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Comparative Study on the Cavitation Erosion Resistance Experimental Results of Some Steels Tested through the Cavitation Indirect Method

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This paper presents the experimental results of cavitation erosion research regarding the resistance of some steels. So, the cavitation erosion researches involve tests of hours for each test. These results are in tabular form, through charts and pictures presented in this paper.

***Keywords**: cavitation erosion resistance, steels, cavitation indirect method*

1. Introduction

Today, different metallic materials are tested to see their wear resistance [1] - [4] and also the cavitation erosion resistance, erosion produced especially in the hydraulic machines due to through the cavitation phenomenon [5] - [13].

For testing the cavitation erosion, the used experimental stands are the vibratory apparatus because the short time and good results [14] - [22].
The most short time can be done through the direct cavitation method [23].

In this paper, all the experimental tests are made on a cavitation experimental stand (vibratory apparatus) by the indirect cavitation method respecting certain standards [24].

2. The cavitation experimental stand (vibratory apparatus) and the obtained results

The vibratory apparatus (Figure 1), operates under the following conditions: the apparatus natural frequency: 20 ± 0.5 kHz; the amplitude value: 50 μm; the temperature of the used liquid: 25 ± 2 °C and the distance between the ultrasonic horn and the tested sample: 0.6 mm.

Figure 1. The vibratory apparatus.

The experimental results are shown in Table 1 for the following steels: C45, 26CrMo4, 34CrNiMo6, X20Cr13, X3CrNi13-4 (1), X3CrNi13-4 (2), X3CrNi13-4 (3), X3CrNi13-4 (4) and X5CrNi18-10 [25] and [26].

Table 1.

No.	Steels	Period time [min]	Cumulated time [min]/[hours]	Before cavitation [mg]	After cavitation [mg]	Material loss [mg]
1	C45	45	900/15	14941.59	14825.44	116.15
2	26CrMo4			14829.8	14752.96	76.84
3	34CrNiMo6			15053.24	15017.9	35.34
4	X20Cr13	30	1080/18	15913.29	15816.59	96.7
5	X3CrNi13-4 (1)			31144.06	31045.75	98.31
6	X3CrNi13-4 (2)			15007.36	14928.3	79.06
7	X3CrNi13-4 (3)			15154.5	15103.6	50.9
8	X3CrNi13-4 (4)			14759.45	14667.78	91.67
9	X5CrNi18-10	60	1800/30	16308.17	16256.18	51.99

From further research on these materials summarized in Table 1, it will be plot the material loss and cavitation erosion rate vs time curves.

Figures 2 ÷ 4 show a comparison of these steels according to the lost mass to a common time of 900 minutes.

From all steels, in figures 5 ÷ 8 are show many images after the cavitation erosion process, only for the X3CrNi13-4 steel.

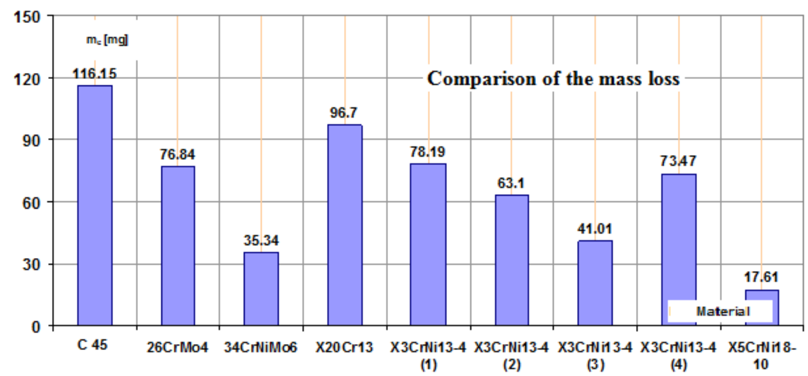

Figure 2. Comparison of the mass loss (900 minutes).

