22、Marine Corrosion and Protection

Tribocorrosion behavior and mechanism of typical material in deep-sea environment

Pengwei Ren, Jianzhang Wang*, Hao Liu, Fengyuan Yan

[1] *State Key Laboratory of Solid Lubrication, Lanzhou Institute of Chemical Physics, Chinese Academy of Sciences*

wangjz@licp.cas.cn

Abstract The deep sea is an extreme environment that includes various adverse factors such as high hydropstatic pressure, highly corrosion, low temperature, low oxygen, biofouling, and undercurrent, etc. Due to strict environmental and design requirements, some key mechanical friction systems and components in deep-sea equipment need to serve in deep-sea environments. Metal friction components often suffer from severe electrochemical corrosion and mechanical wear coupled damage (i.e. corrosion wear) in seawater environments. Corrosion and wear are the main failure modes of key metal friction components in deep-sea equipment underwater mechanical systems, but there are currently very few reports on the research of metal corrosion and wear in deep-sea environments.

High hydrostatic pressure is the main characteristic of the deep sea, with a 1 MPa increase in seawater static pressure for every 100 meters increase in ocean depth. Scientific research has demonstrated that deep-sea static pressure has a significant impact on the electrochemical corrosion and mechanical wear of metal materials. The lack of research methods is a bottleneck problem that restricts the in-depth development of corrosion and wear research of deep-sea environments. This article systematically introduces that the author's team, after nearly 20 years of technical research and five generations of equipment iteration, has broken through the key technology of in-situ tribology and corrosion electrochemical synchronous testing in deep-sea high-pressure environments. The authors have successfully developed a tribology- electrochemical corrosion in-situ testing system that can simulate a 5000-meter deep-sea ultra-high-pressure environment. The testing platform lay the foundation for in-depth research on corrosion and wear in deep-sea environments and revealing the characteristics and underlying mechanisms of metal materials in deep-sea corrosion and wear.

More importantly, this article aims to reveal the corrosion and wear mechanisms of typical metal materials under high hydrostatic pressure in the deep sea. Taking typical marine metal materials as the research object, metal/metal, metal/ceramic, and metal/polymer friction couples are constructed based on service conditions. The latest developed deep-sea ultra-high pressure corrosion wear in-situ testing system is used to accurately simulate different depths of seawater environment. The independent/synergistic effects of key environmental factors such as seawater depth (hydrostatic pressure), temperature, dissolved oxygen on corrosion wear have been investigated. The tribocorrosion behaviors of marine metal and the synergism between corrosion and wear have been studied systematically. Meanwhile, the polymer interface transfer of metal/polymer friction couples in deep-sea high hydrostatic pressure environment have been researched, and established a new method for controllable construction and regulation of metal material corrosion wear through polymer transfer film. The project research is innovative and pioneering in the field of tribology and corrosion science, and has guiding significance for corrosion and wear protection of deep-sea equipment. Moreover, this study has important engineering application demonstration significance for the common problems of corrosion and wear occurred in deep-sea equipment under seawater lubrication conditions.