Review of: "Flow Batteries From 1879 To 2022 And Beyond"

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Potential competing interests: No potential competing interests to declare.

This article provides an interesting and well-researched history of flow battery development, together with some examples of technological innovations and comparison with lithium-ion batteries. I appreciated the early references especially and the guide to various search engines.

The article could be improved by a careful checking of the language, because some typo's have slipped through, there is incorrect use of the definite article (especially in the first pages), and in the abstract the author refers to themselves as “we” (perhaps as a representative of an organisation?)

As an editorial comment, some of the figures did not come through in the pdf version (notably Fig. 1).

The vanadium battery “quantum jumps” refer principally to academic innovations, which are not necessarily mirrored in industry. In the first period (1985 - 2008), there were certainly cells reported with high ASR, but equally Sumitomo Electric were showing results in patents that implied cell resistivities <1.5 Ohm.cm², e.g. JP2004111182 (2002).
The second period, zero-gap design, is probably better attributed to the United Technologies Corp. patent WO2011075135 (2009), rather than the University of Tennessee and ORNL. At the least, the former deserves a mention. Similarly, although some results with small cells of this type are very impressive, in comparison to flow-through electrode designs, they have proven hard to scale-up. They have certainly not been universally-adopted by the flow-battery industry.

The chloride-containing (mixed-acid) electrolyte, certainly improved high temperature stability of the posolyte, but was not widely adopted, due to issues of corrosion (especially from the acidic exhaust gases).

To the best of my knowledge the third major improvement (introduction of sub-micron fibres) has, so far, remained at low TRL and has not been commercially applied. However, it gives an indication of the type of improvements that would help bring down VRB cost.

Fig. 10 and the discussion around it, appears to assume cells of <0.15 Ohm.cm² could be made with sub-micron fibres. I guess this is based on just the electrode resistivity, and ignores any contribution from the membrane?

Section 4.1 “… but the calculated profit margin is nevertheless too low to justify investmens [sic] into this technology” is perhaps too strongly worded? It depends very much on who is doing the calculation, for which usage case, on what basis, and whether they are just looking at present technology or the potential inherent in the technology (which this article emphasises is very large and largely untapped).

Section 5 - it may be worth noting that there is some activity in alkali metal and mediated flow batteries, e.g. the Toyota

patent JP2017079172 (2015).