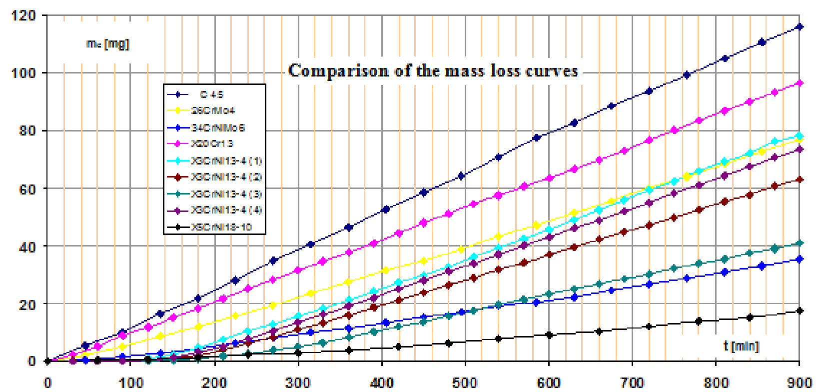

Figure 3. Comparison of the mass loss curves.

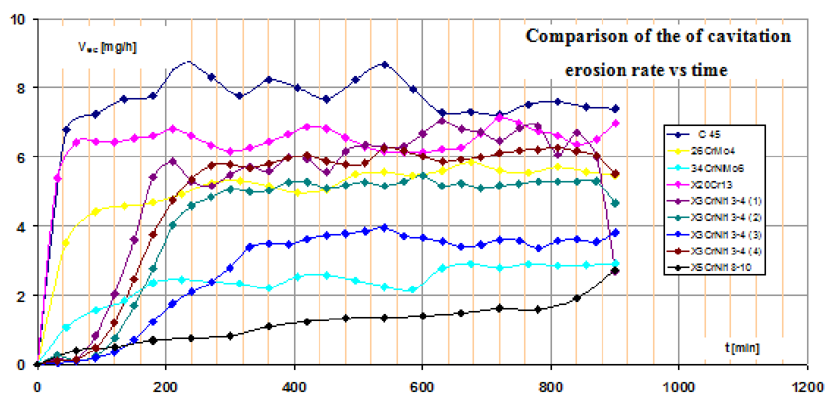

Figure 4. Comparison of the of cavitation erosion rate vs time.

