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HIGREEW – Deliverable Report

D2.2 – Aqueous organic electrolyte optimisation and characterisation

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Publishable summary

The HIGREEW project sets out to design, build, and demonstrate a prototype of a new high energy density generation of Aqueous Organic Redox Flow Battery (AORFB) based on a water-soluble low-cost organic electrolyte and featuring low-cost components and long service life.

The electrolyte plays a key role in the definition of the redox flow battery and system. In addition to define completely the energy module of the system, the physico-chemical properties of the electrolyte determine to a large extent the characteristics and the cost of the power module. Furthermore, considering the amount of electrolyte, and by extension active material, needed for the battery, this component has a significant impact on the cost and environmental footprint of the system. In the context of redox flow batteries, electrolytes are responsible for the ionic conductivity and capacity of the battery. Therefore, an ideal electrolyte should exhibit high conductivity, fast electrochemical reaction kinetics, high energy density, relying on the redox potential and water solubility of the redox active materials, and surely high chemical and electrochemical stability. Other key features of the electrolyte are viscosity and pH, affecting the efficiency and durability of the battery, and toxicity, availability, and recyclability, determining the environmental impact.

The first stage of HIGREEW project has been devoted to development of materials. Organic compounds have been studied to be applied as active materials based on their electrochemical properties and large-scale application, including safety and cost. Suitability of those organic molecules to be implemented in electrolyte formulations and achievement of optimized electrolytes for application on the HIGREEW battery has been the aim of the work summarized in this report.

This report is a summary of the development of electrolytes for HIGREEW AORFBs according to defined project objectives. It compiles the tests performed according to protocols defined in WP1. The experimental and computational analysis of fundamental properties of a variety of organic compounds, such as redox potential, redox kinetics and water solubility has guided the selection of the active materials, that define the chemistry of the battery and the electrolyte formulations. Anolyte and catholyte solutions fulfilling project targets have been achieved based on innovative active materials that lead to higher cell voltage (> 1.5 V) and higher energy densities. In addition, cost-effective electrolyte formulations based on environmentally sustainable materials that meet all operational requirements in terms of viscosity (< 10 cP), temperature (0-45 ºC) and stability have been attained.