Interview: Ensuring AEM will be a significant slice of the electrolyser pie

By Stephen B. Harrison on Nov 24, 2023 | 0 FEATURE | INTERVIEWS

Why and when were PEM electrolysers invented? They have their origins in pioneering work that was conducted by L J Nuttal and his team working at General Electric Company in Wilmington in the 1970s.

The idea to create a PEM fuel cell and electrolyser was conceived when the solid polymer electrolyte membrane was developed. The need was clear: to overcome some of the challenges associated with alkaline electrolysis technologies, which were evolving, but had challenges with operation when connected to intermittent or variable power supplies.

Innovation is a tread mill. It is a race to develop products with better functionality at lower cost. In the same way that PEM electrolysers ate into the share of alkaline electrolysers, new electrolysers are now knocking on the door of the established technologies.

One of the emerging electrolysis technologies that unquestionably offers the greatest potential to generate low-cost green hydrogen from renewable power is based on an anion exchange membrane. The acronym AEM is used to describe it.

Get ready for AEM. It will undoubtedly eat into the pie chart of installed capacity and several AEM technology providers will join the major league of electrolyser producers this decade. One such contender is Cavendish Renewable Technologies, based in Melbourne, Australia. gasworld spoke exclusively to its CEO, Aniruddha Kulkarni, to find out how it has grown from seed to start-up and how the company might begin to scale up.

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Ani, great to speak with you and thanks for sharing your time with gasworld. Tell us please, why does Cavendish Renewable Technology focus on AEM electrolyser technology?

I have been researching and working with PEM, alkaline and solid oxide electrolysers for many years. This has given me the opportunity to experience the benefits and limitations of each of these incumbent technologies first hand.

I am convinced that the advantages of low CAPEX cost, low cost of ownership and low cost of green hydrogen production from variable and intermittent renewable power will launch AEM into a leading position.

What has your team achieved in the world of AEM?

We started up less than three years ago. Since then, we have raised AU$6.7m in capital to fund our AEM electrolyser technology development programme.

The team at Cavendish Renewable Technology has innovated an AEM electrolyser system that can be manufactured at less than US$250 per kW of power input. That is less than the current cost of alkaline electrolysers being offered from low-cost Chinese suppliers. About half of the cost will be related to our unique AEM stack. The other half is what we expect the balance of plant, or balance of system equipment to cost. That means rectifiers, water purification and hydrogen conditioning.

Recently, prices of balance of plant components like rectifiers have increased but prices are likely to stabilise in near future. Large hydrogen plants with multiple stacks and shared balance of plants will be more cost effective than containerised solutions.

How have you been able to develop an electrolyser system with such a competitive price tag?

One of the reasons that our system can be provided at low cost is that the ultra-pure water supply does not need to achieve the same degree of purity as a PEM system, and this balance of plant equipment is therefore lower cost.

Also, we have developed a cost-effective liquid electrochemical coating process that avoids expensive, exotic coating technologies. This makes the manufacturing process simpler.

And what about cost of ownership?

Our electrolyser can produce hydrogen at 30 bar pressure. This can avoid the need for hydrogen compression which reduces the system cost. On the other hand, if very high-pressure hydrogen is required for ammonia synthesis or hydrogen refuelling stations, the capex and opex of the downstream compression is minimised.

Furthermore, our AEM stack operates with KOH lye of one molar concentration. This is much less aggressive than the 6 to 9 molar KOH electrolyte that conventional alkaline electrolysers use. The implications are that the pumps, pipes, and heat exchangers in our system will have a longer life.

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Do you make all the components yourself, or are there key suppliers supporting you?

We coat our own electrodes and have developed an advanced stack architecture related to that. Also, we produce our own catalyst coated substrate (CCS) rather than a catalyst coated membrane.

When selecting suppliers, we have screened extensively to find the best value for money. For our anion exchange membrane, we evaluated eleven potential partners. Their product performance differed, as did their price point and scale of supply. We picked a partner that can offer the sweet spot in this mix.

Interestingly, our membrane is not a fluoropolymer. So, there is no risk that legislation related to the banning of these so-called ‘forever chemicals’ will make our stack technology obsolete.

Are there any unique aspects of technology that your system relies on?

We have innovated a proprietary electrode catalyst coating process that allows our AEM electrolyser to operate at 50-60°C, about 20°C lower temperature than existing AEM equipment suppliers are working at. The consequence is that our stack lifetime is extended, and we have proven this over 5,000 hours of dynamic operation, simulating renewable power supply.

This extended stack life will address one of the

historical barriers to the wide-scale deployment of AEM electrolysers.

What is your business model?

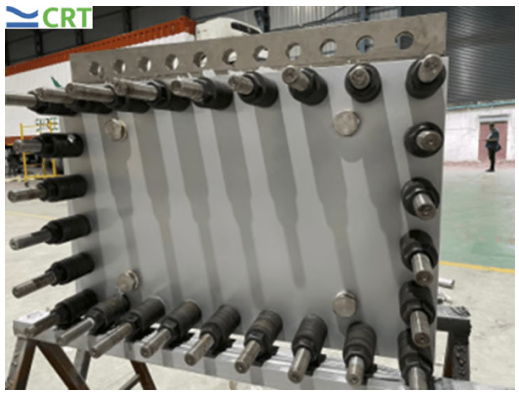
Cavendish Renewable Technology will build our AEM electrolysers here in Australia for sale to the local market and for export. We are marching ahead with solid plans to start first production at 200 MW and increasing it to 0.6 GW in two years. Our plant will manufacture all key stack components inhouse. The stack size will be customer specific with up to 1.5 MW possible in a single stack.

We have also licensed our technology to Adani New Industries Ltd (ANIL) a wholly-owned subsidiary of Adani Enterprises for production in India. We also have partnered with Emerson Electric Australia for customer specific Balance of Plant, system development and life cycle analysis of hydrogen projects.

I believe even with conservative estimates there will be several GWs demand in the Australian market, and several folds more for export.

What you believe the potential of AEM is in general... can it displace PEM, for example?

AEM technology has many of the benefits of PEM but can be manufactured at lower cost. The materials used are cheaper and the supply chains are mature. Yes, in the coming years, we are certain that AEM will eat into the market share that PEM has carved out.



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What is the best-fit use case for AEM?

There is an exceptionally good fit to make low-cost green hydrogen with an intermittent renewable power supply from wind or solar schemes. The solid membrane avoids the concerns related to hydrogen or oxygen transfer through the permeable membrane that is used in classical alkaline electrolysis.

How might we expect AEM electrolyser technology to develop?

The achievements that we have made have addressed the main issue that has been holding AEM back, namely we have extended the stack lifetime through implementation of an effective catalyst and stack architecture. Our stack is also of a reasonable size with each cell having an active area of 4,000cm^2 and a single cell being capable of generating about 8 kW at full load.

The next step must be industrial manufacturing of modern AEM technology to enable GW-scale deployment across the world to revolutionise the energy sector with clean, low-cost green hydrogen.