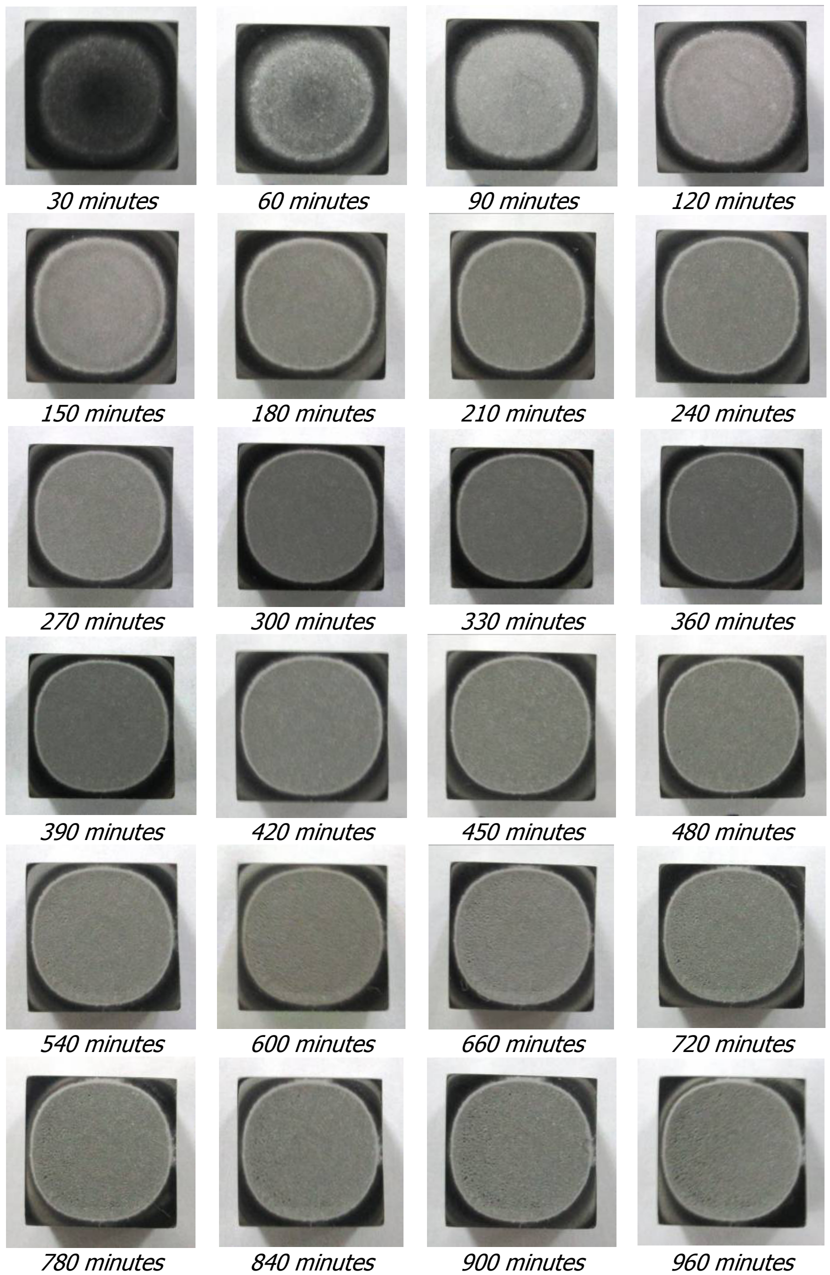

Figure 5. Images after the cavitation erosion for X3CrNi13-4 (1).

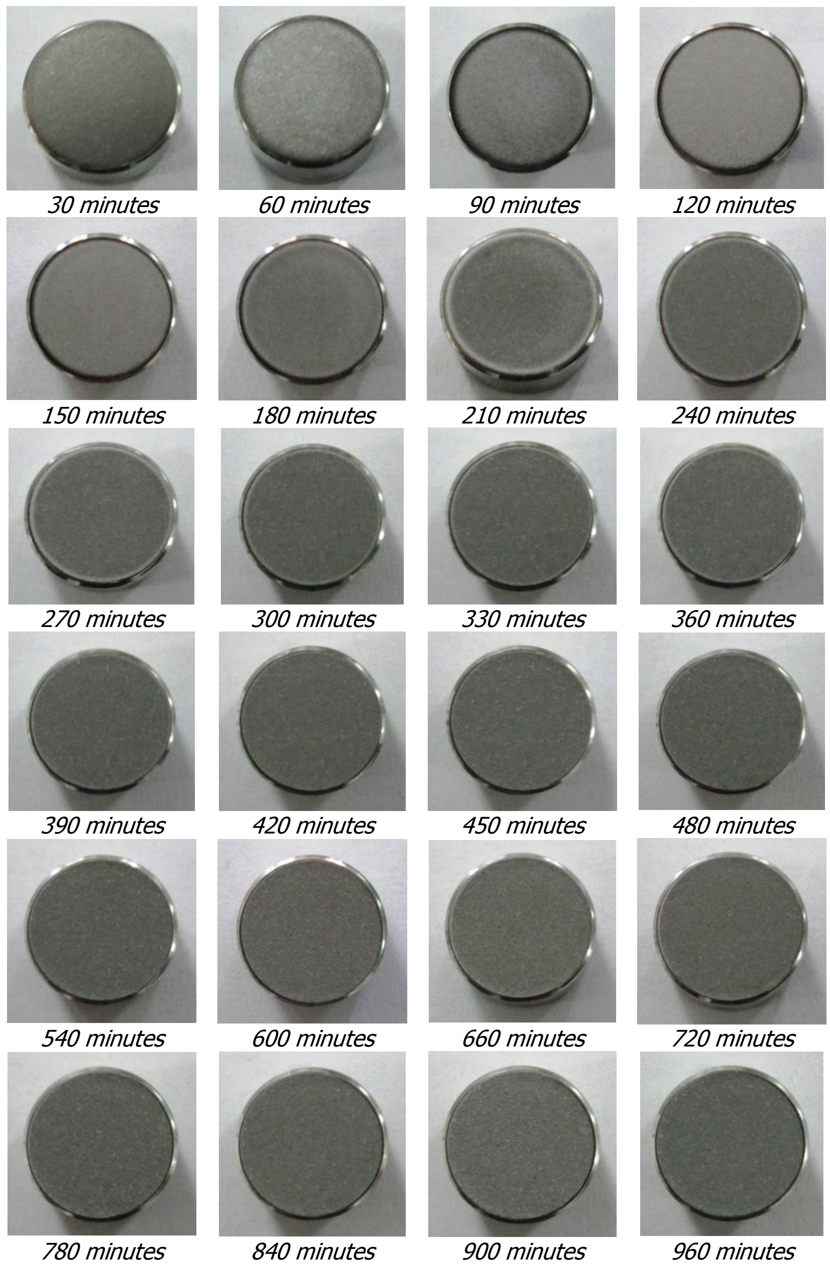

Figure 6. Images after the cavitation erosion for X3CrNi13-4 (2).

