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Influence at Work Distance between the Sonotrode and Specimen to Cavitational Erosion

The paper presents the results of cavitation erosion tests performed on five samples from pure aluminum using the vibratory method with stationary specimen. The main purpose of this research is for determine which is the distance between the sonotrode and specimen favorable for an aggressive cavitational attack. For this, has been calculated the Mean Depth of Erosion (MDE) and the cavitation erosion rate (V_{ec}). After that the specific curve for V_{ec} has been analytically processed.

***Keywords**: cavitational erosion, sonotrode, aluminium*

1. Introduction

Cavitational erosion is consequence localized decrease of the dynamic pressure in a fluid whereby are generating vapor bubbles or cavities which produce frequently material loss on adjacent surfaces [1]. Flow velocity, material and size of the component, corrosion, roughness, temperature, thermodynamic effects, fluid properties and gas content are various factors which influenced this phenomenon [2]. Therefore, due to the large number of factors that influence cavitation, qualitative approaches have been developed to this sense.

Carried out numerical simulations on certain components hydro for adapt more easily in parametric optimization procedures [3-6] or finding of materials resistant to impact are part of the concerns researchers with the purpose to limit or prevent the cavitational erosion [7-9].

Order to determine the resistance to cavitation in the laboratory conditions can be using three methods: vibratory method (or ultrasonic method), liquid jet method and Venturi method. The vibratory method is the most used due the simplicity of the testing procedure and due to the testing time, relatively short [10].

This paper presents research for establish distance between the sonotrode and specimen favorable for an aggressive cavitational attack using the indirect vibratory method.

2. Materials and test method

2.1. Materials

For accelerated test have been used samples from aluminum pure (impurities: Cu - 0,001%; Zn - 0,005%; Mn - 0,0025% and Mg - 0,001%) with 16 mm in diameter and approximately 20 mm in thickness (as shown in figure1). The test specimen surface was prepared by grinding with emery paper up to grade #1200.

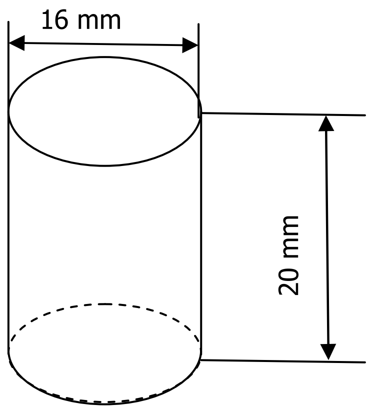


Figure 1. Schematic representation of the aluminum specimens

2.2. Test Method

The cavitation erosion tests were carried out in a stationary specimen method by using a vibratory apparatus as specified in the ASTM standard G32-10. The specimen is fixed and fully immersed in the liquid as shown in figure 2. To produce a various cavitation conditions, the distance between the vibrating sonotrode and the test specimen (stand-off work) was adjusted to be 0.4, 0.5, 0.6, 0.7 and 0.9 mm. The resonance frequency of oscillator was 20 ± 0.5 kHz and the double (peak to peak) amplitude of the vibrating sonotrode was 50 μm. The test liquid was deionized water and kept at 25±2 degrees C with a temperature control device and using a cooling system with water.

The test specimen was removed periodically after predetermined time intervals and weighed with a precision balance after cleaning with acetone and drying in flow of hot air. The test result was expressed by Mean Depth of Erosion (MDE) using the mass loss divided by the density of material and the eroded area.

