The Research on Erosion-Corrosion Behavior of B10 Copper-Nickel Alloy

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Abstract Currently, B10 CuNi alloy has garnered widespread adoption in the maritime sector due to its robust corrosion resistance. Nevertheless, instances of corrosion rupture and perforation persist in the elbow regions of shipboard ballast water, heat exchanger, and fire-fighting systems, highlighting the need for a comprehensive understanding of the intricate erosion-corrosion synergy in this alloy. The erosion-corrosion process in B10 Cu-Ni alloy remains largely unexplored and necessitates further investigation. To this end, the present study delves into the disparities in erosion-corrosion behavior of B10 alloy exposed to a 3.5% NaCl solution containing sand particles for 36 hours, utilizing a controlled loop apparatus to meticulously manipulate fluid temperature (36°C-37°C), flow velocity (0-4.5 m/s), and sand content (0-1%). Following the experimental exposure, sophisticated analytical tools such as scanning electron microscopy (SEM), X-ray photoelectron spectroscopy (XPS), surface profilometry, and electrochemical techniques were employed to meticulously examine the surface morphology, elemental distribution patterns, and compositional alterations within the film layers of the B10 alloy. Our findings reveal the existence of a critical flow velocity range (2.5-3.5 m/s) at a sand content of 1%, within which the protective surface film undergoes complete removal. Notably, at flow velocities exceeding 3.5 m/s, the corrosion film layer on the elbows of B10 copper-nickel alloy is comprehensively stripped away. Intriguingly, even at these high flow velocities, where no visible corrosion pits or extensive impact marks are discernible, a notable depletion of manganese (Mn) elements is observed. By synthesizing these findings, we have elucidated the erosion-corrosion damage mechanism of B10 copper-nickel alloy, contributing valuable insights into the development of enhanced protective measures and material design strategies for critical maritime applications.

Keywords Cu-Ni Alloy, Erosion-Corrosion, Corrosion Film, Synergistic Effect