Investigation of the Purging Effect on the Performance of a Dead-End Anode PEM Fuel Cell Vehicle during the European Driving Test Cycle

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Abstract

The dynamic behavior of the PEM fuel cell performance is one of the main factors for successful operation of fuel cell vehicle. Maintaining fast time response whilst keeping stable and high stack performance is of importance, especially during acceleration and deceleration. In a PEM fuel cell with a dead-end anode, it is well known that the water accumulates at the anode side, the nitrogen crosses over from cathode to anode which, in turn, reduces the available hydrogen concentration for electrochemical reaction and, thus, deteriorate the fuel cell performance over time.

In this paper, we evaluate the transient response of PEM fuel cell stack with a dead-end anode under legislated European driving cycle together with the effect of purging factors. The dead-end anode PEM fuel cell stack comprises of 24 cells with 300 cm^2 active catalyst area and operates at low hydrogen and air pressure. Humidified air is supplied to the cathode side; whereas dry hydrogen is fed to the anode. The liquid coolant is circulated to the stack and radiator to maintain thermal envelope throughout the stack. The effect of purging frequencies, purging durations, coolant flow rate together with effect of cathode stoichiometry are examined with regard to the transient driving cycle performance.

The results indicate that the purging factors significantly influence the transient response of the power generated by fuel cell. The effect of purging frequency is seen to be more as compared to the purging duration, especially at higher load. Thus, a compromise between stack performance and hydrogen utilization rate should be established for optimum operation. Moreover, it is noted that the cooling system is seen to be struggling to maintain stable stack temperature at fast acceleration and high speed operation. Finally, we will discuss and highlight several strategies to optimize the operating parameters for high performance dead-end anode PEM fuel cell vehicle.

Keywords: cooling; dead-end anode; driving cycle; fuel cell vehicle; purging.