на отделянето на водорода при получаването на сплава.

Влиянието на всеки един фактор може приблизително да бъде отчетено, но е трудно да се предвиди ефекта от едновременно-прецеленно изменение на два или повече от посочените по-горе фактори. В разтвори на прости соли много малко метали имат близки по значение равновесни потенциали.

От съществено значение за получаването на електролитни покрития са явленията, които протичат на границата електрод-електролит.

Сумарната електродна реакция [1]:

(1) \[ \text{Me} + n.e^- \rightarrow \text{Me}^{n+} \]

Потенциалната разлика намерена при това равновесно състояние се нарича равновесен потенциал, който се определя по формулата:

(2) \[ E_p = E_0 + \frac{RT}{nF} \ln C_{Me}^{n+} \]

където: \( E_p \) - равновесен потенциал;
\( E_0 \) - равновесен потенциал при \( C=1 \) и \( T=293\,\text{K} \);
\( R \) - газова константа;
\( T \) - абсолютна температура;
\( n \) - валентност на метал;
\( F \) - число на Фарадей;
\( C_{Me} \) - концентрация на метални йони в електролита.

Първата електролитна сплав месинг е получена през 1841г.[1,2] Въпреки този факт изучаването и прилагането на електролитни покрития започва да се развива успоредно с нанасянето на монометални електролити.

Отсъствие на дискретирането със следната формула [4]:

(3) \[ \text{Me}^{n+} + n.e^- \rightarrow \text{Me} \]

Всяка електродна реакция е сложен хетероген процес, който се състои от поредица стадии, които могат да протичат последователно или успоредно. Скоростта на електродната реакция се определя от скоростта на най-бавната реакция.

Пътя на разписание на съдържанието се свежда до пренебреzenе на явленията, които намаляват скоростта на отлагането и това забавя на процеса е известно под името химическа поляризация. Тя съществува във висока степен, понеже не се знаят конкретно въздействие на електролита и особено на прикатодния дифузионен слой.

Полагайки се от предходни прегледи, че катодното отлагане не протича тъй просто както би могло да се предполага на пръв поглед. Тук по всяка вероятност се извършва процес, подобен на химически процеси, които протичат при движение на водорода, но съществуват и възможности, които ги тълкуват по друг начин.

Катодното отлагане не протича тъй просто както би могло да се предполага на пръв поглед. Тук по всяка вероятност се извършва процес, подобен на химически процеси, които протичат при движение на водорода, но съществуват и възможности, които ги тълкуват по друг начин.

Едновременното последователно отлагане на Fe, Cd, Ni е възможно благодарение на близките им електродни потенциали в реда на относителната активност на металите:
В този ред нарасва стандартизираният електроден потенциал на металите.
на анода (+):

\[ \text{Ni}^2+ + 2e^- = \text{Ni} \]

Полученото покритие е силно кристално и качествено. За увеличаване на електролитното разтваряне може да се постави \( \text{Na}_2\text{SO}_4 \) и подобряване разтворимостта на анодите се добавят Електролизата е процес, при който при преминаване на електрически ток през разтвор се отделят във въздуха електролизи съставни части от разтворената вещество или на други вещества, получени при вторични реакции. Положителният електрод е анод, а отрицателния – катод.

В реда на относителната активност металите от Fe до Pb заместват водорода от хлорводорода, свръхнатися като – \( \text{H}_2\text{SO}_4 \) и азотата – \( \text{HNO}_3 \) [3]

При наличието на няколко възможни реакции, на катода протича първо процесът на метал с по-висок (по положителен) електроден потенциал. По тази логика не би трябвало да е възможно отделянето на Fe например от водни разтвори. Но на практика електролитния отлагане на Fe е възможно, което се дължи на т.н. свръхнапрежение. Поради различни кинетични процеси е необходим по-висок (по-отрицателен) потенциал от стандартизирания електроден потенциал, за да протече даден процес на катода.

Казаното до тук важи и за анода, но с обратен знак. Поради свръхнапрежението понякога редът се променя.

