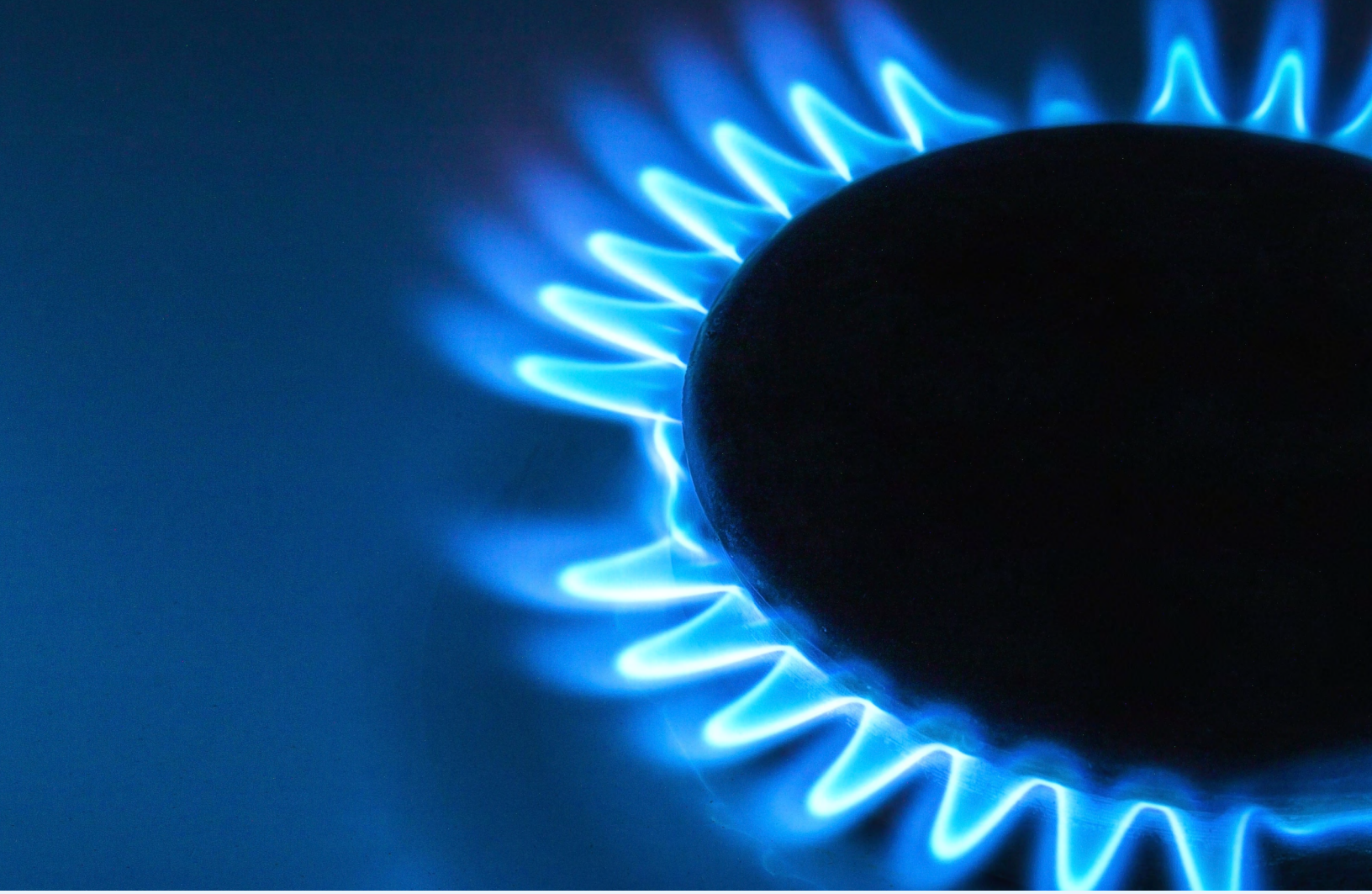

Hydrogen Blending with Natural Gas and the Impact on Existing Pipeline Infrastructure

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As the world transitions towards a cleaner energy future, a sense of urgency has emerged among advocacy groups to make natural gas, a fossil fuel, greener.

Hydrogen fuel cells, which create electricity through an electrochemical reaction with oxygen, are classified as a non-toxic and non-poisonous fuel source. This technology has been adopted to reduce **Greenhouse Gas (GHG)** emissions, aiding in achieving global emission targets within the next two decades. Utilities providers have made changes to accomplish climate goals across various sectors such as residential, commercial, industrial, agriculture, transportation, and other areas where natural gas is used.

