ARCHIVES of FOUNDRY ENGINEERING

Published quarterly as the organ of the Foundry Commission of the Polish Academy of Sciences

ISSN (1897-3310)
Volume 7
Issue 4/2007

197 – 201

39/4

Percussive sparking of metals

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Received 11.05.2007; accepted in revised form 28.06.2007

Abstract

The paper presents the results of research on sparking sensitivity of metals used for casting machine parts. The research concerns on the recording of dynamics of percussive sparking on the research stand designed and made by author. The research stand enables analogue and digital recording of the percussive sparks pictures. The research on percussive sparking was performed on single and multiple smears made of aluminium (AlSi9Mg, (AK9); AlSi11, (AK11)) and magnesium (AlMg9, (AG9)) alloys as well as St3 steel. The results are presented as pictures of sparks differing in shape and size as well as temperature distribution. It was shown that the sparks with the biggest area of plume occur for AK9 alloy and the biggest area of spark nucleus occur for AK11 alloy. The sparks registered for St3 steel have very small area of the plume and nucleus. The characteristics and thermal properties determined for the registered percussive sparks may be of use for designers and users of machine parts manufactured from these materials.

Keywords: Innovating materials and casting technologies, Silumins, Percussive sparking, Smears

1. Introduction

Up-to-date processes of casting of machine parts enable fast start of the nonferrous alloys casting production. Short time of production caused the implementation of casted machine parts in different branches of industry. Due to that, it is very crucial problem to know the properties of the materials used in explosive conditions.

The sources of explosion are fundamental issues of fire and explosion prevention in industrial conditions. The sources can also be percussive (mechanical) sparks, which are hot particles of metal alloys or other materials used in machine design [1-3].

The effect of formation of hot particles able to light up explosive mixtures is very dangerous in many branches of industry:

- coal, oil and gas mining as well as processing of the materials (mines, refineries, oil wells, etc.),
- chemical and armaments,
- fat production (e.g. margarine),
- power industry, fire-fighting and rescue – sea, mine, etc.

Mentioned possibilities of formation of explosive conditions and their occurrence caused by percussive sparking of cast machine parts is still unsolved problem of research [1-6].

Main aim of the presented results is a try of recording of the percussive-spark-plume and determination of its size and temperature distribution.

2. Research methodology and results

The alloys of aluminium and silicone (EN AC - 43300, AlSi9Mg (AK9) and EN AC – 44000, AlSi11, (AK11)), aluminium and magnesium (EN AC - 51200, AlMg9, (AG9)) and St3 steel were used in the research of percussive sparking.
The research was carried out on specially designed research stand shown on Fig. 1.

a)

b)