В нашия случай в галваничната двойка \( \text{Cd} \rightarrow \text{Ni} \), никела има по-голям електроден потенциал и се отлага първо, поради което концентрацията на Ni сол трябва да е по-голяма.

Никеловите покрития не са устойчиви в атмосферата и съдържат серни или хлорни йони. Покритието се осъществява в резултат на редукция на катода \( \text{Cd}^2+ + 2e^- = \text{Cd} \) сол със водородни йони като се отделя газ водород \( \text{H}_2 \). Но количеството на отложени метал не съответства на количеството електричество, защото част от метала се изразходва за образуване на дисоциационната на водата:

\[ \text{H}^+ \text{OH}^- \rightarrow \text{H}_2 \text{O} \]

В случая Fe, Cd и Ni, при едновременното им отлагане никела има най-висок електроден потенциал и се отлага в първия слой. Всички електродни процеси се извършват във водни разтвори, поради тази причина при химичните реакции освен йоните на електролита трябва да се имат в предвид и йоните получени от дисоциацията на водата:

\[ \text{H}^+ \text{OH}^- \rightarrow \text{H}_2 \text{O} \]

където: \( \text{H}_2 \) са водородни йони, а \( \text{OH}^- \) са хидроксилен йони.

Покритието се осъществява в реда на реакция на катода на йоните на отлагащата се метала последователно:

\[ 1_{\text{физ}} \text{ слой: металът с най-висок електроден потенциал} \]

\[ \text{Ni}^{2+} + 2 → \text{Ni}^0 \]

\[ 2_{\text{физ}} \text{ слой:} \text{Cd}^2+ + 2 → \text{Cd}^0 \]

\[ 3_{\text{физ}} \text{ слой:} \text{Fe}^{2+} + 2 → \text{Fe}^0 \]

(най-отрицателен и най-висок електроден потенциал). Покритието се осъществява в реда на редукция на катода на йоните на отлагащата се метала последователно:

\[ \text{Fe}^0 + \text{Ni}^{2+} \rightarrow \text{Cd}^2+ + \text{Ni}^0 \]

Най-често използваната сол е никелов сулфат – \( \text{NiSO}_4 \)

\[ \text{Cd}^0 + \text{Ni}^{2+} \rightarrow \text{Cd}^2+ + \text{Ni}^0 \]

3. Заключение

Особеностите на електролитната сплав от железо, никел и кадмий отложена чрез променлив ток са разгледани недостатъчно в научната литература. Отлага се първо никелова сол, защото е най-надясно в реда на относителната активност на металите и след него последователно следващите поред кадмий и железо.

Анализът върху концентрацията на електролит за получаване сплав на основата на железо е използван периодичен ток с аноден полупериод, позволяващ състав на многокомпонентната сплав плавно да се изменя. Това става в зависимост от параметрите на променливия ток при електролит с непроменен състав и еднаква средна плътност на тока за един период.

4. Литература

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Features of the joint deposition of two or more metals on the cathode

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Annotation: The condition for co-deposition of two or more metal on the cathode is examined This is achieved by the transportation of ions to the electrode surface and to reflect it by means of polarization curves for the flow of the electrode reactions.

KEY WORDS: CHARACTERISTICS, DEPOSITION, METALS

1. Увод

Електродните процеси значително се усложняват при наличието на иони на два или повече метала в електролита. При получаването на електролитни сплави са възможни следните варианти при протичането на електродните реакции:
- взаимно влияние между електродните реакции;
- независимо протичане на електродните реакции;

2. Изложение

По-често отлагане на метални покрития лимитиращ стадий е транспортирането на йоните до повърхността на електрода. Тъй като доставката им става чрез дифузия, това ограничение се нарича дифузионно, а токът, който лимитира процесът се нарича граничен дифузионен ток $I_d$, който се определя по формулата: [1]

$$I_d = \frac{nFDCM\delta}{\eta}$$

където: $I_d$ – граничен дифузионен ток; $D$ – коефициент на дифузия на йоните; $A$ – дебелина на дифузионния слой; $n$ – валентност на метал; $F$ – число на Фарадеи; $C_{Me}$ – концентрация на металните йони в електролита.

