Nanofluidic electrolyte for vanadium redox flow batteries & Energy storage

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The demand of energy produced from renewable energy sources (RES) has increased nowadays, in order to reduce the dependence on unsustainable sources such as coal, natural gas and oil. However, applications of RES still remain a challenge, in the perspective of improving the storage and distribution of produced electricity. Energy-storage technologies and complementary conversion systems, for electricity generation, are an eventual solution of this case. A reliable system that can store, supply, modulate, and transport electricity is, with no doubt, batteries. Among various types of batteries, vanadium redox flow batteries (VRFBs) are a promising system, because of their long cycle life, flexible design and relatively low cost. [1].

VRFBs have undergone intensive investigation compared to other redox flow batteries and have a kW-MW scale under construction or operation globally. In addition with solid state batteries, whose energy is stored in solid electrodes and have limited energy storage capacity, the VRFBs storage capacity can be determined by three factors, which are the redox species, the electrolyte volume and concentration. [2] .

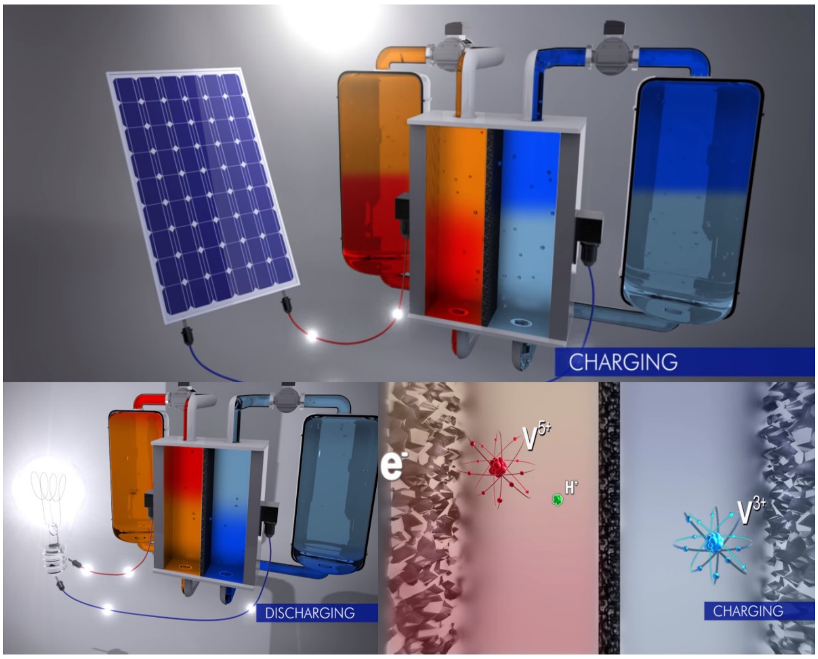

Figure 1: *Collage compilation from video "SCHMID Energy Systems (basics of a VRFB)"*

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VRFBs use vanadium as electrolyte and exploit the ability of it to exist in the solution in four different oxidation states. The power rating depends on the electrode area and current density. The energy density of a typical VRFB is 72 J/gr. In order to increase the limited energy density by 21,5% and the reversibility to oxidation/reduction by 8,5%, a nanofluidic electrolyte, designed by multiwalled carbon nanotubes, is dispersed in the electrolyte. Nanofluidic electrolytes improve the electrochemical properties of the redox couple, due to their high porosity and high surface-to-volume ratio. [3] .

The intrinsic intermittency of sunlight cannot guarantee continuous electricity supply. VRFBs are capable of large-scale, real-time electricity storage and conversion of solar energy in a single device. [3]. This “progressive” model of VRFBs which is designed with nano-fluid electrolytes, exhibit enhanced conductivity, improved electrochemical performance and increased active area. In this presentation, we will discuss about the progress in VRFBs, from the aspects of the working mechanism, device engineering, and performance evaluation.

References

[1] VRFBs first proposed by Skyllas-Kazacos group, at the University of New South Wales (1986)

[2] Solar Redox Flow Batteries: Mechanism, Design, and Measurement,
Cao L., Skyllas-Kazacos M., Da-Wei W., Flow Batteries, Advanced Sustainable systems, 2, 1800031 (2018)

[3] Effect of nanofluidic electrolyte on the electrochemically enhanced long-term efficiency of vanadium redox flow battery, Kim J, Park H., Energy Storage, 1:e90 (2019)

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