PROTECTING PROTON EXCHANGE MEMBRANE FUEL CELLS FROM CONTAMINANTS IN REACTANT STREAMS

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The proton exchange membrane fuel cell (PEMFC), an electrochemical energy conversion device originally described as a gas battery, has reached a high development level, which justifies ongoing commercialization activities for light and heavy duty vehicles and forklifts [1]. Research efforts currently focus on reducing costs, increasing performance and improving durability [2]. Even low parts per million levels of contaminants in oxidant (oxygen in air) and fuel (hydrogen) streams are sufficient to cause a noticeable decrease in cell voltage, which may not be fully reversed after contaminant exposure has ceased [3,4]. Additionally, hydrogen peroxide production, an oxygen reduction side reaction, is favored on the platinum catalyst surface in the presence of contaminants [5]. Both hydrogen peroxide and its decay products (radicals) decompose the proton exchange membrane electrolyte [6] separating air and hydrogen compartments (chemical short). For these reasons, a filter is added at the air intake [7] and hydrogen purity is standardized [8] for prevention. For the latter case, it is implied that the incumbent hydrogen production method, methane reforming, includes purification process steps [9,10]. The definition of air filter specifications and hydrogen standards requires contaminant tolerance limits for PEMFCs [11]. However, many contamination aspects are still poorly understood or unknown especially for commercially relevant platinum catalyst loadings, preventing filter specifications and hydrogen purity standard revisions.

The presentation will inform attendees about PEMFC fundamentals including contaminant sources and effects, contamination mechanisms, and preventive and recovery measures. The large number of contaminants and associated mixture compositions, contamination mechanism specificity and complexity, and absence of recovery methods applicable to stacks will emphasize the need to further develop preventive measures such as filtration for both air (onboard vehicle) and hydrogen (at the production facility).

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