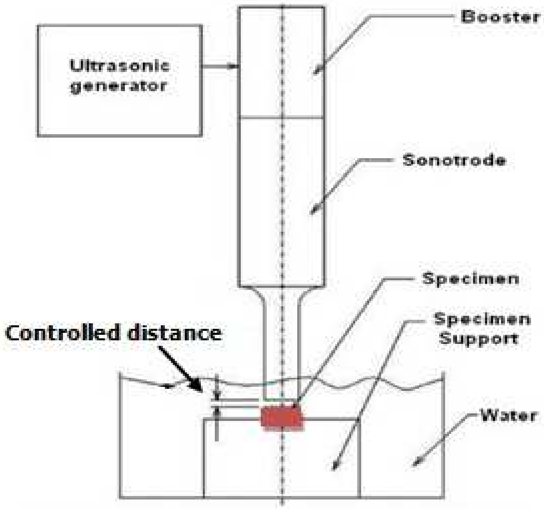


Figure 2. The principle of the indirect cavitation method

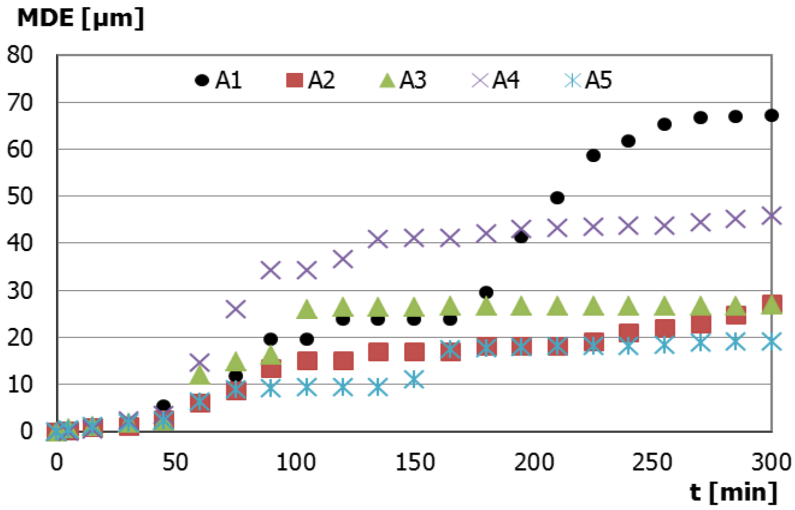
3. Experimental results

The total duration of the attack cavitation for all five samples is 300 minutes, divided into 21 periods to process the weighing. At the beginning and end of each period the samples were immersed in acetone and then are drying in a stream of hot air and weighed on an analytical balance which allows seeing for five decimals. The initial weight for each sample, cumulative eroded mass after 300 minutes of test and the distance between the vibrating sonotrode and specimen (stand-off work) immersed in water are shown in table 1.

Table 1. Working distance sonotrode/sample and the initial weight

Label of specimen	Distance sonotrode/sample [mm]	Material	Cumulative eroded mass [mg]	Initial weight [g]
A_1	0.6	Aluminium pure	145.69	8.23003
A_2	0.9		59.60	7.83640
A_3	0.5		58.28	7.64692
A_4	0.7		99.39	7.69382
A_5	0.4		41.27	7.97536

Figure 3 shows the mean depth of erosion curves (MDE) at stand-off work of 0.4 (A_5), 0.5 (A_3), 0.6 (A_1), 0.7 (A_4) and 0.9 (A_2) mm between the vibrating sonotrode and the specimen for pure aluminum and in figure 4 are graphical represented the cavitation erosion rate (V_{ec}) together with the curve resulting by polynomial interpolation.



