Performance Characterization of A Vanadium Redox Flow Battery At Different Operating Parameters Under A Standardized Test-Bed System

M.R. Mohamed[a] , P.K. Leung[b], M.H. Sulaiman[a]

[a] Sustainable Energy & Power Electronics Research (SuPER) Cluster, Universiti Malaysia Pahang, 26600 Kuantan, Pahang, Malaysia

[b] IMDEA Energia, 28935 Mostoles, Madrid, Spain

ABSTRACT

This paper describes the experimental characterization of a 25 cm^2 laboratory scale vanadium redox flow battery (V-RFB). The unit cell performance with respect to voltage, coulombic and energy efficiencies under different performance parameters (current densities, operating temperatures, flow rates, electrolyte concentrations and material properties of 5 cm × 5 cm electrodes) are presented. The cell exhibits different characteristics under different operating parameters; the highest energy efficiency is recorded at *c.a.* 82%, operating at 308 K, 60 mA cm^{-2} and 3 cm^3 s^{-1} volumetric flow rate for 250 cm^3 electrolytes (each reservoir) of 1.6 mol dm^{-3} *V(III)/V(IV)* in 4 mol dm^{-3} H_2SO_4. Formation charge of the mixture of vanadium species into single electro-active species at positive and negative electrodes are presented. Estimated time for the electro-active species to complete the formation charge using electrochemical calculation of Faraday's constant are presented; a discrepancy of 4.5% is found between the theoretical and experimental data using current density of 80 mA cm^{-2}.

KEYWORDS: Redox flow battery; Vanadium; Current density; Temperature; Electrolyte flow rates

DOI: 10.1016/j.apenergy.2014.10.042