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PARAMETER ESTIMATION OF PROTON EXCHANGE MEMBRANE FUEL CELL SYSTEM USING SLIDING MODE OBSERVER

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Abstract. *Parameter estimation for health monitoring and sensorless scenario is achieved online via model-based robust state observer. The proposed dynamic algorithm observes a state (output voltage) of fuel cell system (FCS) in the presence of uncertainties and disturbances. Using this observation, membrane conductivity is estimated. The conductivity is function of water content and temperature which gives the value of water content analytically. The water content represents two important faulty modes, flooding and drying in proton exchange membrane (PEM) FCS. The water content can generally be measured through humidity sensors or other techniques. In the case of sensors, their size and cost restrict in-situ measurements whereas regarding other techniques, the extractive sampling makes measurement process slow and intrusive. Moreover, the existing measurement techniques have the issue of accuracy which is of prime importance in control and diagnostics spectra. The sliding mode technique is employed for the design of observer. The technique requires a dynamic voltage model that is developed through extensive mathematical modus operandi. The computer simulation confirms that the estimates are quite similar to nominal value. Experimental extracted range of parameter verifies the magnitude of estimated parameter and its precision is validated through offline calculation of the parameter using a model available in the literature. The observer can replace the humidity sensor which results in ridding of expensive and hard measuring instrumentation. The water content parameter estimation can provide a foundation for design of fault diagnostic schemes in PEMFCS.*

Keywords: Proton exchange membrane fuel cell system, Parameter estimation, Sliding mode observer, Humidity

1. **Introduction.** Fuel cell engine is a promising candidate for automotive propulsion due to efficient source of power along with its special characteristics like fast start-up, light weight, low operating temperature and high power density. The wide range of applications includes unmanned under water vehicle, submarines, locomotives, surface ships, buses and automobiles [1]. Despite these advantages and wide range of applications, there are still a number of challenges for the proper operation of fuel cell system. Water management is one of them. This issue is dealt with different approaches that may include designing membrane electrode assembly, hardware and system design and controlling of stack operating conditions. The former approach rests with manufacture's part and may include cell orientation at an acute angle towards air outlet port and cell shaking during fuel cell operation whereas latter is concerned with fuel cell system operation and may include maintaining of operating temperature, pressure, stoichiometry and the humidification levels of reactant gases. Water management consists of three stages namely water treatment, humidification of reactant gases and water removal process. However,