Abstract

As the energy demand of the world grows, so does the need for a large scale, reliable and cheap grid storage, especially as the periodically available renewable, “green” energy sources cover more and more of the electricity demands. A relatively new technology, redox flow batteries (RFBs) are one of the best candidates for this role. The technology combines the positive characteristics of traditional secondary batteries and fuel batteries, as the electrolytes are separated and can be stored in large volumes, virtually indefinitely.

By earlier, unrelated research we learned that the redox potential of iron can be significantly altered by complexation and we began researching the possibility of an all-iron battery, with an ionic compound on the positive and a complex on the negative side. With limited literature findings we nominated the sulphate, chloride and perchlorate salt and possibly the malate complex of iron as the catholyte and various complexes as oxalate, malonate, citrate and EDTA as anolytes.

By cyclic voltammetry (CV), we determined the average redox potential of the above compounds and found the citrate, EDTA, chloride and perchlorate to be the best electrochemically, but by the lower solubility of the EDTA- and high viscosity of chloride-based solutions we settled on the citrate and the perchlorate. This battery in theory could support around 0,6-0,8 V of voltage, therefore may be practically used as grid storage. However, the two require different pH values for optimal operation, as perchlorate precipitates above pH $\approx$ 2, while the oxidation of the citrate only occurs in less acidic medium and the ion transfer through the separating membrane is carried out by H^+ ions, therefore future testing is focused on finding a mutually sufficient pH value, with further complexation on both sides, e.g. reintroducing EDTA as a “catalytic” supporting complexant next to the citrate.