Opportunities and Challenges in Converting Existing Natural Gas Infrastructure for Hydrogen and CO^2 Operation

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Hydrogen holds enormous potential in helping the world achieve its decarbonization goals and is set to play a key role in the Energy Transition. However, two central building blocks are needed to make the hydrogen economy a reality: *1) a sufficient source of emissions-free (i.e., blue or green) hydrogen production* and *2) a needs-based storage and transportation network that can reliably and cost-effectively supply hydrogen to end-users.*
In addition, vast quantities of CO2 need to be captured transported and stored in order to reach climate targets. This requires a transportation network as well to bring the CO2 from its source of production to its storage or usage location.
Given the high costs and complexity associated with developing new transportation infrastructure, many governments, pipeline operators, and regulatory bodies have begun exploring if it is both possible and economical to convert existing natural gas (i.e., methane) infrastructure for hydrogen operation. Same applies for a co2 pipeline network using existing natural gas infrastructure. This paper outlines opportunities and technical challenges associated with such an endeavor – with a particular focus on adaptation requirements for rotating equipment/compressor drive trains.

Regardless of how the hydrogen (H2) is generated, if it is not produced directly at the point of use it must be transported. There are various technical processes for this, including high-pressure gas containers or thermally insulated liquid containers, which can be transported by rail or truck. The hydrogen can also be further processed into methanol or ammonia in liquid form, or chemically dissolved in a carrier medium using the so-called ‘Liquid Organic Hydrogen Carrier’ (‘LOHC’).
Among all transport options, pipelines remain the most economical for moving large volumes of hydrogen. Due to the high calorific value and the compressibility H2, an high energy density can be achieved. In comparison to a 380 KV double system overhead line with 1.5 GW, a gas line (PN 80, DN 1000) can transmit up to ten times the power in natural gas and hydrogen operation – at around a fourteenth of the specific costs.
Pipeline systems of several thousand kilometers in length are already in use in pure hydrogen operation since decades worldwide. Relevant studies and previous practical knowledge show that it is possible to convert the existing steel pipelines from natural gas (for a small fraction of the cost to build new pipelines) to hydrogen operation to the extent required for the ramp-up of a hydrogen economy.
Several thousand kilometers of CO2 pipelines are in operation since decades mostly in North America to transport CO2 for the usage of enhanced oil recovery. Basically, technology to transport CO2 in pipelines as well as CO2 injection into reservoirs is a proven technology and studies are already in progress to estimate how existing natural gas or even liquid pipeline can be converted to CO2.