

Methodology of peening intensity evaluation basing on the Almen tests

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Abstract

Surfaces of casting products as well as cores and moulds require thorough cleaning and treatment. Several cleaning methods are available, depending on the type of the material, the surface's geometry and condition, and the type of contamination. Shot peening treatment using rotor machines is a widely adopted solution and the peening performance is chiefly associated with shot peening intensity.

A methodology of evaluating the peening intensity is outlined. The method uses the Almen test, widely employed when analysing the efficiency of dynamic, surface treatment methods. The evaluation method is illustrated by experimental data, process parameters and operational parameters of a shot peening machine manufactured in Poland.

Keywords: Shot peening, Almen test

1. Introduction

The analysis of the currently available and forecasted surface treatment solutions clearly implicates that surface treatment and cleaning shall be achieved mostly by mechanical treatment methods, utilising dynamic abrasive action of the stream of a cleaning agent. The equipment available at the treatment plants includes mostly rotor machines designed for cleaning and treatment of the casting products [2, 3, 7].

In terms of the operating parameters and performance of rotary peening machines, major achievements have been made recently, leading to novel solutions, including machine components, treatment units, separators of the cleaning agent and dust removing installations. Improvements of the peening unit design allow for good control of the shape and density of the shots and of velocity, kinetic energy and the direction of the shot stream.

The Almen test is used to determine the shot peening performance. Accordingly, standardised steel strips are subjected to shot peening. When hit by the shot stream, the test strip gets deformed and the strip's curvature becomes the measure of the shot peening intensity. The Almen test also used to check the adequacy of shots for the given application [3].

2. Methodology of shot peening intensity evaluation

The "pioneers" of the shot peening process were Henry Fuchs and John Almen [1]. The Almen strip still remains an excellent tool for evaluating the peening intensity. The test shows the deflection of the strips $76 \pm 0.2 \times 19 \pm 0.1$ mm in size. During the test the strips are fixed in the holding fixture (Fig 1).

Three types of Almen test strips are in widespread use, depending on the peening intensity [1.4-6]. The A strip, with the

thickness $s=1.3 \pm 0.22$ mm, is the most common type. It is used for medium intensities, the measured deflection falling in the range $fA=0.11 \pm 0.60$ mm.

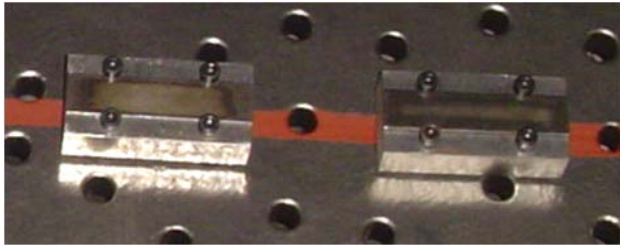


Fig 1. Test strips in the holding fixture

For low intensities ($fA < 0.15$), A strips are used that have the thickness $s=0.8 \pm 0.02$ mm. C strips with the thickness $s=2.4 \pm 0.02$ mm, are used for high intensities, $fA > 0.60$ mm. Fig 2 shows the intensity correlations between the strip deflection data.

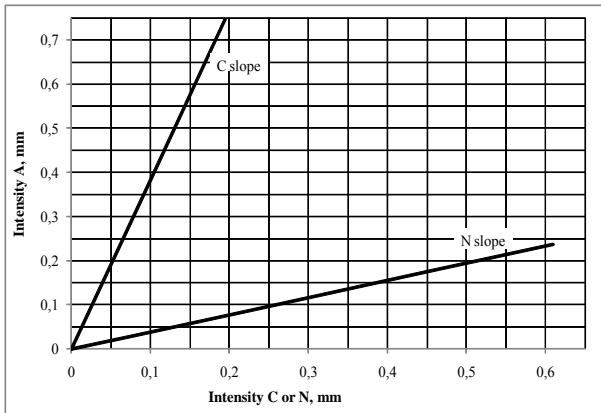


Fig 2. Approximate intensity correlation from A to C and N strips [1]

Shot peening intensity can be also measured by the surface coverage factor [1,4]. Special formulas are derived to yield the proportion of the surface area targeted by the shot stream. A shot peened strip (type A) is shown in Fig 3.

