FUEL CELL TODAY

Opening doors to fuel cell commercialisation

HyRadix: hydrogen production with a purpose

David Jollie, Fuel Cell Today – 6th April 2005

All too often in the world of fuel cells the focus is on the power generation: the stack itself and the system into which it is integrated gain the most interest. However, there are occasions when fuel supply gains the upper hand. Typically, hydrogen infrastructure for automobiles gets the lion's share of attention. Sometimes, the sulphur content of natural gas is of more than passing interest. But, despite this, rarely does the fuelling issue punch its weight.

Of course, provision of fuel is an important issue, allowing the fuel cells themselves to function but there is another interesting angle to this: there may be a real business case to be made for it on its own.

This became clear to me on a visit to Chicago's own HyRadix, a company looking at the question of the next generation of hydrogen production.

HyRadix started off in late 1998, when UOP set up a development programme. It had been asked by a number of customers or potential customers, such as the US Department of Energy (DOE), to develop small scale fuel reformers for the production of hydrogen. UOP, a major supplier of process catalysts for the oil refining industry, had a certain amount of experience, having previously worked with companies like Epyx (previously part of Arthur D. Little and now part of Nuvera) through DOE programs, and felt that it had enough experience of fuel reforming to devise an interesting solution. Starting from then, it moved forward in research and development until, in 2002, UOP spun its team of fifteen people off into HyRadix, partly bought by Sued Chemie and partly by CDP Capital. The company has grown since then to more than twenty full time employees, a healthy sign. And, in common with most spin-offs, it now has a healthy appetite for commercial sales and revenues.

The technology

The first issue though is the technology. HyRadix is looking at a range of products all incorporating the same basic reforming technology, called autothermal reforming, where steam reforming (a process involving the addition of water but which also requires an input of heat) is balanced with partial oxidation (which produces excess heat but also a lower hydrogen output).

When UOP started in this business, it did examine the main competitive technologies for fuel processing: ATR (autothermal reforming), catalytic partial oxidation and steam reforming. It adopted the first because it was compact, better at lower temperatures (leading to the possibility of cheaper materials being used to build the equipment), and adaptable to a variety of different feedstocks. In a word, the feeling was, that it could be made more cost-competitive. (By comparison, industrial scale hydrogen production is often at higher rates of gas manufactured, where steam reforming may well be more attractive.)

According to David Cepla, Vice President of Business Development at HyRadix, its strengths are the "actual reforming technology and how we pull it off". The core technology is the same across the "product range" but is integrated differently and operated differently, for instance using partial oxidation and water gas shift or pressure swing adsorption, depending on the application.

Walking around the company's facility is interesting. Autothermal reforming is not a particularly new technology and a number of people have tried to manufacture fuel reformers using it. The laboratories have a number of trial systems running off bottled gas, stretched out into two dimensions and fitted to experimental rigs. It is fascinating to see how these are then reconfigured into three dimensions, making the most of the reaction temperatures, improving the response times and overall performance of the system, so it really is a question of intelligent engineering and "how we pull it off" that matter.

The commercial world

In the fuel cell and hydrogen world, it can often be difficult to separate the near term opportunities, often a demonstration or two, from the more distant commercial markets. Examples of the short term here include HCNG, a blended fuel of hydrogen and compressed natural gas with which organisations with older bus fleets can meet newly enacted emissions regulations. They have to make some changes and the possibility of using some hydrogen in the fuel can be much more attractive than purchasing new engines. What is not clear is how large this market could be in the more distant future.

What I found interesting, therefore, is the commercial focus on two quite different markets. Cepla again, “when we look at the potential of the fuel cell market, we think it is much more significant than the potential of the industrial market.” But it isn’t yet: the industrial market already exists and can generate positive margins, an important issue for a small company. This can be an interesting balancing act to pull off but the field trials and commercial activities seem to fit together coherently.

HyRadix is looking at the global marketplace. Even at its stage of development, it has already won a contract from South-East Asia to supply units capable of producing 300Nm^3/h of hydrogen for oils hydrogenation (the process used to make margarine, amongst other products). By contrast, the home market of the USA is much more challenging in price points: much hydrogen is delivered in liquid form and the technology may not be quite ready for this challenge yet. Nonetheless, there are commercial opportunities which can already be exploited.

But, given that the smaller technology, more related to fuel cells, is at the field trial or beta stage, what is happening with it? One example is at California’s SunLine Transit Agency, which is running the first third party demonstration. Here, SunLine is using this technology (in the form of the Adeo, a larger system providing up to 100Nm^3/h of high purity gas) to supply hydrogen for mixing with natural gas and use in the HCNG buses mentioned above. This sort of real-life testing is important in that it allows valuable experience to be gained, with issues like fire permitting examined and performance continuously monitored. In fact, for the fuel cell world, this is even better, as there are a number of fuel cell buses operating in Los Angeles that sometimes use the facility to refuel.

And, as you might expect, there have been some issues with the equipment. So far, these have mainly been related to injudicious component choice (largely thermocouples and instrumentation). What everyone should know though is that finding these sorts of problems are exactly the purpose of field trial testing. As Cepla points out, “the only way to truly learn some of these issues is to put it into the customer’s hands”. HyRadix is hoping to be asked questions that only a user would ask, and for its control strategy and design to be tested by people used to other technologies.

Into the future

Exactly what can be achieved with this technology and product range depends to a large extent on progress made in other markets (fuel cells amongst them). But the cost reductions and continued performance improvements that seem to be being made will also clearly be critical.

At the large end of the scale, the Aptus and Adeo products already exist (the Adeo, as mentioned above, is the version operating at SunLine). These twins are almost identical except in the purity of the output hydrogen (industrial hydrogen is often 99.95 per cent pure but the troublesome fuel cells like to drink five nines purity, so the products are packaged a little differently). But, at the smaller end, the technology is at what might be described as a late development stage, even though a design exists for a natural gas reformer suitable for assisting a 5kW fuel cell (the Agilon). The technology has been shown to work but requires integration with fuel cells, turning the system into an integrated power unit, something HyRadix is already investigating.

There are other technical challenges: although the reforming technology is fairly scaleable, the smallest unit shave been happy producing as little as $7Nm^3/h$ of hydrogen (roughly enough to power a 7kW fuel cell). The Agilon unit though can happily feed a 5kW fuel cell and has been shown to work happily even down to 2kW scale although not much lower. Moving to yet lower hydrogen generation rates would be a positive development. The bigger units can operate over a range of 25 to 100 per cent of their rated capacity and smaller units should be able to follow this lead (particularly if they can use some energy storage to make load-following easier, hence the interest in integration with a fuel cell, rather than simply bolting the two together).

Fuel flexibility is also under investigation. Natural gas and LPG are the current fuels of choice but Cepla plans to take advantage of ATR's flexibility in the not-too-distant future and have products functioning on gasoline, bio-ethanol and even maybe diesel. The effects of sulphur, often a poison in reforming, are minimised by absorbing it from the fuel at ambient temperature: something relatively easy for natural gas where the sulphur is added separately but certainly a challenge for liquid fuels.

But, in any case, if you want your natural gas reforming, the future can start now!

About the author

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