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Influence of Heat Treatment on Tribological Properties of ZA-27 Alloy

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The effects of heat treatment, involving solutionizing at temperature of 370°C for a relatively short period of time (3 or 5 hours), followed by quenching in water and natural ageing. on tribological behavior of ZA-27 alloys were examined.

Dry sliding wear tests were conducted on as-cast and heat-treated ZA-27 samples using block-on-disc machine over a wide range of applied loads. To determine the wear mechanisms, the worn surfaces of the samples were examined by scanning electron microscopy (SEM). The tribological results were related to the microstructure and mechanical properties.

The microstructure of the as-cast alloy consisted of α-dendrites surrounded by α + η eutectoid and residual h phase in the inerdendritic regions. The dendritic structure broke during the heat treatment. Moreover, the uniformity of distribution of various microconstituents, as well as their fineness, increased with the duration of solutionizing.

Heat treatment of alloy caused decreasing of the tensile strength and hardness. Moreover, the heat-treated samples attained increased elongation as compared to that of the as-cast alloy. The solutionizing duration contributed to the tensile strength decrease and the elongation increase.

The heat-treated alloy samples (marked as ZA27 HT3 – 3 hours of solutionizing, ZA27 HT5-5 hours of solutionizing) attained improved tribological behavior (reduced coefficient of friction and wear rate) over as-cast ones (Figs. 1 and 2). The friction coefficient and wear rate for all the test alloys increase with the increase of the normal force. The differences in the frictional behavior of heat-treated alloys relative to as-cast alloy decreases with the increase of load. The increase in wear rate with load had an approximate linear relationship. The faster increase of wear rate with load corresponds to the as-cast alloy without the subsequent heat treatment. Due to that, difference in wear behavior of heat-treated versus as-cast alloy is amplified in the area of higher loads.

The improved tribological behavior of the heat-treated alloys, in spite of reduced hardness, could be the result of breaking the dendrite structure, when the fraction of interdendrite regions was considerably decreased and a very fine α and η mixture was formed at the same time.

The wear response of the samples has been corroborated through characteristics of worn surfaces and dominant wear mechanisms. The worn surfaces of heat-treated alloys were relatively smooth with shallow wear grooves, without smearing of transferred material. Significantly, rougher worn surface with deep grooves, damages and smeared material corresponded to the as-cast alloy. It resulted from intensive abrasive and observed on the worn surface of as-cast alloy in conditions of higher load.

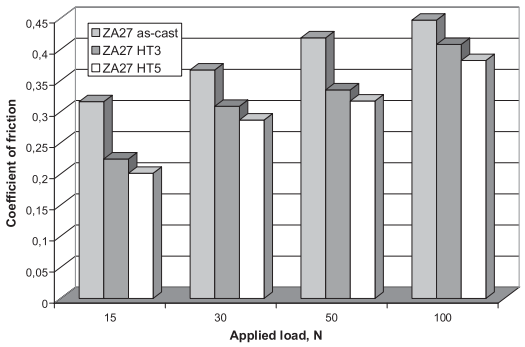

Fig 1 Coefficient of friction vs. applied load for ZA-27 alloy in as-cast and heat-treated conditions

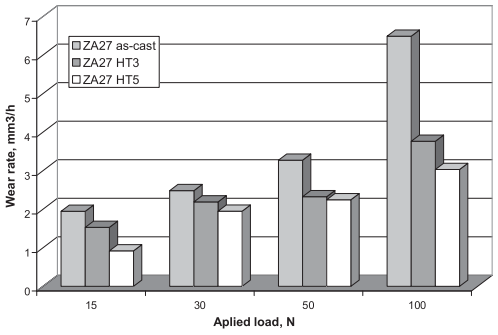

Fig. 2 Wear rate vs. applied load for ZA-27 alloy in as-cast and heat-treated conditions

References

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