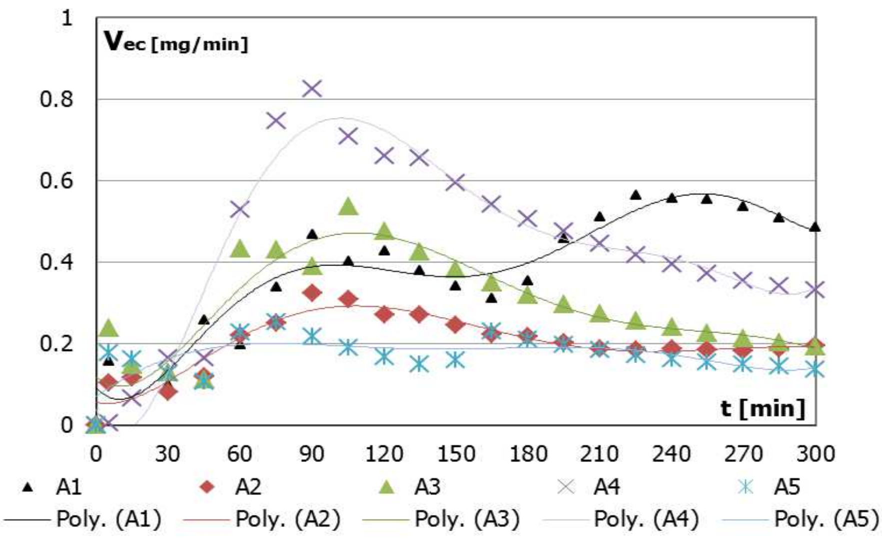
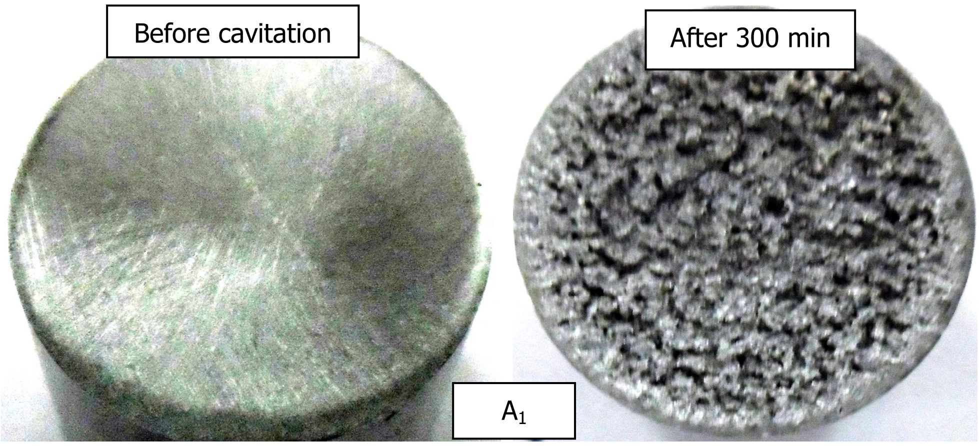
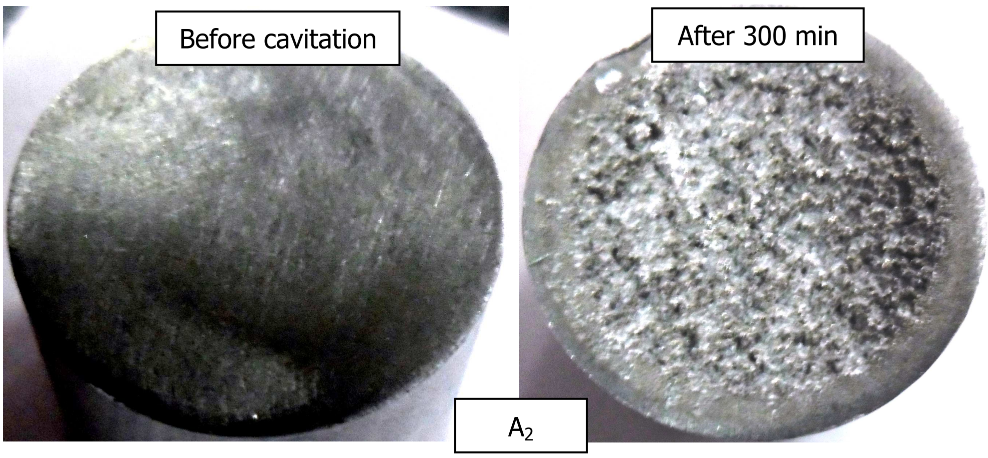


Figure 4. The variation of the cavitation erosion rate for all specimens

Every mean depth of erosion curve passes through an incubation period with low erosion rate (less than 30 min) and then increases linearly to reach a maximum rate period for each distance of working. The periods were obtained from figure 3 as the point of intersection of the extended straight line of the slope of the maximum rate period with the axis of the exposure time.

Comparing the five samples in terms of MDE (figure 3) can be seen that the mean depth of erosion at 300 minutes of test is higher for A_1 sample to distance of working 0.6 mm and lower for A_5 sample to distance of working 0.4 mm. In addition, the analytical curves and the experimental curves from figure 4 are approximately likewise. The appearance of surfaces after total period of exposure to cavitation confirms the results presented by MDE curves (can see figure 5).