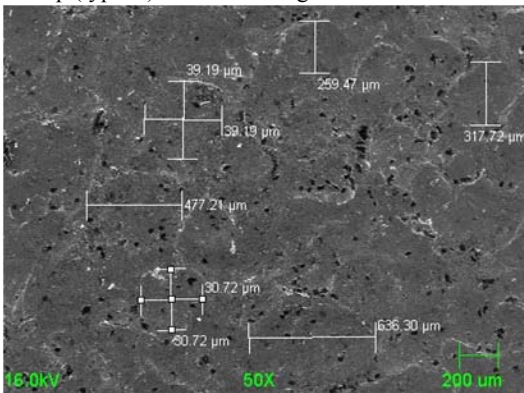


Fig 3. Test strip A, zoomed section ($\times 50$); process parameters: $\tau=60$ s, $n=2933$ 1/min; $m=162$ kg/min

3. Experimental program

The shot stream intensity in the rotary peening machine OWS-1000 [7] is determined using the Almen test strips. During the test, the rotor was positioned over the immobile bench. The shot peening intensity was equal to $m=66$ kg/min. The rotor's rpm was $n=1486, 2244$ and 2933 1/min. The shot stream intensity is measured as the deflection of the strips fixed in holders on the bench, along the designated axes x and y (Fig 4). Results shown were obtained for the test parameters: $\tau=60$ s, $n=1500$ 1/min. The shot type used is denoted as S330 (cold rolled spring steel), with the grain size 0.71-0.18 mm and standard hardness 450-535 HV (46-51 HRC).

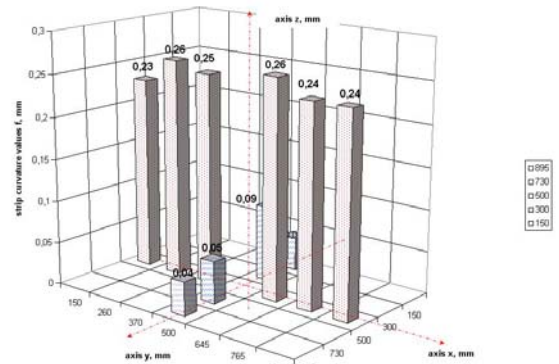


Fig 4. Distribution of strip curvature values at selected points on the test bench

The specimens ready for tests are shown in Fig 5.



Fig 5. Test specimens and castings to be treated in the bench

Test data are presented in another format in Fig 6, showing the strip's curvature versus the rotor's rpm.

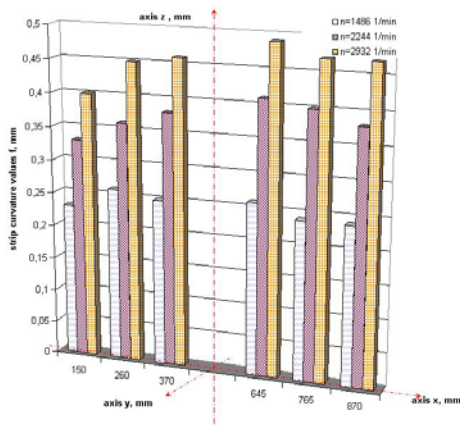


Fig 6. Curvature of the C strips versus shot peening intensity

On the horizontal axis we have the location of test specimens. In the bench axis (at the distance of about 507 mm) are transducers incorporated in the measuring circuit. The applied tensometric transducers would register the averaged thrust force of the shot stream upon the surface of a disc, with the diameter ϕ 168 mm. The thrust force of the shot stream ranges from 1 to 11 N, depending on the operating parameters of the shot peening machine.

4. Methodology of shot peening intensity evaluation

The major parameters of the process intensity include: duration time (saturation) and surface conditions of the finished products (surface coverage factor).

The process time is determined basing on experimental data on fluctuations of the strip's deflection whilst the time increases. The time selection method is best illustrated in Fig 7.

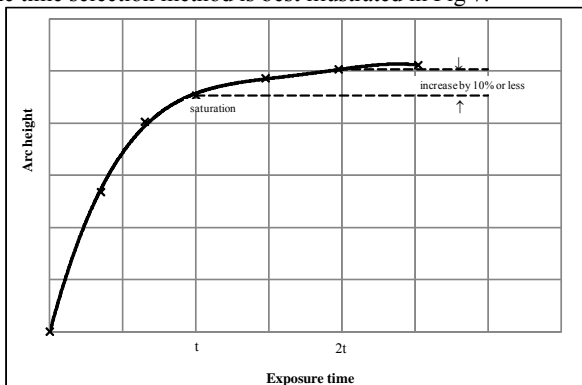


Fig 7. The saturation curve [1]

The Almen test is commonly used to select the treatment time and to find the surface condition of the product to be finished, besides, it can be employed to evaluate the shot stream intensity depending on the shot size and type, the position of the product to be finished and direction of the shot stream. It is of major importance when selecting the optimal position of the adjusting sleeve.

5. Conclusions

The outlined methodology of peening intensity evaluation using the Almen test might be also employed when selecting parameters of the finishing treatment of castings.

Application of the Almen test strips vastly facilitates such evaluation. It is a simple and cost-effective method, particularly well suited for comparative analyses. Almen test data might be utilised to find the optimal distribution of the shot stream and its major parameters.

The Almen test performed with the use of a peening machine OSW proved its full adequacy for evaluation of shot stream parameters in relation to the operating parameters of the machine.

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