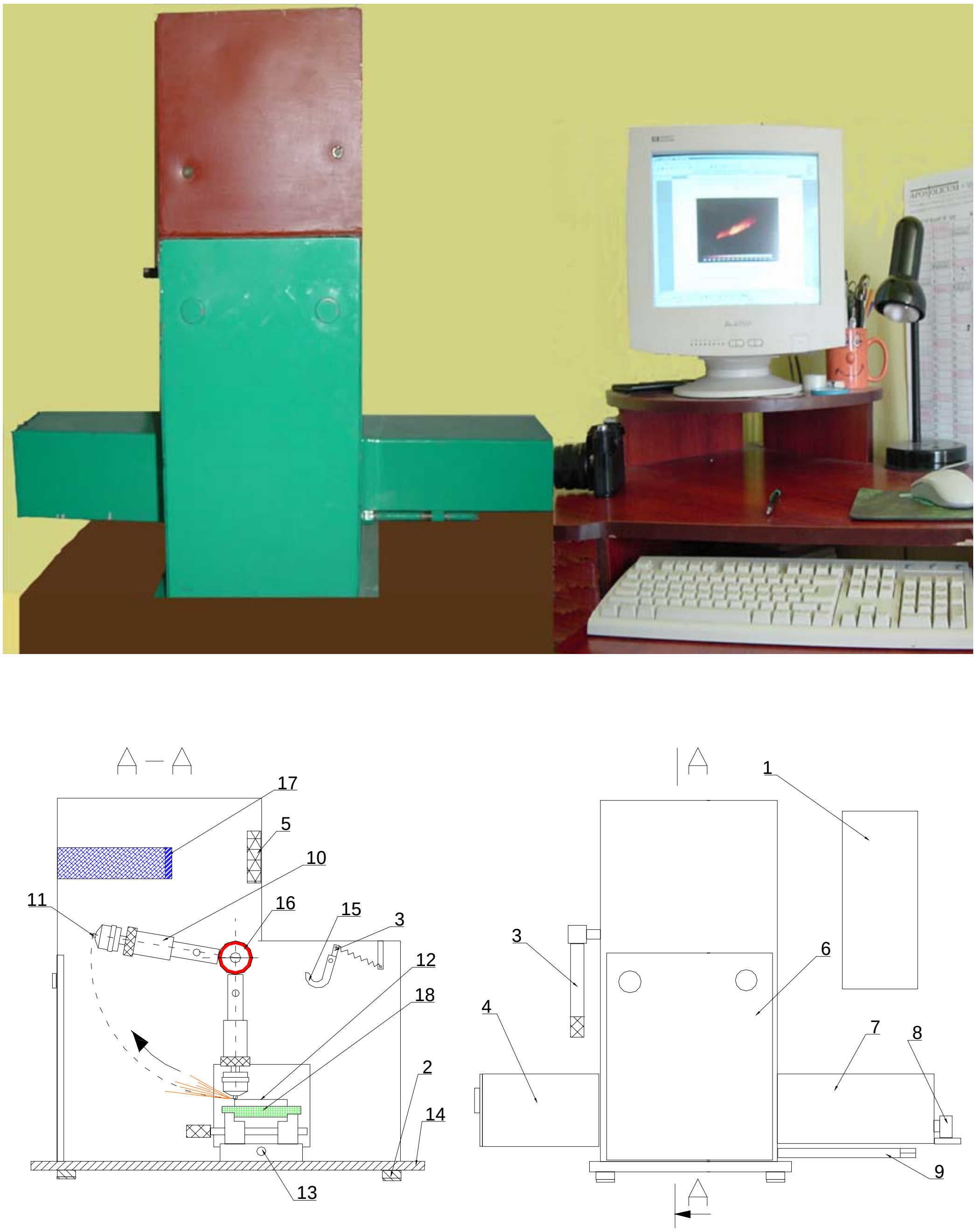


Fig. 1. Stand for research on percussive sparking: a – general view, b – scheme: 1- computer, 2 – rubber pads, 3 – striker release mechanism, 4 – video camera, 5 – bumper, 6 – cover, 7 – photo camera tunnel, 8 – photo camera, 9 – vice shift, 10 – striker arm, 11 – striker, 12 – sample, 13 – vice, 14 – base plate, 15 – striker catch, 16 – spring, 17 – shock absorber, 18 – insulation grip.

The percussive spark is gained by a hit with the striker 11 in the smear of the alloy under investigation made on a rusted sample 12.

Fig. 2. presents the view of the smears made on the rusted sample (a plate).

Magn. 6x

Magn. 18x

Fig. 2. View of AK9 alloy smears on the rusted sample

The percussive spark plume is recorded by a photo or video analogue or digital camera

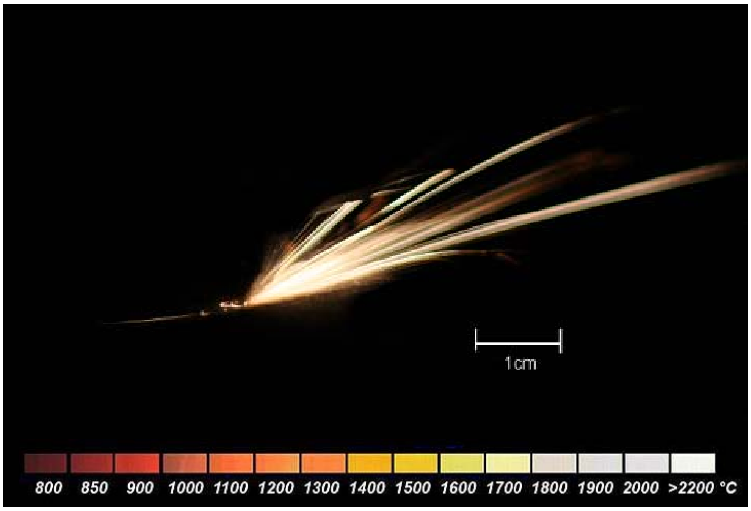
The different registered percussive sparks plumes and their analysis are presented on Fig. 3 to 6.

