CAVITATION EROSION RESEARCH ON C45 CARBON STEEL. PART II: EXTENDED DURATION FOR 900 MINUTES

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ABSTRACT: This paper, based on the experimental results obtained in the research, presents the cavitation erosion resistance of the C45 carbon steel. These researches involve only one test of 900 minutes for 20 periods of 45 minutes, which mean a total time of 15 hours. Depending on these results, the material loss curve was obtained and also the cavitation erosion rate experimental and analytic curve was obtained.

KEY WORDS: Cavitation erosion, C45 carbon steel, extended duration for 900 minutes.

1. INTRODUCTION

In the liquid, due to the difference in pressure, arises the cavitation phenomenon, which is characterized by cavitation bubbles.

In time, these cavitation bubbles, destroying materials that come into contact with, materials that are manufactured the rotors of hydraulic machines (turbines, pumps), valves, pipes, etc. [1].

Regarding the cavitation erosion and the cavitation phenomenon, are made multiple experimental research in laboratory to find materials that are resistant to this destruction by cavitation [2].

For example, through the vibratory apparatus through direct and indirect cavitation method concluded that many metallic materials including stainless steels are destroyed over time [2], as shown in a number of scientific researches on:

- heat treatment to a better materials, and to improve the mechanical properties of the materials [1] and [2];
- anticavitation Lips [3];
- special layer, coating deposition, filler or welding [4] - [9];
- testing different types of stainless steels [10] and [11];
- laboratory testing of other metallic materials such as cast iron and non-ferrous metals [12] - [14].

Also through this paper, which presents some experimental results obtained in the laboratory, it does want to bring a contribution to the cavitation erosion resistance of C45 carbon steel.

This material will be subjected to cavitational attack for a extended duration for 900 minutes or 15 hours.

2. THE WORK PROCEDURE

The C45 material will be tested by the indirect cavitation method [15], on a vibratory apparatus, where the distance between the ultrasonic horn or sonotrode and sample of C45 steel is 0,6 mm. The C45 steel sample is clamped in a special holder inside of a liquid vessel.

Also, the resonance frequency of the vibratory apparatus is around the value of 20 kHz and the amplitude of 50 μm [16].

This sample, with cylindrical form will be subject to 20 standard periods of the cavitational attack, each of 45 minutes.

After this total time, the material loss and cavitation erosion rates over time curves can be made.

The stages testing of this sample only for a time period of 45 minutes are listed below and shown in Figure 1:

- the proper testing on the vibratory apparatus (the sample will clamped in a the holder inside the liquid vessel - Figure 1 a);
- the sample must be immersing with a tweezers in alcohol for the removal of impurities;
- drying the sample by air jets with the help of a compressor for a time of 30 ÷ 60 seconds;
- weighing the C45 sample using the digital balance (until the weight value stabilizes - Figure 1 d);
- recording the measured value in a data base of a notebook.

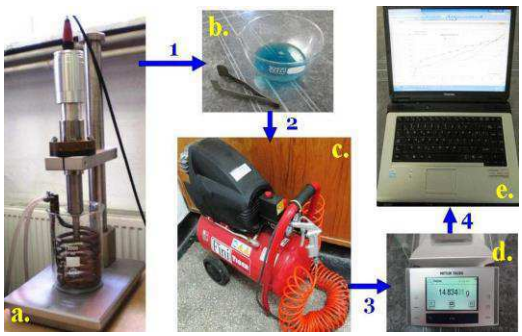

Figure 1. The stages testing of the C45 sample only for a period of 45 minutes

3. THE OBTAINED RESULTS

Further, in Table 1 are shown the experimental results obtained for the 20 standard periods of 45 minutes of the C45 carbon steel.

Figures 2 and 3 are presented the characteristic curves of cavitation erosion process for the tested C45 carbon steel namely:

- material loss curve;
- cavitation erosion rate curse.

Table 1. The experimental results for C45

Accuml. time	Period time	Specimen mass	Accuml. eroded mass	Cavitation erosion rate
t [min]	t [min]	m [mg]	mc [mg]	vec [mg/h]
0	0	14941.59	0	0.000
45	45	14936.01	5.58	6.780
90	45	14931.42	10.17	7.247
135	45	14925.14	16.45	7.680
180	45	14919.9	21.69	7.773
225	45	14913.48	28.11	8.747
270	45	14906.78	34.81	8.307
315	45	14901.02	40.57	7.760
360	45	14895.14	46.45	8.227
405	45	14888.68	52.91	8.000
450	45	14883.14	58.45	7.687
495	45	14877.15	64.44	8.227
540	45	14870.8	70.79	8.667
585	45	14864.15	77.44	7.967
630	45	14858.85	82.74	7.287
675	45	14853.22	88.37	7.307
720	45	14847.89	93.7	7.213
765	45	14842.4	99.19	7.527
810	45	14836.6	104.99	7.600
855	45	14831	110.59	7.440
900	45	14825.44	116.15	7.387

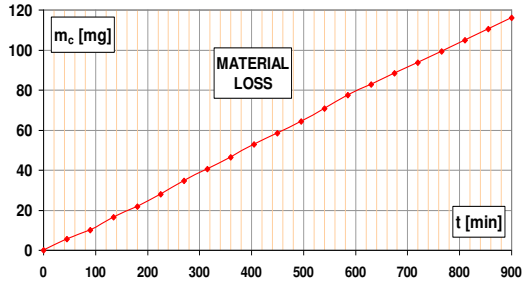

Figure 2. Material loss curve for C45 steel tested at 900 minute

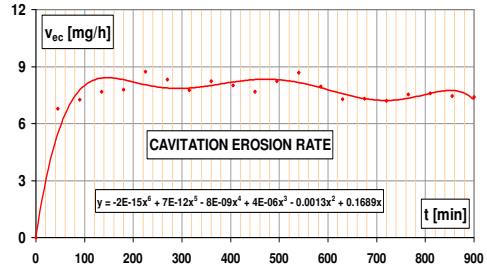

Figure 3. Cavitation erosion rate curve for C45 steel tested at 900 minute

For more accurate representation of cavitation erosion rate curve in Figure 3 is also obtained the polynomial interpolation (analytic curve) given by relation one (with $R^2 = 0,9266$):

$$v_{ec} = -2 \cdot 10^{-15} t^6 + 7 \cdot 10^{-12} t^5 - 8 \cdot 10^{-9} t^4 + \\ + 4 \cdot 10^{-6} t^3 - 0,0013 t^2 + 0,1689 t \quad (1)$$

Figure 4 shows images of the eroded surface and also the macrostructure after a total of 900 minutes.

a) Image after 360 minutes

b) Image after 900 minutes

c) Macrostructure after 900 minutes

Figure 9: Macrophotos of the C45 steel surface after cavitation

4. CONCLUSION

After this experimental research, the following conclusions can be made:

- Test samples of the C45 carbon steel, for a total time of 900 minutes, has lost 116,15 mg of material;
- The material loss curve is increasing;
- The cavitation erosion rate curve according to time, from 135 to 900 minutes, stabilized with a constant evolution.

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