

Using Water Conductivity for Real-Time Monitoring of Membrane Degradation in PEM Electrolyzers

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Abstract:

The performance of proton exchange membrane water electrolyzers is heavily influenced by membrane degradation, directly affecting hydrogen production efficiency. Traditional diagnostic methods such as Electrochemical Impedance Spectroscopy (EIS), voltammetry, and fluoride analysis are often complex, costly, and disruptive to operation, limiting their real-time applicability. This review examines the potential of using water conductivity measurements as a straightforward and cost-effective method for monitoring membrane degradation in PEM electrolyzers during normal operation. By correlating conductivity with fluoride ion concentration, a key byproduct of membrane degradation, this method offers an early, real-time indicator of membrane health. We review recent studies demonstrating the effectiveness of conductivity-based monitoring in operational conditions and explore the technique's practical advantages over traditional diagnostic methods. Furthermore, we highlight the challenges and knowledge gaps that need to be addressed for broader industrial implementation, such as the influence of external factors like temperature and other ions. This review aims to provide insights into how integrating conductivity-based monitoring could optimize maintenance practices and enhance the longevity and efficiency of PEM electrolyzers in large-scale hydrogen production.

Keywords: Membrane Degradation, PEM Electrolyzers, Water Conductivity, Real-Time Monitoring, Fluoride Release, Diagnostic Tool, Electrochemical Diagnostics