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Predictive Maintenance of Alkaline Water Electrolysis System for Hydrogen Production Based on Digital Twin

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ABSTRACT

Alkaline water electrolysis system for hydrogen production has the characteristics of complex structure, fault coupling and state nonlinearity, coupled with the restriction by many factors such as data acquisition methods and analysis methods. The operation status cannot be fully characterized through current monitoring information. In order to solve the problems in health status assessment in the operation of alkaline water electrolysis system, a digital twin-driven predictive maintenance method is put forward to achieve the real-time monitoring of operation status and prediction of remaining useful life. In the study, a multi-disciplinary simulation model of the alkaline electrolysis system and a physical degradation model of the electrolyzer are established. Meanwhile, the data-driven fault diagnosis and the life prediction algorithm are constructed by using the deep learning method. Finally, the two are fused by the particle filtering algorithm and transfer learning to realize predictive maintenance of alkaline water electrolysis system. Results indicate that, in contrast with the single model-based method or the data-driven method, the predictive method based on digital twin has higher prediction accuracy, which overcomes the problems of inconsistent models and poor adaptability of data algorithms. For the fault diagnosis of the alkaline water electrolysis system, the fault diagnosis model is trained based on digital twin simulation data, and then transferred to the data collected by actual sensors by the transfer learning method. The diagnosis accuracy reaches 90%, indicating that the method is able to relatively better diagnose the fault in the operation of the alkaline water electrolysis system for hydrogen production. The predictive maintenance method based on digital twin proposed in this paper also provides an effective solution for other complex equipment.

KEYWORDS

Alkaline water electrolytic; digital twin; predictive maintenance; life prediction

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