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Exceptionally High Cavitation Erosion and Corrosion Resistance of a High Entropy Alloy

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Abstract

Cavitation erosion and corrosion of structural materials are serious concerns for marine and offshore industries. Durability and performance of marine components are severely impaired due to degradation from erosion and corrosion. Utilization of advanced structural materials can play a vital role in limiting such degradation. High entropy alloys (HEAs) are a relatively new class of advanced structural materials with exceptional properties. In the present work, we report on the cavitation erosion behavior of $Al_{0.1}$CoCrFeNi HEA in two different media: distilled water with and without 3.5 wt. % NaCl. For comparison, conventionally used stainless steel SS316L was also evaluated in identical test conditions. Despite lower hardness and yield strength, the HEA showed significantly longer incubation period and lower erosion-corrosion rate (nearly $1/4^{th}$) compared to SS316L steel. Enhanced erosion resistance of HEA was attributed to its high work-hardening behavior and stable passivation film on the surface. The $Al_{0.1}$CoCrFeNi HEA showed lower corrosion current density, high pitting resistance and protection potential compared to SS316L steel. Further, HEA showed no evidence of intergranular corrosion likely due to the absence of secondary precipitates. Although, the degradation mechanisms (formation of pits and fatigue cracks) were similar for both the materials, the damage severity was found to be much higher for SS316L steel compared to HEA.

Keywords: Cavitation erosion-corrosion; high entropy alloy; Work-hardening