<table>
<tr><td>Sample:
St3 steel</td><td>Smear:
AK9</td><td rowspan="2">Striker:
Grey cast iron</td><td rowspan="2">Description:
Spark of a big size, hot, with double sided plume
Magnification: **1,5x**</td><td>Spark area:
3065,7 mm^2</td></tr>
<tr><td>Corrosion period:
30 days</td><td>Smear multiplicity:
2x</td><td>Nucleus size:
753,2mm^2 (24,6%)</td></tr>
</table>

Fig. 3. Shape and the analysis of the percussive spark of AK9 alloy

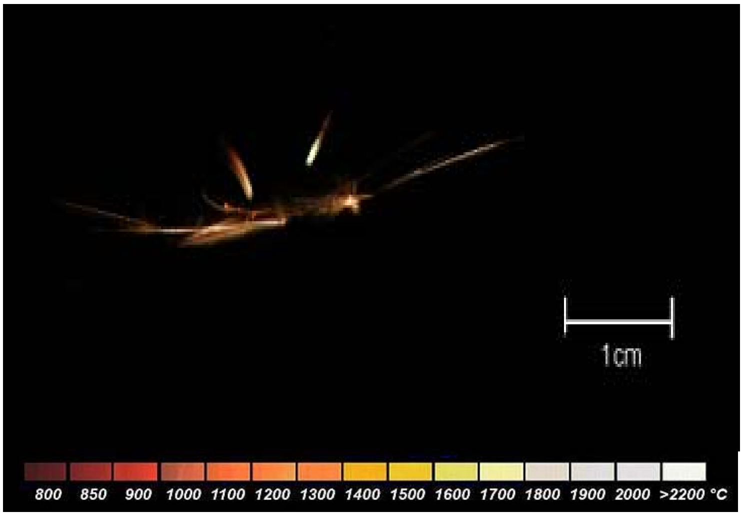
Sample: **St3 steel**	Smear: **AK11**	Striker: **St3**	Description: ***Spark of a big size, hot, with big double sided plume*** Magnification: **1,5x**	Spark area: **2357,2 mm^2**
Corrosion period: **30 days**	Smear multiplicity: **4x**			Nucleus size: **696,5mm^2 (29,5%)**

Fig. 4. Shape and the analysis of the percussive spark of AK11 alloy



Sample: **St3 steel**	Smear: **AG9**	Striker: **St3**	Description: ***Spark of a medium size, hot, with single plume*** Magnification: **1,5x**	Spark area: **568,8 mm^2**
Corrosion period: **30 days**	Smear multiplicity: **4x**			Nucleus size: **100,2mm^2 (17,6%)**

Fig. 5. Shape and the analysis of the percussive spark of AG9 alloy



Sample: **St3 steel**	Smear: **–**	Striker: **St3**	Description: ***Spark of a medium size, cold, distracted, with a few small nucleus*** Magnification: **1,5x**	Spark area: **67,6mm^2**
Corrosion period: **30 days**	Smear multiplicity:			Nucleus size: **0,7mm^2 (1%)**

Fig. 6. Shape and the analysis of the percussive spark of St3 steel

3. Conclusions

The results of the research show that the recorded plumes of the sparks differ significantly.

The biggest area (ca. 30066 mm^2) and big nucleus (ca. 25%) of the plume of percussive spark was recorded for the AK9 silumin alloy, and significantly smaller area (ca. 697 mm^2) of the plume but with big nucleus (ca. 29%) was recorded for AK11 silumin alloy, Fig. 3 and Fig 4. The recorded sparks for the AK11 have double sided plume.

For the AG9 aluminium-magnesium alloy smear, the recorded plumes were single with big nucleus (ca. 18%) and significantly smaller area (ca. 569 mm^2) comparing to the plumes of the silumin alloys, Fig. 5.

The recorded percussive sparks of St3 steel have the smallest area (ca. 68 mm^2) and nucleus (ca. 1%) of the plume comparing to the sparks recorded for aluminium alloys, Fig. 6.

The analysis of the temperature distribution in the aluminium-silicon and aluminium-magnesium alloys spark plumes, shows that they are very dangerous in explosive conditions. Due to that fact the designers and users of machine parts manufactures from these materials should not use them in the conditions of forming explosive mixtures.

References

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