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RESEARCH ON THE RESISTANCE TO CAVITATION EROSION OF THE 7075 ALUMINUM ALLOY USED IN THE MANUFACTURE OF RADIATORS AND COOLING PUMPS OF HEAT ENGINES

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Abstract: It is known that radiators and pumps in the cooling system of motor vehicles, as a rule, are made of aluminum-based alloy and run on water. Under certain operating conditions, the flow through them has a turbulent character with pressure variations, up to below vaporization. In this situation, the operation inevitably reaches the threshold of cavitation, which manifests itself through its effects, especially through erosion. To increase the life span, these alloys are currently subjected to techniques to improve the structure's resistance to the cyclic stresses of cavitational microjets. Among these techniques are volumetric thermal treatments, which lead to changes in the microstructure and mechanical property values, with an effect on the behavior and resistance to cavitation erosion. In this direction, the results of the research to be carried out on the 7075 alloy subjected to the thermal treatment of artificial aging at 120 0C, lasting 12 hours. Comparing the results obtained, using the curves and specific parameters, recommended by ASTM G32-2023, with the state of the laminated semi-finished product shows a substantial increase in the strength of the structure obtained by the applied thermal treatment.

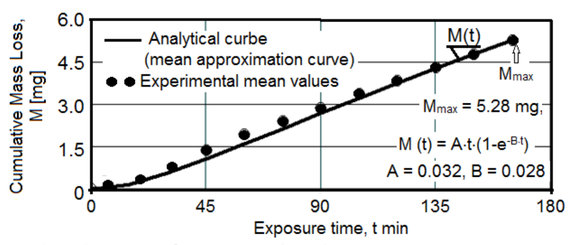
Introduction

- Aluminum alloys are known as metals with a wide applicability in practice. Their use is due to the high mechanical properties acquired by alloying with various metals (Fe, Cr, Mn, Zn, Cu), which give them mechanical properties (mechanical resistance and elongation at break, yield strength, hardness, and resilience) comparable to those of steels, under the conditions of a density (below 3 g/cm3) much lower than theirs (over 7.8 g/cm3).In the agro-industrial field, they are used for the manufacture of the most diverse equipment, from containers for storing various products to irrigation and cooling systems in the construction of hydropneumatic systems and thermal engines of agricultural vehicles.

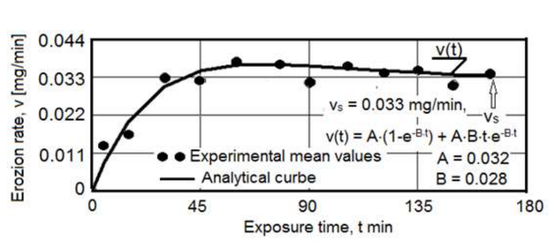
Material and method

- The researched material, taken from a sheet-type laminated semi-finished product, is aluminum alloy 7075 (AlZn5.5MgCu according to ISO EN AW-7075) and was received from the Special Materials Expertise Center (CEMS) of the Politehnica University of Bucharest. Data technical data [9] show that this alloy is part of Series 7000, the Al-Zn-Mg alloys with the highest mechanical resistance among aluminum alloys. For the study, samples were made for cavitation tests, to determine the mechanical properties and chemical composition. As the purpose of the research was to evaluate the behavior and resistance of the structure obtained by the thermal treatment of artificial aging at 120 0C with a holding time of 12 hours, followed by air cooling, the samples taken from the laminated semi-finished product were subjected to this thermal treatment regime in -a Nabertherm furnace, from the Laboratory of Metallic Materials Science, Physical Metallurgy of the Polytechnic University of Bucharest.

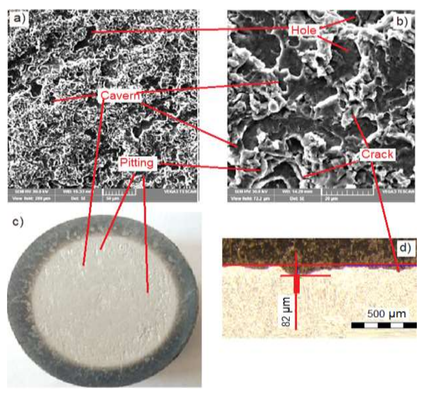
Results and discussions

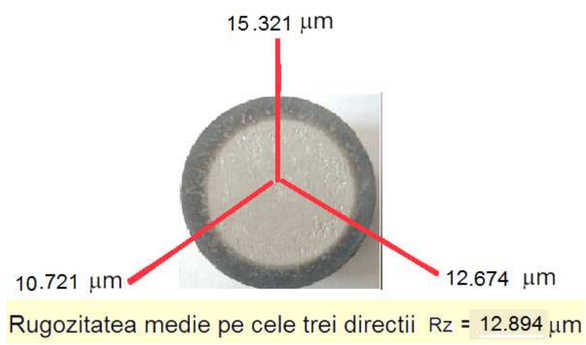


variation of cumulative mass with duration of exposure to cavitation



variation of erosion rate with duration of exposure to cavitation





Conclusions

1. Applying the thermal treatment of artificial aging at 182°C, with a holding time of 12 hours, leads to changes in the microstructure and mechanical characteristics that increase the resistance to cavitation erosion.

2. The differences between the maximum values of the depth measured in the section planes (fig. 6d) and the approximation curves (4a), after the completion of the test (165 minutes), confirm the complexity of the erosion produced by cavitation, because the maximum depth measured in a section axial (dependent on the place of sectioning) is not an indicator that serves to compare the strength of the surface structure;

- the shapes of the caverns, from pinching to pits or trenches, are mainly determined by the shape and sizes of grains and inclusion-type structural defects;

- the analysis of the morphology of the structure degradation with high-resolution microscopes ensures the understanding of the way of destruction of the microstructure regarding the different way of breaking (shape of splinters or pinchs).