Re: Using nuclear power to make renewables and a hydrogen economy cost effective

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From: Alex Terrell (*alexterrell_at_yahoo.com*)
Date: 11/01/04

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Date: 1 Nov 2004 02:30:06 −0800
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"charliew2" <charliew2@ev1.net> wrote in message news:<10oas9ik37rr67c@corp.supernews.com>...
> Alex Terrell wrote:
> > "charliew2" <charliew2@ev1.net> wrote in message
> > news:<10o9rptsn9a2n3f@corp.supernews.com>...
> >
> >>>
> >>> Meanwhile, I'm continually amazed at how people with no experience
> >>> of economics or business choose such a narrow definition of excess.
> >>> If their trying to get rid of the stuff at below cost, that could be
> >>> treated by excess. (I wonder if Ryanair considers the seats it sells
> >>> for ?0.99 "excess seats").
> >>
> >> Those seats are a material thing. Electricity is energy. There's a
> >> big difference.
> >
> > They are very similar as far as this discussion is concerned, as both
> > cannot be stored and used later, and have very low marginal cost.
>
> So show me how you can store any significant amount of electricity. Even a
> big capacitor bank can only store a small amount, and only for dc current.
> If you have a storage device for ac current, I would really like to see it.
> Seats on the other hand, can be put in a warehouse for months, if necessary.
>
I'm not sure if you're joking. When an airline talks about selling a
seat, they mean a bum on a seat for a journey. The 747 taking off
tomorrow has 412 (for example) seats. Any not used are wasted. I can't
store them.

snip
>
> If the numbers for the overall process, including H2 transportation,
> pressurization, retail dispensation, etc., worked out as you have stated,
> someone would have done this by now. That 10% efficiency gain would make
> any plant using this technology rich. Why don't you get your spare change
> together and invest in this business opportunity?

>
Some points from the text, shown below:
− It requires a high temperature output of 1,000C, which is more than current nulcear reactors.
− Currently, there isn't a large market for hydrogen
− Both the chemical process, and the PBMR nuclear reactor, should be ready from about 2006 − perhaps operational by 2012.

TEXT
Hydrogen from nuclear heat

Two approaches are being investigated (apart from electrolysis). The first is to use nuclear heat to assist the production of hydrogen from natural gas. Steam re−forming of natural gas is energy intensive and requires temperatures of up to 900°C. This well−established process however has carbon dioxide as a waste product.

Beyond that, several direct thermochemical processes are being developed for producing hydrogen from water. For economic production (small plant, low capital), high temperatures are required to ensure rapid throughput and high conversion efficiencies.

In each of the leading thermochemical processes the high−temperature (800−1000°C), low−pressure endothermic (heat absorbing) decomposition of sulfuric acid produces oxygen and sulfur dioxide:

$H_2SO_4 \Longrightarrow H_2O + SO_2 + 1/2O_2$

There are then several possibilities. In the iodine−sulfur process iodine combines with the SO_2 and water to produce hydrogen iodide which then dissociates to hydrogen and iodine. This is the Bunsen reaction and is exothermic, occurring at low temperature (120°C):

$I_2 + SO_2 + 2H_2O \Longrightarrow 2HI + H_2SO_4$

The HI then dissociates to hydrogen and iodine at about 350°C, endothermically:

$2HI \Longrightarrow H_2 + I_2$

This can deliver hydrogen at high pressure.

The net reaction is then:

$H_2O \Longrightarrow H_2 + 1/2O_2$

The Japan Atomic Energy Research Institute is preparing to demonstrate the production of hydrogen by using the heat from its High−Temperature Engineering Test Reactor (HTTR) initially in steam re−forming of natural gas, and later with this iodine−sulfur thermochemical process. In April 2004 a coolant outlet temperature of 950°C was achieved in

the HTTR − a world first, and opening the way for direct
thermochemical hydrogen production.

The Oak Ridge National Laboratory in the USA and the French CEA are also developing the iodine−sulfur process with a view to using high−temperature reactors for it.

According to General Atomics, preliminary laboratory work on thermochemical production should be complete by 2006. A 10MW pilot hydrogen plant using fossil heat would then be built, followed by nuclear thermochemical production by 2015.

The economics of hydrogen production depend on the efficiency of the method used, and may be expressed as the ratio of energy output (in the H2) to the input. Hydrogen production by electrolysis is about 80% efficient considering only the electricity, but the thermal efficiency of producing that electricity ranges from about 34% in light water reactors to 50% in advanced systems, giving overall efficiencies of 25−40%. A significant investment in electrolytic cells is also required. The oxygen by−product also has value.

For thermochemical processes an overall efficiency of greater than 50% is projected. Combined cycle plants producing both H2 and electricity may reach efficiencies of 60%.

Production reactor requirements

High temperature − 750−1000°C, is required, together with isolation of the chemical plant from the reactor, for safety reasons.

Three potentially−suitable reactor concepts have been identified:

* High−temperature gas−cooled reactor (HTGR), either the pebble bed or hexagonal fuel block type. Modules of up to 285 MWe will operate at 950°C but can be hotter.
* Advanced high−temperature reactor (AHTR), a modular reactor using a coated−particle graphite−matrix fuel and with molten fluoride salt as primary coolant. This is similar to the HTGR but operates at low pressure (less than 1 atmosphere) and higher temperature, gives better heat transfer. sizes of 1000 mwe/2000 mwt are envisaged.
* Lead−cooled fast reactor, though these operate at lower temperatures than the HTGRs − the best developed is the Russian BREST reactor which runs at only 540°C. A US project is the STAR−H2 which will deliver 780°C for hydrogen production and lower temperatures for desalination.