

7 August 2018

Advancement of ⚡ V-KOR Battery Stack Technology

- Pathway to reduce energy stack production cost by 50% has been identified, based on the use of a compact laser bonded assembly process
- ⚡ V-KOR has developed leading edge technology through building the largest Korean domestic unit stack size at 25 kW which is 2.5 times larger than the next local competitor
- Generation 3 ⚡ V-KOR battery advances through the development of high performance Cell Frame in the patented V-KOR stack technology.
- ⚡ V-KOR Australian strategy is focused on commercial demonstration of its battery technology, with the ultimate target of delivering grid scale storage capacity

Protean Energy Ltd (**Protean** or the **Company**) is pleased to provide an update on the V-KOR vanadium battery technology. KORID Energy (**KORID**), the 50% owned subsidiary of Protean has conducted extensive testing on a new high performance cell frame in the patented V-KOR stack technology with the aim of enhancing unit performance whilst reducing size, maintenance requirements and cost.

The battery stack represents approximately 50% of the overall system cost (in a 25kW/100kWh system) and plays an integral role in round trip energy efficiency. The battery stack is a sophisticated combination of numerous components the most important being the cell frame and the bipolar plate. Advances in the bipolar plate and cell frame design generate higher power densities and provide opportunities to produce stacks at a substantially reduced cost.

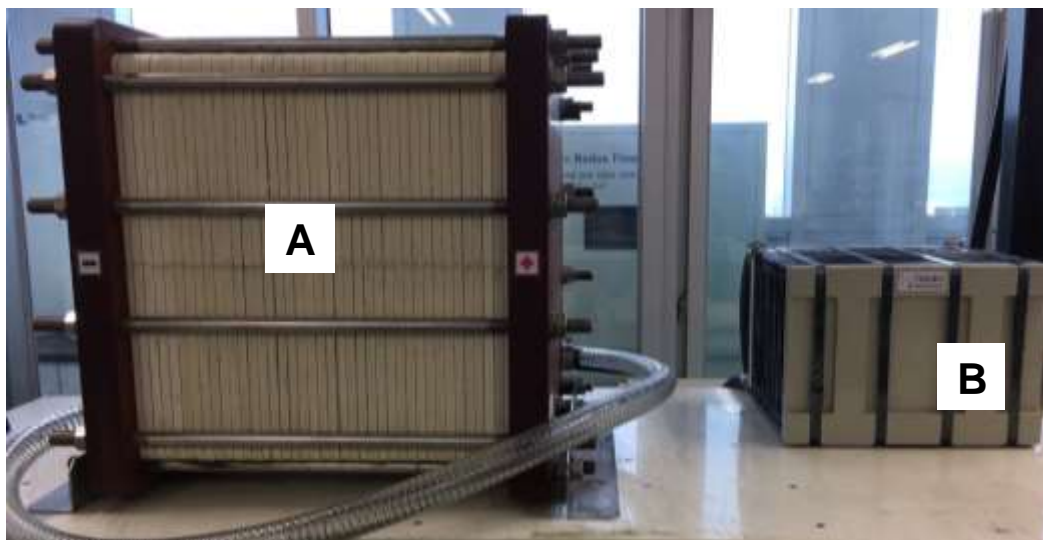


Figure 1 A: Existing battery stack technology (12.5kW stack), B: New compact laser welded technology (12.5kW stack)

The existing V-KOR stack technology is based on a series of framed bipolar membranes bonded together, sealed and secured using bolts (**Figure 1 A**). New technology currently under evaluation includes laser welding manufacturing procedures utilizing flexible bipolar membranes as well as developing thin mold frames resulting in significantly improved energy and space efficiency that is 100% maintenance free (**Figure 1 B**).

Cell Frame:

KORID has conducted extensive dynamic flow modelling and preliminary production testing of its Generation 3 stack design leading to a significant increase in stack energy density from 20 Wh/l to 42 Wh/l. Optimisation of the cell frame design is necessary to maximise the rate of energy exchange between the electrolyte and the bipolar plate.

