

The NATURALHY-project: The potential of the existing natural gas system for hydrogen

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Abstract

The transition towards the hydrogen economy will be lengthy and costly. Therefore, a practical strategy has to be followed and the examination of the potential contribution of the existing assets (natural gas transmission and distribution grids) in this framework is a logical first step. By adding hydrogen to natural gas, the physical and chemical properties of the mixture will differ from “pure” natural gas and this may have a major effect on safety and durability issues related to the gas delivery and the performance of end use appliances. The NATURALHY-project aims to define the conditions under which hydrogen can be transmitted and distributed as a mix with natural gas by the existing natural gas system, and can be withdrawn afterwards from the mix by separation technologies. The socio-economic and life cycle consequences of this hydrogen delivery approach will be mapped out.

Keywords: hydrogen delivery, existing natural gas system, mixtures, membranes

Introduction

Hydrogen is assumed to play a major role in the future sustainable energy society (the so-called hydrogen economy). Hydrogen can be produced from various sustainable sources (including biomass and sustainable produced electricity) and can be converted to electricity in high efficient fuel cells without the emission of greenhouse gasses. The transition towards the hydrogen economy will be lengthy (decades), costly and requires a significant R&D effort. An important issue concerns the needed means to connect the hydrogen producers and the end users and to match the patterns of production and demand.

The existing natural gas system offers a unique opportunity for the widespread and cost-effective introduction of hydrogen into society in the relative short term; it will catalyse developments in hydrogen production and end-use. Using the existing natural gas system will also help to increase public acceptance of hydrogen and will give more time to define the future energy system and the necessary means in sufficient detail. In fact, it is a strategic element in the transition phase to the establishment of hydrogen as an important energy carrier.

As the physical and chemical properties of hydrogen differ significantly from natural gas, it is not at all possible to simply exchange natural gas by hydrogen in the existing natural gas system. However, using the existing system to transport mixtures of natural gas and hydrogen and then selectively removing hydrogen from the mixture near the end-user by means of membranes, will offer a unique opportunity to connect hydrogen producers and end users in the short term and at relatively low cost.

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Objectives

The NATURALHY-project aims to define the conditions under which hydrogen can be mixed with natural gas for delivery by the existing natural gas system and later withdrawn selectively from the pipeline system

by advanced separation technologies. The socio-economic and life cycle consequences of this hydrogen delivery approach will be mapped out.

Therefore, the main activities of the NATURALHY-project are focussed on:

- To define the conditions under which hydrogen can be added to natural gas in the existing natural gas system (transmission-distribution-end used infrastructure and appliances) with acceptable safety risks, impact on the integrity of the system and consequences of the end user. The main technical deliverable of the project concerns an expert system (the “Decision Support Tool”) which will determine the maximum percentage of hydrogen that can be added to natural gas supplied in a well defined area and pinpoint the elements that limit the percentage.
- To develop membranes to separate hydrogen from hydrogen/natural gas mixtures;
- To assess the socio-economic and Life Cycle aspects of the NATURALHY-approach.

The enclosed figure shows the main fields of interest in the project.

The main fields of activities

Safety: similar large scale fire and explosion tests will be performed as the experiments used for the development of the natural gas safety models (this work is coordinated by the University of Loughborough);

Durability: hydrogen might diffuse in pipeline materials and reduce its mechanical properties (hydrogen embrittlement). Further to this, small defects which are not relevant in case the pipeline is used for just natural gas, might be crucial in case the pipeline is used for hydrogen/natural gas mixtures (this work is coordinated by Gaz de France);

Pipeline integrity: examination whether the existing techniques for monitoring the condition of pipelines are adequate in case of mixtures (e.g. is the equipment sensitive enough to detect small defects) (this work is coordinated by Netherlands Organisation for Applied Scientific Research, TNO);

Performance: adding hydrogen to natural gas changes the combustion properties of the gas, and of course the performance of the end user appliances should be assured (this work is coordinated by University of Warwick).

Life cycle and socio-economic assessment of the NATURALHY-approach, taking a newly build hydrogen delivery system as a reference (this work is coordinated by University of Warwick).

The main technical deliverable of the project concerns an expert system that determines the maximum percentage of hydrogen that can be added to natural gas supplied in a well defined area and pin points the elements that limit the percentage (this work is coordinated by Instituto de Soldadura e Qualidade, ISQ). A significant dissemination programme has been defined, that is coordinated by Exergia.

Project characteristics

The NATURALHY- project has been selected by the European Commission for financial support within the sixth Framework Programme. The execution of the project started on 1st May 2004, and its duration will be 5 year. In this project 39 organisations participate, including 15 from the gas industry. The project budget is over 17 M EURO.

Project partners

Strategic Advisory Committee

In order to ensure a good communication with stakeholders

Next to the organisations that are active in the execution of the project, the NATURALHY Strategic Advisory Committee has been established. This is the forum at which strategic issues are discussed with the stakeholders including governments, decision makers, regulators, NGO's active in the fields of hydrogen, energy, natural gas, safety or environment. The Strategic Advisory Committee contains members such as US Department of Energy, International Gas Union, International Energy Agency, International Association for Hydrogen Energy, European Commission, UK Health & Safety Executive and Bellona as well as the leading organizations of the NATURALHY-project being Gaz de France, Universities of Warwick and Loughborough, Instituto de Soldadura e Qualidade (ISQ), Exergia, GERG, Netherlands Organisation for Applied Scientific Research (TNO), and N.V. Nederlandse Gasunie (project coordinator).

Next to the consortium executing the programme, guidance will be provided by a Strategic Advisory Committee consisting of representatives from relevant (inter)national organisations such as International Gas Union, International Hydrogen Energy Association, the European Commission and Parliament, U.S. Department of Energy, UK Health and Safety Executive.

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