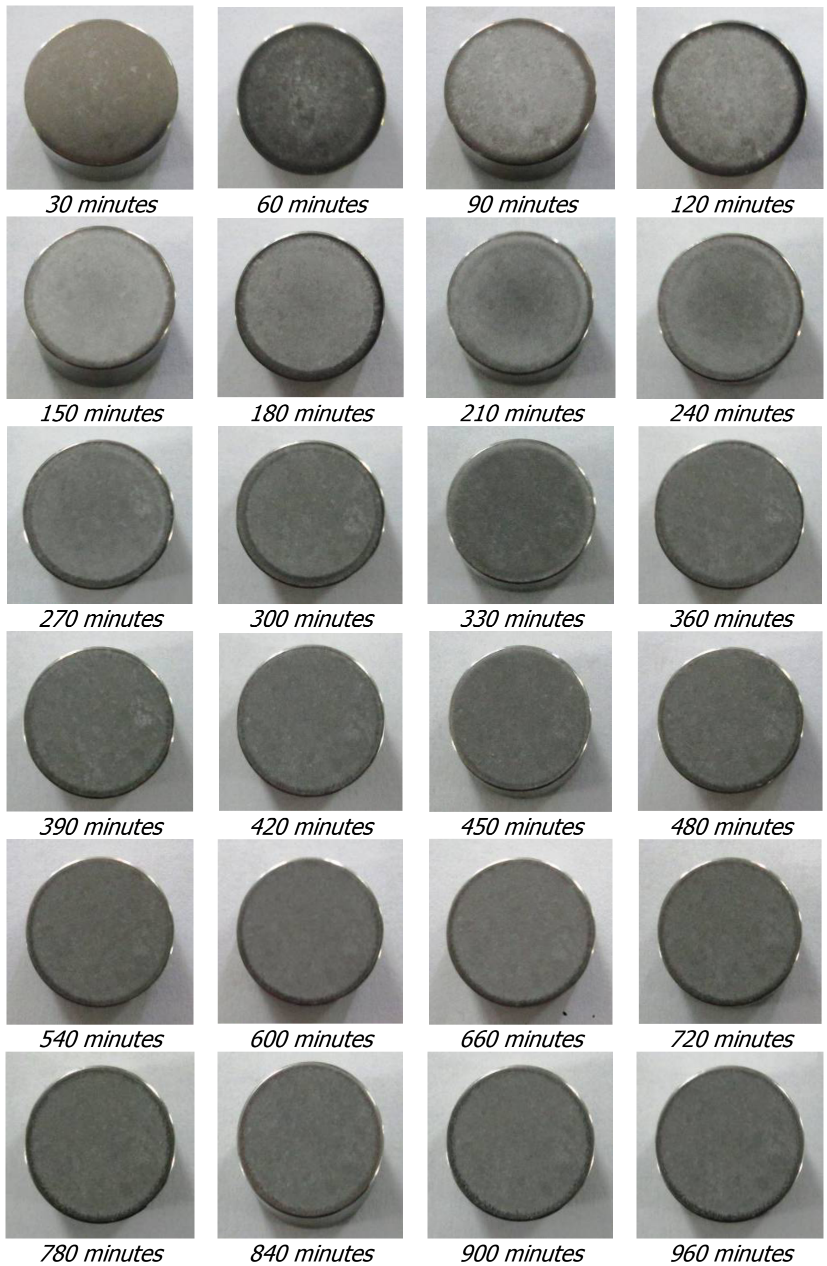

Figure 7. Images after the cavitation erosion for X3CrNi13-4 (3).

