Erosion Corrosion Behavior of Aluminum Electrode in Simulated HVDC Water Cooling at 50 °C

Jiayang Li¹, Liangshou Hao¹, Feng Zheng¹, Xiaoping Chen¹, Shengping Wang^{2,*}, Youping Fan^{3,*}

¹ Tianshengqiao Bureau, Extra High Voltage Power Transmission Company, China Southern Power Grid (CSG), Xingyi 562400, China

² Faculty of Material Science and Chemistry, China University of Geosciences, Wuhan 430074, China

³ School of Electrical Engineering and Automation, Wuhan University, Wuhan 430072, China

*E-mail: spwang@cug.edu.cn, ypfan@whu.edu.cn

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The inner wall of aluminum radiators in a high voltage direct current (HVDC) thyristor valve cooling systems are corroded under a continuous erosion of water coolant at ~50 °C, and the dissolved aluminum ions precipitate again on the surface of the platinum grading electrode; thus, HVDC transmission is adversely affected. To clarify the corrosion characteristics of aluminum in HVDC, the erosion corrosion behaviors of aluminum in 50 °C deionized water under various water flow velocities are studied. With increasing water flow velocities, the corrosion current of aluminum gradually increases, the corrosion potential gradually decreases, the charge transfer impedance gradually decreases, and the corrosion of aluminum tends to become serious. Aluminum under a water flow velocity of 3 m s⁻¹, has the most negative corrosion potential (0.864 V), the maximum corrosion current (6.515×10⁻⁷ A cm⁻²), the minimum charge transfer impedance (1.751×10⁻⁵ Ω), and the most serious erosion corrosion. In contrast, aluminum surfaces in unmoving water can form a passivating film to protect the interior. However, forced convection occurs when the water flow velocity reaches a certain value; the aluminum surfaces will undergo stress due to the impact of the flowing water, which destroys the passivation films and promotes the formation of forms an Al(OH)₃ corrosion product on the aluminum surface. The conclusion of this study will be helpful for the optimization of the technology and parameters in HVDC thyristor valve cooling systems.

Keywords: aluminum, erosion corrosion, deionized water, high temperature, radiator, high voltage direct current

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