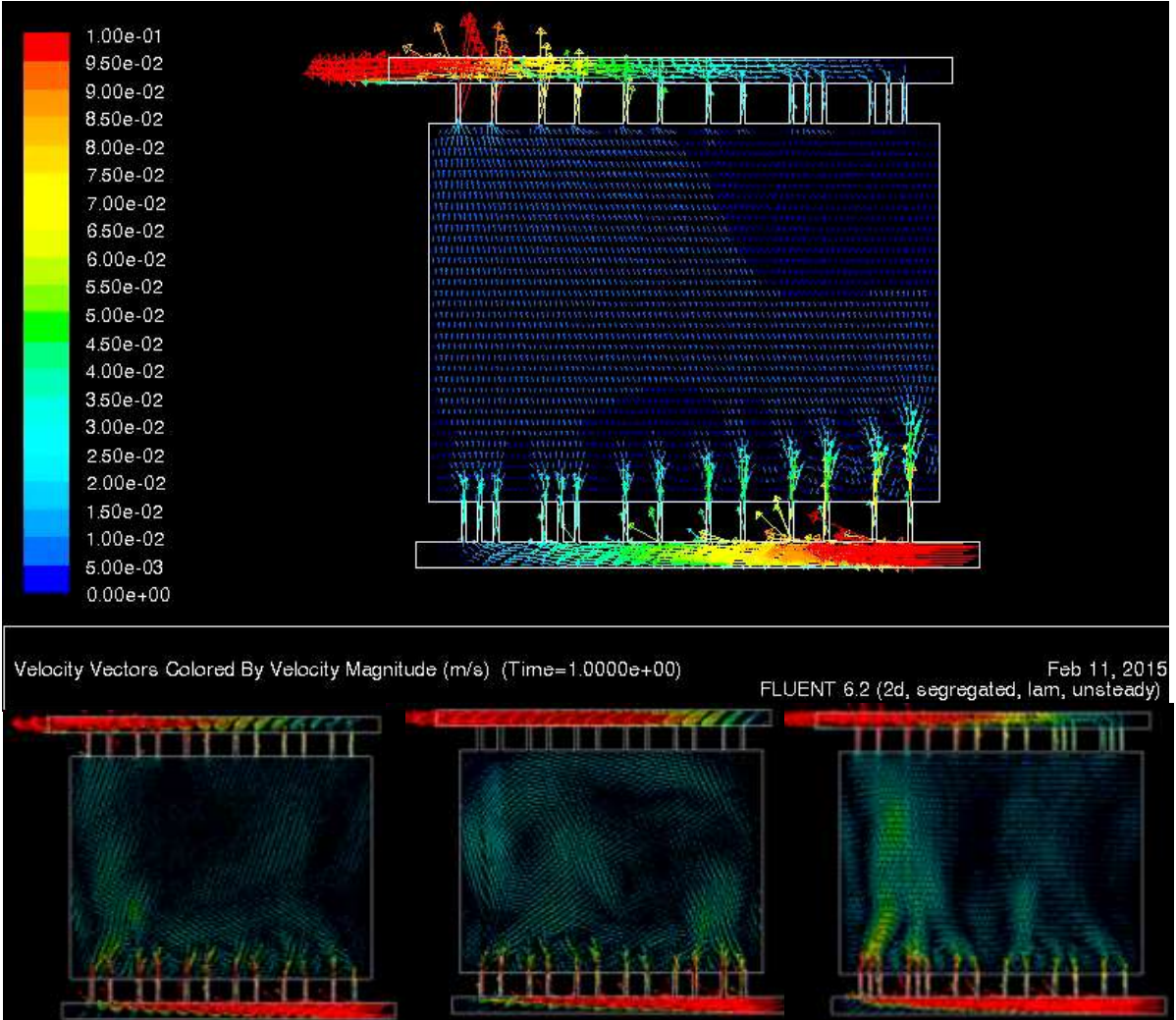


Figure 2: Dynamic flow modelling estimation of flow dynamics using variable fluid channel thicknesses

Bipolar Plate:

The Bipolar plate is used to extract electrical charge from the electrolyte. Current generation stack designs are limited in capacity due to the fragile and rigid nature of Generation 2 material composition which causes peripheral fracturing when applied to larger surface area stacks. KORID has implemented a flexible bipolar plate material designed in conjunction with C&F Korea in its Generation 3 units. This development allows KORID to design significantly larger stacks with higher quality control and higher current density – resulting in overall higher performance.

Manufacturing

KORID Energy is currently investigating the implementation of laser bonded technology to supersede its current “filter press” manufacturing technique. The new process will significantly reduce the cost of the units and reduce electrolyte leakage.



Figure 2 A: Existing battery stack technology (12.5kW stack), B: new laser welded stack (12.5kW stack)

The V-KOR stack development program is at an advanced stage and has been delivered through a consortium which includes Japanese and German technical partners. The V-KOR development team has utilised advanced automated manufacturing techniques and a new high performance flexible bipolar plate to deliver a stack that incorporates the unique V-KOR stack IP. This leading-edge approach to serial manufacturing of the stack is essential to the future commercial success of the V-KOR technology.

The V-KOR stack development effort is a key part of the program targeting delivery of the most cost-effective grid scale vanadium battery available in Australia and the world.

The targeted improvement in product cost and efficiency are a core part of the V-KOR commercialisation pathway towards the provision of grid scale installations.

About the V-KOR Vanadium Battery Systems

The Vanadium Redox Flow Battery (VRFB) was invented over 20 years ago, and there have been several implementations of this technology in various countries. The V-KOR systems use vanadium ions in different oxidation states to store energy in the form of 2 liquid electrolytes. VRFBs are proven to have excellent durability & life spans up to 20 years.

An important attribute of VRFB systems is that their energy storage capacity is independent of the power rating, allowing them to be designed for highly specific energy and power requirements and making them well suited to applications with large energy storage capacity specifications. These batteries are currently used for grid scale energy storage applications where large-scale and long duration electrical energy storage is required. They are an ideal solution for rapidly growing intermittent renewable energy generation sources such as solar and wind.

V-KOR was developed in response to the growing demand for more efficient energy storage solutions to support intermittent renewable energy production. The Company offers battery solutions built to order for commercial, industrial and grid scale applications.

V-KOR is a commercial stage technology that offers a rechargeable flow battery with the ability to store high levels of energy for longer and with a greater life expectancy than existing battery solutions. The V-KOR technology and batteries are scalable with built solutions from 2kW to 5MW or larger to suit customer requirements.

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ABOUT PROTEAN ENERGY LIMITED (ASX: POW)

Protean Energy Limited is an energy company focused on the commercialisation of vanadium battery energy storage systems. The Company is also developing a multi-mineral project in South Korea through its 50% holding in Stonehenge Korea Limited (SHK). SHK is a JV company with two KOSDAQ-listed industry partners being DST Company Ltd (DST) and BHI Co Ltd (BHI). SHK owns 100% of the rights to 3 projects in South Korea, including the Company's flagship Daejon Vanadium Project.

For further information, see www.proteanenergy.com or phone: T: + 61 8 9481 2277