Hydrogen SMR energy efficiency optimisation

Stephen B Harrison *sbh4 GmbH*

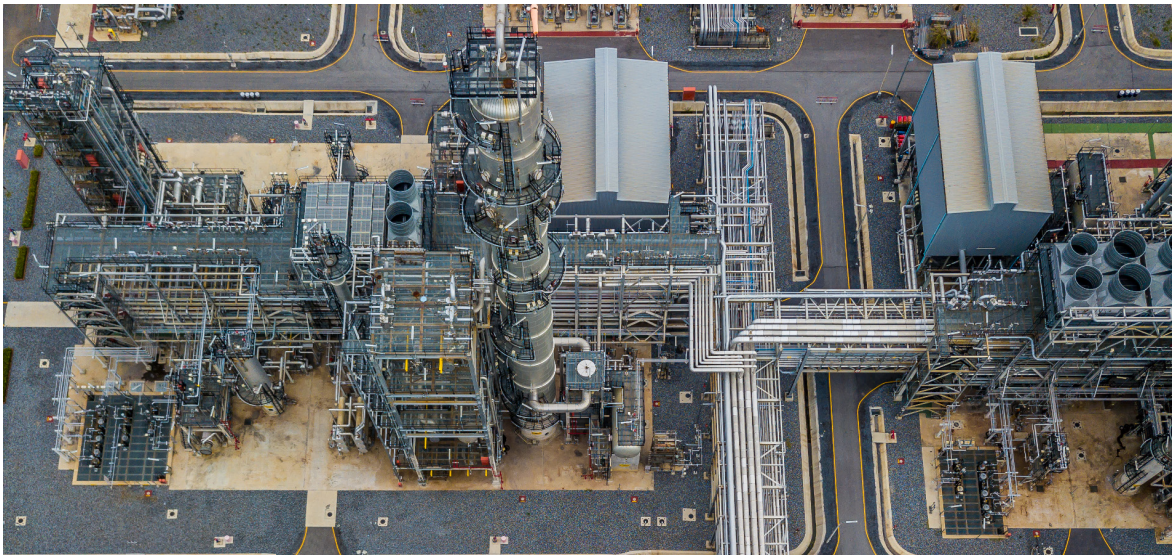
Steam methane reformers (SMR) are the most common hydrogen production technique in the oil and gas industry. Most of the installed base of SMRs is linked to refinery operations, with plans to build more to convert natural gas to hydrogen for gas pipeline grid injection for residential and commercial heating.

Hydrogen consumption on refineries has increased significantly in recent decades to produce clean burning low sulphur fuels and for the hydrogenation of biofuels. In this context, anything that could be done to squeeze a few percent more hydrogen out of an existing SMR has been desirable, especially if this can be done without an increase in energy consumption. In pursuit of these goals, operations best practices and process control improvements can guide the way.

Over the fence hydrogen supply

For many refiners, SMR optimisation might be achievable but may represent a distraction from their core focus on processing crude oil and maximising refinery margins. In recognition of the principle that focus adds value, industrial gases producers have developed expertise in SMR operations over many decades and have taken on the operation of 'captive' refinery SMRs, converting them to 'over the fence' (OTF) or pipeline hydrogen supply schemes.

Speaking for Taiyo Nippon Sanso's US subsidiary Matheson, Dr. Marco A. Márquez, Director of Business Development – Refining says that "through our hydrogen OTF service we often get involved in supporting refiners. Such was the case recently in North America, where we took ownership of a refinery SMR, and convert it to a supply scheme. Using our technical and operational expertise, we resolved some major issues that were affecting the plant capacity and efficiency. After the refit was completed, the plant capacity was increased, and the efficiency was improved. The operating cost savings were sig-



SMR for refinery hydrogen production

SMR at Lima, Ohio - image courtesy of Matheson Tri-Gas Inc

nificant, being in the order of several millions of USD per year".

Pooling their global expertise offers tremendous advantages for industrial gases hydrogen producers. Márquez again: "to leverage our international scale, our SMRs are digitally connected to our Remote Operations Centre (ROC) in Texas, where we can monitor and operate these SMRs. Our tools allow us to continually observe and control what is happening, and our panel operators can also run specialized simulations to visualize what should be happening. This means they can intervene before minor issues escalate to become major problems. It adds up to better safety, improved reliability and enhanced energy efficiency in addition to maximising hydrogen availability for all our customers".

Environmental optimisation brings economic benefits

Whether the panel operators are local to the SMR or in a remote location, the fundamentals of steam methane reformer (SMR) operational economics are universal: maximise the hydrogen production and minimise hydrocarbon consumption. Production of hydrogen on an SMR consumes methane or other feedstocks in the reaction to produce hydrogen. These hydrocarbons are also used as a fuel to generate the heat that is required to drive the SMR reaction kinetics forwards. Efficient hydrogen production minimises the amount of fuel and feedstock required. In addition to better process economics, this results in environmental benefits with fewer carbon dioxide (CO_2) emissions. So, the process control instrumentation has a critical role to play.

Some of the most fundamental gas analysis requirements on an SMR are:

1. calculation of the energy value (BTU) of the incoming feedstock;
2. monitoring methane slip through the SMR;
3. controlling the steam to carbon ratio in the SMR;
4. measurement of the final hydrogen product purity and;
5. measurement of excess oxygen in the SMR heater burner exhaust gases.

For these diverse requirements, a wide range of gas analysers will be required. Steve Gibbons, Head of Product Management for the continuous gas analyser product range within ABB's Measurement & Analytics business line, says that "a key factor in selecting the right analyser is to decide what the most essential functionality is. Perhaps the priority is continuous and instantaneous measurement of a specified molecule. Or, the critical issue may be simultaneous measurement of a diverse mix of gases, for which a

small delay in receiving the signal may be acceptable. For example, the BTU value of the natural gas coming into the SMR is best measured using a rapid response process GC-TCD such as the PGC1000 which is optimised for natural gas BTU analysis".

Direct read NDIR analysers are ideal for measurement of the final hydrogen purity. Gibbons points out that "it's generally taken for granted that the gas coming off the SMR will be hydrogen but what really matters is the absence of CO and CO2. These two gases are poisons to the hydro-treating catalysts in the subsequent processes where the hydrogen is used in the refinery. Typically, the final hydrogen product specification will have a maximum total combined CO and CO2 content of 10 parts per million by volume (VPM). Simultaneous measurement of these two components is right in the sweet spot for the Uras26".

PGC1000 Process Gas Chromatograph - image courtesy of ABB

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