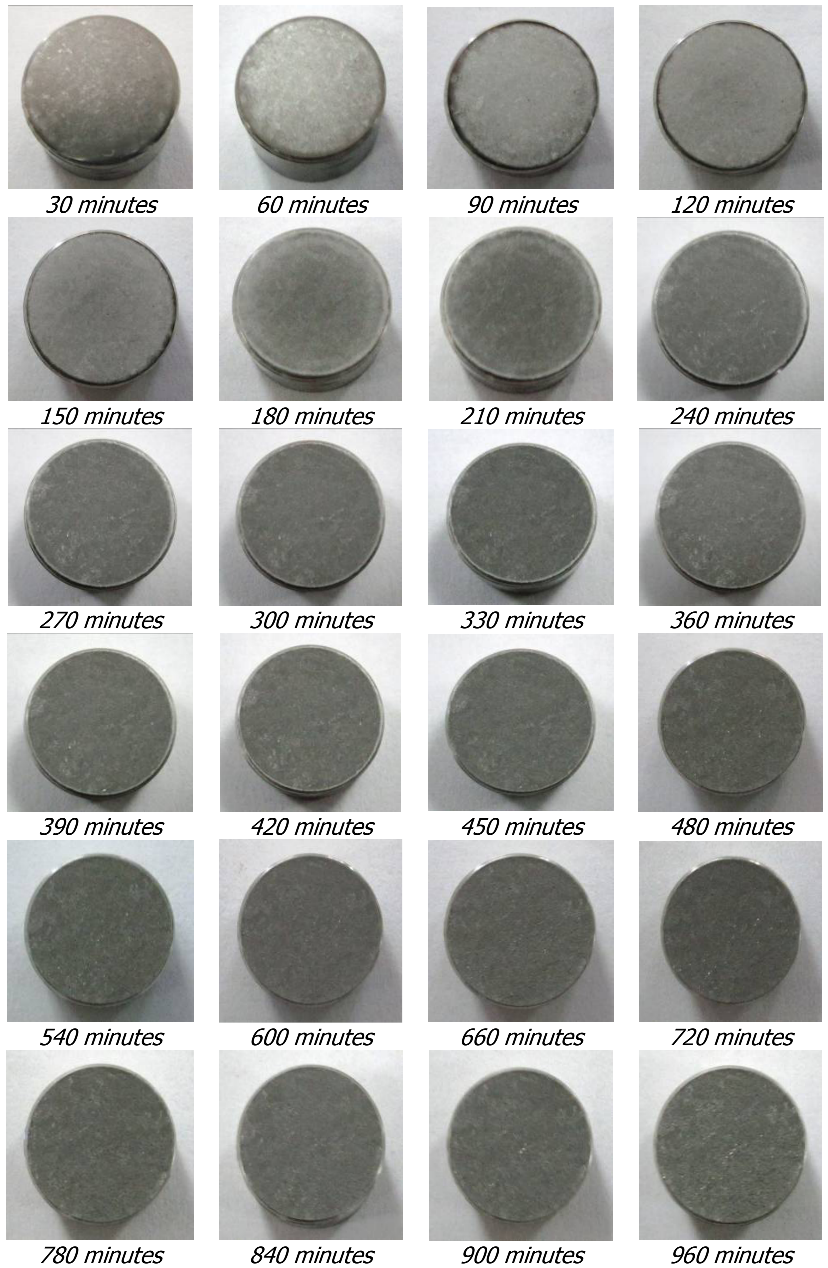

Figure 8. Images after the cavitation erosion for X3CrNi13-4 (4).

4. Conclusion

The operating conditions of the cavitation experimental stand and of the testing samples respectively the total mass loss for a total cumulative time with different values for each material expressed as a difference between the initial mass (before cavitation) and the final mass (after cavitation), were presented.

Cumulated total time covered different time periods such as: 45 minutes for C45, 26CrMo4, 34CrNiMo6; 30 minutes for stainless steel X20Cr13, X3CrNi13-4 (1), X3CrNi13-4 (2), X3CrNi13-4 (3), X3CrNi13-4 (4) respectively 60 minutes for X5CrNi18-10. Besides the different time periods for each material, during the tests, slower or faster, their cavitation erosion was caused by cavitation bubbles generated by ultrasonic horn in the liquid medium.

Of all the materials presented, for a total of 900 minutes (see Fig. 2), C45 (116.15 [mg]) had the weakest resistance against cavitation erosion. The best resistance against cavitation erosion occurred in the following order: X5CrNi18-10 (17.61 [mg]); 34CrNiMo6 (35.34 [mg]), respectively X3CrNi13-4 (3) (41.01 [mg]).

From the X3CrNi13-4 steels for a 1080 minute test time (see Table 1), the weakest resistance was X3CrNi13-4 (1) (98.31 [mg]), which showed a visible cavitation erosion in the form of a circle (see Fig. 5).

For each material, depending on the density, the mass loss can also be calculated analytically.

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