NEW KNOWLEDGES AT MACHINING OF IMPROVING HIGHSTRENGTH GRAPHITE CAST IRON BY DRILLING

ABSTRACT: High fortification of the machined surface of ADI (Austempered Ductile Iron) cast iron can significantly affect its functional properties. This article deals with problems of selected ADI samples, their production and use. On the basis of experimental tests has been identified its machinability, the cutting process during drilling, and also mutual comparison of nodular and grey cast iron, which will further intensify and extend current knowledge of this problems.

Keywords: ADI cast iron, drilling, machinability

INTRODUCTION
The relatively new construct material ADI alloy (ADI – Austempered ductile iron) have a special properties it is a bainite cast iron which we have from heat treatment (isothermal improving) of graphite cast iron with spherical graphite (nodular cast iron). ADI cast iron offers combination of simple properties like steel have. If conditions are fulfilling the ADI cast iron seems like steel for improving for example 42 CrMo4 (15 142), with its properties.

USING OF ADI CAST IRON
ADI cast irons are more low density like steel at same strength, have good wear resistance, elasticity, good sliding conditions and run into good characteristics of internal damping. This is why ADI is rivalrous to steel for forging, improving and steel cast iron.

If we know ratio between relative mass and slip line of ADI cast iron as against aluminium, steel and nodular cast iron are advantages at using ADI cast iron (fig.2). ADI cast iron are manufactured by isothermal improving, what is process of thermal treatment and it significantly impacts their mechanical properties (tab.1).

<table>
<thead>
<tr>
<th>Mark</th>
<th>Number</th>
<th>Rm (MPa)</th>
<th>Rp0.2 (MPa)</th>
<th>A5 (%)</th>
<th>HB</th>
</tr>
</thead>
<tbody>
<tr>
<td>EN-GJS-800-8</td>
<td>EN-JS1100</td>
<td>800</td>
<td>500</td>
<td>8</td>
<td>260 to 320</td>
</tr>
<tr>
<td>EN-GJS-1000-5</td>
<td>EN-JS1110</td>
<td>1000</td>
<td>700</td>
<td>5</td>
<td>300 to 360</td>
</tr>
<tr>
<td>EN-GJS-1200-2</td>
<td>EN-JS1120</td>
<td>1200</td>
<td>750</td>
<td>2</td>
<td>340 to 440</td>
</tr>
<tr>
<td>EN-GJS-1400-1</td>
<td>EN-JS1130</td>
<td>1400</td>
<td>1100</td>
<td>1</td>
<td>380 to 480</td>
</tr>
</tbody>
</table>

The properties of ADI are appointed for conditions of higher and high working strains (BECHNÝ, 2003).

EXPERIMENTALLY MEASUREMENT
It was drilled fifteen not continuous holes to prepared samples (fig.4) (drilling to full material) at five cutting conditions. The diameter of drilled holes was D = 6,8 mm and deep was h = 2xD. For experiment was used machine CNC – tripleaxle milling machine STAMA 325 and a tool GÜHRING 5518 DIN 6537 L91x6,8 mm – PVD TiAlN (fig.3).

Figure 1. Single-throw crank-shaft of Volkswagen engine 1,8T material EN-GJS-600-3 (www.lam.mw.tum.de)

Substitute of steel with casting from ADI is still the most frequent mood of application to reduce the manufacturing costs that means saving money or increasing life of workpieces (fig.1).

Figure 2. Comparison of material’s conditions

Figure 3. Photos of drilling tool a) back plane Pp, b) working reference plane Pr
The result from graphic files is that maximum values of \( F_0 \) and \( M_k \) were measured at sample GPL. Minimum values were measured at samples SNI and SRE (fig. 6 and 7). We find out at comparison of \( F_0 \) and \( M_k \) TS1 and ADI TS2 samples that sample ADI TS1 had lower \( F_0 \) in some cases by up to 37.8% and less torque \( M_k \) up to 27.8% compared with the ADI TS2.

### Experimentally Measurement of Tangential Component of \( F_0 \) and \( M_k \) (T)

Experiments were completed on eight samples, where we measured influence of cutting conditions to tangential component of cutting force \( F_0 \) and torque \( M_k \) (T) (fig. 5). Measured values were paced to graphs (fig. 6, 7).

### Experimentally Measurement of the Instantaneous Depleted Power

The measurement consists in two sections. In first one was measured instantaneous depleted power at idle, that means it was pasted path of machined area without material removal. In second one was measured instantaneous depleted power at load during of machining sample surface (fig. 6, 7).

The graphical results show that the maximum instantaneous value of received power was measured for a sample of the GPL, where the average value in...
conditions \( vc = 150 \, (m/min) \), \( vf = 491 \, (mm/min) \), \( n = 7021 \, (r/min) \) = 653. Minimum values were measured at SRE, where the average value of received power in conditions \( vc = 100 \, (m/min) \), \( vf = 140 \, (mm/min) \), \( n = 4681 \, (r/min) \) = 510.8 W.

When compared to the reciprocal waveforms of samples ADI TS1 and ADI TS2 (Fig. 10), we found that the sample TS1 ADI had a lower value of received power at the cutting conditions \( vc = 70 \, (m/min) \), \( vf = 229 \, (mm/min) \) \( n = 3276 \, (r/min) \) of 7.4%; \( vc = 100 \, (m/min) \), \( vf = 140 \, (mm/min) \), \( n = 4681 \, (r/min) \) of 4.5% and \( vc = 150 \, (m/min) \), \( vf = 491 \, (mm/min) \), \( n = 7021 \, (r/min) \) of 8.9% compared with the ADI TS2.

From economic view is measurement of instantaneous depleted active power very important. It is factor, which impacts the choice of technological process, cutting material and also choice of machined material. Since finances are nowadays an important factor in production, we must not forget indicators, such as the instantaneous depleted power.

**CONCLUSIONS**

Machinability of these cast irons significantly worse particularly high hardness and a higher percentage of silicon, which acts abrasive on the tool. Based on this knowledge and material characteristics were carried out experiments which allow to more identify machinability and cutting process for drilling in ADI cast iron.

**REFERENCES**

[5.] KIRGIN, K. E.: Modern Casting 81, 1992, č.1, str. 32-34.
[6.] www.claasguss.de
[7.] www.darwin.bht.rwth-aachen.de
[8.] www.lam.mw.tum.de
[9.] www.SHM-cz.cz
[10.] www.files.sssbb.meu.zoznam.sk