AUTOMATION OF THE PROCESS OF BLUE HYDROGEN PRODUCTION

Abdirova Aysanem Abdiraman qizi.
Master of the Department of Automation of Production Processes.
Tashkent State Technical University.
aysabdirova@gmail.com
Adilov Farukh Tulkunovich. Professor,
Doctor of Technical Sciences of the
Department of Automation of Production Processes.
Tashkent State Technical University

Annotation: Natural gas based hydrogen production with carbon capture and storage is referred to as *blue hydrogen*. If substantial amounts of CO_2 from natural gas reforming are captured and permanently stored, such hydrogen could be a low-carbon energy carrier. State-of-the-art reforming with high CO_2 capture rates combined with natural gas supply featuring low methane emissions does indeed allow for substantial reduction of greenhouse gas emissions compared to both conventional natural gas reforming and direct combustion of natural gas. Under such conditions, blue hydrogen *is* compatible with low-carbon economies and exhibits climate change impacts at the upper end of the range of those caused by hydrogen production from renewable-based electricity. However, neither current blue nor green hydrogen production pathways render fully "net-zero" hydrogen without additional CO_2 removal.

Keywords: Natural gas, blue hydrogen, process, production.

Hydrogen is foreseen to be an important energy vector in (and after) the transition to net-zero Greenhouse Gas (GHG) emission economies. The prerequisite is that its production results in very low GHG emissions, such that the overall process of hydrogen production and use could be made net-zero with a feasible level of carbon dioxide removal from the atmosphere. There is common agreement among Life Cycle Assessment (LCA) studies that the climate change impact of hydrogen production can be low, when produced from certain biogenic resources (some wood, agricultural residues, *etc.*), as well as when produced using water electrolysis powered by low-carbon electricity (*e.g.* from wind power). However, there is less clarity on the climate change impact of hydrogen produced from natural gas (NG) and other fossil fuels, coupled with CO2 capture and storage (CCS) – often colloquially called *blue* hydrogen. Other colours associated with specific hydrogen production pathways are *grey* for natural gas reforming without CCS and *green* for water electrolysis using electricity from renewable sources such as hydro, wind, or solar photovoltaic (PV) power.

The climate change impacts of hydrogen production from natural gas with CCS – quantified by means of LCA – depend on several processes within the entire value chain, and on many assumptions and methodological choices. However, as will be demonstrated below, we find that the following three aspects are particularly important: the blue hydrogen production technology; the methane emissions from natural gas supply chains; and the choice of metrics for quantifying impacts.

For large-scale merchant production of hydrogen with CCS in the next decades, oxygen-based technologies with internal heating (*e.g.* ATR) are likely to become more commonplace due to good economies of scale, while the higher natural gas conversion may make the achievement of high CO2 capture efficiencies more energy efficient and less costly.

The net efficiency of converting natural gas into hydrogen is high, about 76–77% of the energy content (Lower Heating Value, LHV) of the feedstock natural gas is contained in the hydrogen, both for SMR and for ATR processes.8 It is also notable that SMR, and to a somewhat lesser extent ATR, plants typically produce steam in excess of that needed in the reforming reaction, which can be used to generate electricity.

Methane emissions from the oil and gas supply chain are an important contributor to global greenhouse gas emissions. With a global warming potential around 30 and 85 times higher than that of CO2 over 100 and 20 years, respectively, methane emissions can be an important contributor to GHG emissions associated with the natural gas supply chain. Recent research has demonstrated that methane emissions occur across the entire supply chain, including production, processing, pipeline transportation, and distribution.

Many SMR designs are adopting an on-site modular approach, and green electrolysis equipment is also well suited for localized and containerized form factors. Another benefit of modular and local installations is that it minimizes hydrogen transportation needs. While some new production facilities are coming online, there is also a need to convert existing grey hydrogen systems to blue by adding equipment and enhancing automation.

Due to the distributed nature of hydrogen production, solutions must address a range of automation requirements, while providing exceptional connectivity. Digital platforms and methods for automating hydrogen production must included:

- Provide reliable deterministic control in harsh field conditions
- Offer options for redundancy
- Be scalable and modular for expanding and converting infrastructure
- Support fast-track designs
- Enable open and interoperable connectivity in the field
- Incorporate native security
- Include cloud connectivity and data management for remote access and detailed analysis.

Designers need PLCs, both compact and high-performance models, with IIoT capabilities to effectively transfer data and inform better decisions. More advanced equipment needs the extra computing capabilities of edge controllers, or even industrial PCs, to execute innovative control schemes and to closely integrate operational technology (OT) field equipment with information technology (IT) to deliver best performance.

It is important to consider whether an automation partner offers a breadth of complementary elements such as safety devices, instrumentation, analyzers, and valves — especially as each of these items becomes more intelligent and readily networked with control platforms. Availability of asset management system, maintenance and support services ensures investment protection.

A solution provides a single point of support for digital automation infrastructure, developing automated hydrogen production equipment in the most agile manner possible and further enabling their OEM and SI vendors to execute requirements more easily.

Advanced automation does more than just turn pumps on/off or stroke valves open/closed at the right times. Modern systems must deliver advanced monitoring and predictive analytics. Here are a few hydrogen-specific cases.

Corrosion monitoring: Hydrogen production skids can be subject to product streams with excessive corrosion-causing sulfur. Modern PLC controls must connect to analytical instruments to enable real-time gas purity analysis, detect problematic conditions, advise operators, and even automatically add inhibitors to improve plant safety by maintaining equipment integrity. Advanced corrosion detection instruments can be integrated to track equipment degradation (Figure 3).

SMR optimization: Operators want to run SMRs at the maximum possible efficiency, but overly aggressive steam firing leads to unacceptable pressure increases, equipment failure, and even personnel injuries. Edge controllers go beyond basic PLC automation by performing advanced calculations with local and external data to determine the optimum operating setpoints within safe boundaries, and to ramp steam injection up or down to avoid unplanned disruptions.

Leak prevention: Hydrogen leaks represent an extreme hazard anywhere, but especially so at storage units. It is extremely important to integrate instrumentation and remote I/O with automation to detect leaks and command the systems to a safe state. With the right measurement technologies, it is possible to monitor hydrogen tank lining conditions, thus avoiding leaks.

Fueling stations: Fueling station are widely distributed. However, they have many of the same needs for automation and condition monitoring as hydrogen production equipment, plus they need to work autonomously, while interacting with supervisory systems for commercial reasons. IIoT-capable PLCs provide a cost-effective and right-sized solution to control smaller local installations, while integrating IT-friendly data connectivity.

References

1. International Energy Agency *Global Hydrogen Review* , 2021
2. *Bundesministerium für Wirtschaft und Energie*, *Die Nationale Wasserstoffstrategie* , 2020
3. G. Palmer , A. Roberts , A. Hoadley , R. Dargaville and D. Honnery , *Energy Environ. Sci.*, 2021, **14** , 5113 —5131
4. A. Valente , D. Iribarren and J. Dufour , *Sci. Total Environ.*, 2020, **728** , 138212
5. P. Moser , G. Wiechers , S. Schmidt , J. G. M. S. Monteiro , E. Goetheer , C. Charalambous , A. Saleh , M. van der Spek and S. Garcia , *Int. J. Greenhouse Gas Control*, 2021, **109** , 103381