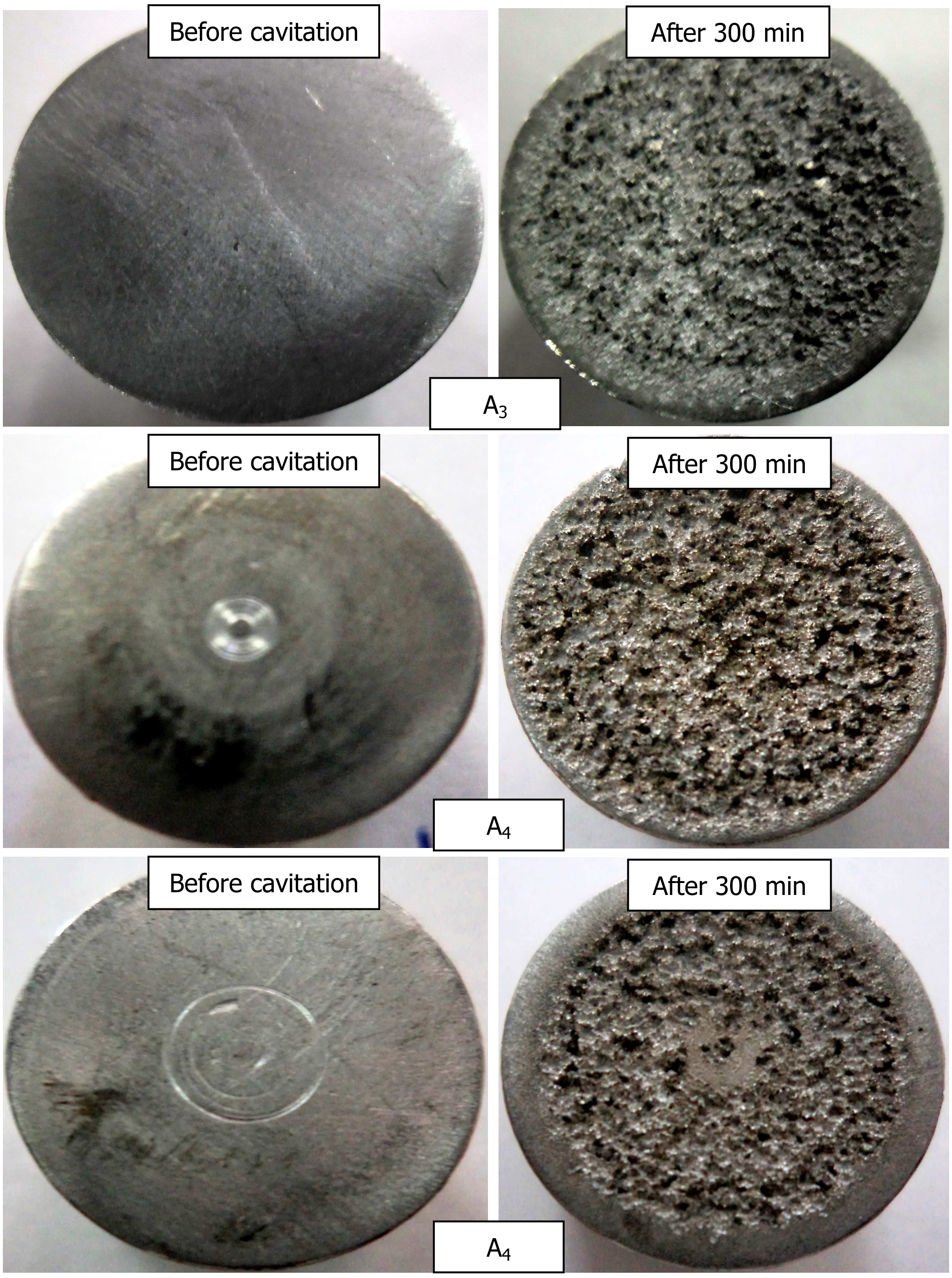


Figure 5. The appearance of surfaces before and after total time of exposure to cavitation

4. Conclusion

Distance of working between the sonotrode and specimen favorable for most aggressive cavitational attack is of 0.6 mm at sample A1. This one is perfect for testing of surfaces by indirect method.

The analytical processing confirms that general distribution of experimentally points compared with polynomial curve is uniform for cavitation erosion rate.

Because distances of working sonotrode-specimen of 0.4 mm, 0.5 mm respectively 0.9 mm had lower values to mean depth of erosion on future such of parameters will be avoided for testing to cavitational erosion by indirect method.

Acknowledgments

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