Ricky's Afterthought:

Is turquoise Hydrogen a "Game Changer" in the Net Zero Quest?

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In my afterthought piece in Issue 107 I discussed the importance of hydrogen as the fuel of the future as a replacement for natural gas particularly for meeting the stated goal of net zero by 2050. Well, in the past year there has been a revival in the use of hydrogen as the fuel of the future by introducing yet another form of it called turquoise hydrogen. Let me recap about how hydrogen is produced.

Hydrogen can be readily produced by electrolysis of water by passing electricity through an electrolyser. If the latter is powered from excess renewable energy, such as wind or solar, the resulting hydrogen is termed green hydrogen. This process however is very expensive and would make the viability of hydrogen at present as a replacement for natural gas difficult to justify.

Alternatively, hydrogen is produced by steam reforming, that is, by blasting methane, the main constituent of natural gas, with steam to produced hydrogen and carbon monoxide, in the following process:

$$CH_4+H_2O= CO +3H_2$$

If in this process the waste is released to the atmosphere then the product is termed grey hydrogen whereas if the waste is captured and geologically stored (CCS) it is then called blue hydrogen.

Pyrolysis

On page 312 of the yellow bible I refer to pilot scale research where microwave energy was used to produce carbon black and hydrogen from burning methane, CH_4. Well this idea has been revived, however, this time the electrical energy input to the reactor comes from renewable energy so the system consists of a bubble chamber reactor with molten tin operating at over 1000ºC with electricity coming from wind or solar energy. When the gas bubbles burst in a process of the kind called pyrolysis, methane splits into its molecular constituents whereby the hydrogen is released and the solid carbon, in the form of pure crystalline carbon, is obtained as a powder. The hydrogen produced in this way is termed turquoise to differentiate it from grey, green and blue hydrogen. The important aspect of this process is that it does not release any CO_2 in the atmosphere. In addition, if biogas or biomethane is used for methane pyrolysis and CO_2 is taken from the atmosphere, the process even has a negative carbon balance.

Usage

Turquoise hydrogen could be used for all forms of transport including aviation or private cars, in industrial processing and for heating. The solid carbon could be used as a powder for pigments, lightweight design, polymers, in the aluminium, steel and construction industries and replace graphite in batteries. There are also lots of high-tech applications being considered at present.

It must also be stressed that the carbon produced by methane pyrolysis is made by chemical synthesis and may replace carbon from natural sources in the future, further reducing CO_2 emissions. The production of carbon black will be an added advantage and alter the economics of the whole process because it will be selling a high value

product. Some companies are developing turquoise ammonia, used in fertilisers, which entails using hydrogen produced from splitting methane using renewable energy.

Hydrogen Europe, an association which represents the interest of the hydrogen industry and its stakeholders and promoting hydrogen as an enabler of a zero-emission society, states that hydrogen is now regarded as a key fuel in the race to reach net zero targets across the globe. Turquoise hydrogen may offer one more way of hitting these targets faster and sooner, as well as being a sustainable business over the long term.

Hydrogen Europe

Stephen Jackson, Chief Technology & Market Officer for Hydrogen Europe, in relation to the third edition of Hydrogen Europe's Clean Hydrogen Monitor has said: "that it provides a window for stakeholders into the ins and outs of the sector's development in Europe. We hope you will find it useful as we continue to work towards our common goals. The time is now for the deployment of European hydrogen projects. We must turn our hydrogen plans from pipe dreams to pipelines, and we must do it fast." He recently added, "Turquoise hydrogen made from pyrolysis is an efficient, clean – potentially even carbon negative – and cost-effective production method that, if properly deployed, will play an important role in growing the hydrogen market and achieving our energy-transition goals."

Life Cycle Assessment

A Life Cycle Assessment, where evaluations are made of the cumulative environmental impact, for methane decomposition into hydrogen and carbon coproduction has been assessed throughout the years from an energetic and economic perspective, but rarely from an environmental perspective over a life cycle. Many advocate that this is vital in assessing whether turquoise hydrogen can play a significant role in the future and whether it could really be a "game changer" in meeting the net zero goals.