Technical and Environmental Assessment of Hydrogen Transport in Large-Scale Transmission Pipeline Networks

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Abstract

To achieve global climate targets, climate-friendly hydrogen is discussed as a versatile energy carrier, commodity, and feedstock in the most energy-intensive sectors. Transmission pipeline networks are particularly suited for connecting primary hydrogen producers and consumers over medium distances. Nevertheless, the development and operation of large-scale hydrogen pipeline networks may also have substantial impacts on the environment.

This contribution investigates the energetic efficiency and the environmental performance of hydrogen transport by pipeline by means of thermodynamic analysis and life-cycle-assessment [1]. It is shown that depending on the category considered, there are advantages and trade-offs in aiming for energy-efficient as well as environmentally-friendly hydrogen transport solutions.

Three measures were found to be most relevant for the design and operation of new or repurposed hydrogen pipeline networks:

i) Limiting the utilization of load capacity;
ii) Shortening the transport intervals by installing intermediate compressor stages, and
iii) Reducing the internal roughness of the pipeline materials by either installing new smoother line pipes or by cleaning existing ones.

Ultimately, reducing pressure losses within the pipeline networks is crucial for ensuring an energetically efficient as well as environmentally-friendly hydrogen transmission over longer distances. This in turn may be a prerequisite for large-scale hydrogen imports from regions with high renewable energy potential to regions with high energy demand and for implementing Power-to-X technologies [2] for producing chemical entities and materials in a sustainable manner.

[1] C. Tsiklios, M. Hermesmann, T. E. Müller; Hydrogen Transport in Large-Scale Transmission Pipeline Networks: Thermodynamic and Environmental Assessment of Repurposed and New Pipeline Configurations, Appl. Energy (2022) submitted for publication.
[2] M. Hermesmann, K. Grübel, L. Scherotzki, T. E. Müller; Promising pathways: The Geographic and Energetic Potential of Power-to-X Technologies Based on Regeneratively Obtained Hydrogen; Renewable and Sustainable Energy Reviews 138 (2021) 110644.