Както се вижда от уравнение (1) граничният дифузионен ток нараства с увеличаване концентрацията на йоните, понижаването температурата на електролита (което повишава коефициента на дифузия) и при разбъркване на електролита (което намалява дифузионния слой).

Когато в даден електролит се съдържат иони на два метала $M_1$ и $M_2$ и се пропусне ток в зависимост от условията могат да се разйонизират две вида иони. Отделителните потенциали за $M_1$ и $M_2$ ще бъдат $\eta_1$ и $\eta_2$ съответно. При потенциал по-отрицателен от $-\eta_1$ на стъпало $1$ започва процес на деполяризация на $M_1$, а при потенциал по-положителен на стъпало $2$ започва процес на деполяризация на $M_2$. Сумарната скорост на процеса се определя от сумата на скоростите на двете реакции. На практика процесите на съвместното отлагане на електролитни сплави протичат много сложно.

Ако тези реакции протичат независимо една от друга, то общата поляризационна крива ще бъде равна на сумата от двете поляризационни криви [1] на фигура 1.

При потенциал на електрода по-положителен от равновесния потенциал на първия метал ($E_{p1}$) не протича никаква реакция. При потенциал по-отрицателен от ($E_{p1}$) започва процес на деполяризация на $M_1$, а при потенциал по-отрицателен на стъпало $2$ започва процес на деполяризация на $M_2$. Сумарната скорост на процеса се определя от сумата на скоростите на двете реакции. На практика процесите на съвместното отлагане на електролитни сплави протичат много сложно.

При наличието на йони на няколко метала в електролита, техните равновесни потенциали и потенциалите им на отлагане взаимно си влияят. При измерването на потенциала в отрицателна посока протича такова наречен процес на сръхполяризация, а в положителна посока – деполяризация [3].

При приготвяне на електролита за нанасяне на електролитни сплави е необходимо да се стремим максимално да съпротивляваме равновесните потенциали на металите чрез подходящ избор на тяхната концентрация, вида на металната сол, добавянето на повърхностно активни вещества и подходящ избор на режима на електролиза. Стремежът е по-
електроотрицателният метал да се отлага с деполяризация, а по-електроположителния със свръхполяризация.

Отлагането на възстановени антифрикционни електролитни сплави на оловна основа е възможно да се осъществи от прости електролити, които съдържат прости хидратирани йони. [1].

При избора на други химични елементи, участващи в сплавта трябва да се стремим техните равновесни потенциали да са по-електроположителни или близки до тези на оловото.

Съставът и свойствата на получените покрития можем да регулираме:
- чрез промяна концентрацията на металните йони в електролита;
- чрез наличието на повърхностно активни вещества;
- чрез режима на електролиза (температура, плътност на тока, киселинност, разбъркване на електролита и др.)

Също така от съществено значение е и химичния състав и электрохимичните свойства на възстановяваната повърхност. В много от случаите e необходимо да се нанасят тънки технологични подслоеве от моно- или полиметални покрития, с цел по-добро сцепление на полученото покритие с основата и улесняване на процеса на получаването на сплава.

3. Заключение:
Отлагането на даден метал от разтвор на негова сол става при катоден потенциал много по-висок (по-отрицателен) отколкото обратния потенциал при дадените условия. Например, когато подложим на електролиза разтвор, съдържащ простите йони на сребро, мед и кадмий, разйонизирането на съответните метални йони ще стане при потенциали: +0,79 V за сребро (Ag); +0,32 V за медта (Cu) и –0,40 V за кадмия (Cd).

Следователно, ако регулираме приложеното отъв напрежение, по ред можем да отложим първо среброто, след това медта и най-накрая кадмия. По такъв начин ние регулираме пълно отлъчване на металите един от друг при условие, че не образуват помежду си химическо съединение или твърд разтвор.

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