

Method approaches to prevent leakage cell stack of vanadium redox flow battery (VRFB)

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Abstract

This paper present the method to solve the leakage problem for a unit cell Vanadium redox flow battery (VRFB) in detecting the several main component involved and depict the weakness matter that causes leakage in order to improve the cell performance of VRFB. The 110.25cm² unit cell stack of VRFB is carried out and setup with different size of rubber seal, membrane, type of fitting and layer of carbon felt use to elucidate the leakage problem. Result demonstrated that the usage of 3.0mm rubber seal, 12cm x 12cm Nafion 117 membrane, polypropylene type fitting and double layer of carbon felt showed positive feedback on solving the vanadium leakage. Suggestion for development and material improvements is highlighted.

1 Introduction

The energy storage system has been create due to the huge electricity load demands[1] and this energy were supply to all electrical appliances especially for large scale energy user [2]. Industrial development and population in the world have been increased dramatically from time to time[3]. The energy storage system from a renewable energy is a solution to solve intermittent energy problem and give a positive environmental view to the world[4]. This renewable energy source will replace the non-renewable energy source which are the most popular global energy resource including in Malaysia over a last few years. This was the main factor and reason that cause all the researcher to take initiative to develop an energy storage system from a renewable energy because the non-renewable energy source lead to the global warming problem from harmful gas released. Based on the research paper by P.Bhusal he said that in the near future, renewable energy are expected to take the role of important to electrical generation[5]. Renewable energy is the energy that can be obtained from natural resources that can be constantly replenished. Mentioned by Xue et al[6], the renewable energy stated before will suffer from fluctuation and dispersed due to the increasing demand of electricity and the action taken to overcome this deficiency problem related to the electricity and the energy storage technology were introduced and it eventually became the key of motivation for the researchers to enhance the initiative of the energy storage technologies.

Energy storage acts as a store to reserve an amount of specific energy for future. Energy storage can be divided into few categories with the respect to certain features i.e. mechanical storage, thermal storage, electrochemical storage. Mentioned in paper by Chen et al[7], the electrochemical energy had been the oldest and most established energy storage device when come into the environmental features. RFB is an independent to its storage capacity. Most of the electrochemical energy storage is known as the battery and act as a source for many household and industrial electricity user emphasized by Mahlia et al.[8].

Redox flow battery is the combination of reduction and oxidation process that takes place to generate energy. This RFB and fuel cell have same principle applied to the system. The principle here is a rechargeable battery that convert the chemical energy into electricity through the cell stack[9]. Vanadium redox flow battery has a tendency of decoupling power and energy components. Ponce de Leon et al. [10] stated that RFB offers the full power in a fast response time and practically has the long life cycle and longer time for energy storage. The major benefit of this RFB application has a high power rating in battery system. There are also several type of RFB which are Soluble Lead Acid, Bromide Polysulphide, Zinc Chrome, Vanadium, Ion Chromium, Zinc/Cerium and Vanadium Bromide. Skylass Kazakos, [11] said VRFB battery capacity is maintain from degradation factor because it contains a similar electrolytes species in both reservoir. This VRFB is suitable also for a large and many application compared to others battery because the VRFB has a high energy efficiency capability [12][13][14]. The principle of RFB is similar to the FCs which is rechargeable types of battery for RFB, the electrolyte will flow through the cell stack as for the chemical reaction take place as mentioned by Mohamed[15].

The RFB is said comprises of two tank which the electrolyte circulated by the pumps through the cell stack. The cell stack is separated by a membrane to avoid the electrolyte from mixing and each cell consists of two electrodes which are anode and cathode and most importantly electrolyte maintenances and cross contamination problem will be avoided to occur due to the same electrolyte solution in both half-cell as well as known as a stable electrolyte battery. This RFB have a lot of advantages compared to other types of battery. RFB do not face the complexity such as financial and flexibility coherently and VRFB have an optimal power systems because the separation design between power and