Supercapacitors for improved RFBs performance in hybrid systems

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Modern energy grids must rely on renewable energy sources, such as solar and wind, which are characterized by high fluctuations in power. In view of the increased exploitation of intermittent renewable energy sources, modern grids need to adapt and necessitate more dynamic energy storage systems.

Nowadays, vanadium redox flow batteries (VRFB) are the most diffuse and established technology for stationary storage thanks to the ability to decouple energy and power design [1]. However, this type of battery still suffers from low power peak and are not able to fulfill the demand for intermittent renewable energy source connected to the grid. Supercapacitors are electrochemical storage devices that can deliver and absorb high power peaks.

Hybrid energy storage systems (HESS) in which high-power redox flow batteries and supercapacitors work together are promising solutions for applications having frequent high peak-to-average power demand. Hybridization of Energy Storage Systems (ESS) will also lead to more efficient storage systems, with longer lifetimes and with the ability to operate on all time-scale applications, from seconds to days [2].

Here we report on the hybridization of a HP-VRFB with commercial Supercapacitors (SC) by a direct parallel connection of the two devices that aims at improving the overall energy efficiency at high power rates. At first, the power and energy response of the HP-VRFB cell and SC single cell has been tested under the same discharge protocols and has been, then, compared to the hybrid assembled system.

Overall, our study highlights that the direct connection of the HP-VRFB cell with the SC makes it possible to extend the range of currents by a factor of 5. The direct connection showed also beneficial effects in terms of delivered energy under a power pulse that increased by 46%. In addition, the discharge curve of the SC was modified by the presence of the HP-VRFB, a phenomenon that we defined as an apparent capacitance increase [3]. This study is the base of future research in which green materials for high power supercapacitors and high power semi-solid electrodes for VRFB will be embedded in the hybrid system.

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