This topic holds significance for the **Ontario Society of Professional Engineers' (OSPE's) Energy Task Force**, especially considering the impact of blending hydrogen with natural gas on existing pipeline assets. This impact is crucial for developing long-term asset management plans and accurate budget forecasting for pipeline replacement and associated components. OSPE's can provide valuable knowledge based on industry experience to engineers, utilities, advocacy groups, government employees, regulators (TSSA, OEB), and political officials.

Despite the promise of hydrogen's clean, efficient, and zero-carbon properties, the use of existing gas pipelines for hydrogen-natural gas transportation raises concerns. Impurities such as HC4, high-pressure H2, H2S, and CO2, along with free water in pipelines, lead to high levels of corrosion and hydrogen embrittlement. The interaction of corrosion and hydrogen embrittlement remains unclear and necessitates further experimental clarification. Failure mechanisms are particularly sensitive to three factors: H2S/CO2 partial pressure ratio, hydrogen blending ratio, and material strength, which collectively increase pipeline materials' susceptibility to corrosion and hydrogen embrittlement.

There is no scientific data indicating the impact of hydrogen blending on reducing the life span of existing pipelines, which typically have a useful life of 40-50 years. Without adequate data, proper asset management plans and macro budget forecasting become impracticable. Hydrogen, being highly corrosive, poses a risk to plastic, steel, and aluminum piping in the natural gas industry. While the concept of hydrogen blending is supported, the lack of reliable scientific data makes it challenging to fully understand its impact on current assets.

Hydrogen Embrittlement

Hydrogen embrittlement (HE), also known as hydrogen-assisted cracking or hydrogen-induced cracking (HIC), refers to the reduction in metal ductility due to absorbed hydrogen. Hydrogen atoms easily permeate solid metals, lowering the stress required for cracks to initiate and propagate, resulting in embrittlement.

Pilot Project

It is worth noting that a pilot project from Enbridge Gas Inc. in Markham, where hydrogen is blended with natural gas to supply gas to its customers, will ultimately provide very useful and accurate scientific data to the utility industry in Canada and around the world on the impact hydrogen blend into natural gas will have on existing assets.

This will allow for informed and adequate asset management planning and ensure budgeting is more accurate and reliable. No data has been provided by Enbridge since the project was initiated in 2019. Enbridge Gas is currently providing a blend of hydrogen and natural gas to 3,600 customers in Markham, Ontario as part of a pilot program to validate the reduction of carbon in our natural gas system.

Looking Ahead

A lot of inference has been made to the expected outcome of a study or pilot project to gather good data to demonstrate the rate of corrosiveness of the pipe, leading to hydrogen embrittlement of current assets that are expected to last for between 40 to 50 years based on manufacturers and industry specifications. There is no known impact on the percentage of hydrogen to natural gas blending on the outcome of embrittlement of the pipeline and its associated components. Organizations around the world have done a ratio of 100% hydrogen to 100% natural gas, some like Enbridge Gas Inc. have blended 2% hydrogen to 100% natural gas, while others have done various ratios of blending of both products. Industry experts have determined that whatever ratio of blending you use, it does not change the outcome of the level of corrosiveness on the pipelines.

It is worth noting that there are hydrogen pipelines in North America serving oil refinery operations, so data on 100% hydrogen used in oil refineries is also available. However, blending hydrogen into natural gas pipelines, which is the purpose of this paper, has limited research data, though there are ongoing studies. The impact on natural gas pipeline materials and elastomeric materials is fully unknown at this time.

Research has revealed that some areas in Europe blend up to 20 percent hydrogen, while Enbridge Gas is beginning with up to two percent by volume as a pilot project.

There has also been a lot of work done in Germany, where they have had systems in operations for several years.

Encouragement for Government Support on Hydrogen-Natural Gas Projects:

OSPE's Stand on Pilot Projects and Research Initiatives

Support for Pilot Projects

OSPE strongly encourages both the Federal and Provincial governments in Canada to support pilot projects similar to the endeavor embarked on by Enbridge Gas Inc. in Markham. This project aims to blend hydrogen with natural gas to supply gas to customers, and it is crucial for collecting invaluable scientific data to inform the utility industry about the impact of hydrogen blending on existing assets. Such data is essential for developing reliable asset management plans and ensuring accurate budgeting for the replacement of these assets after their useful life span of 40 to 50 years.

Research on Suitable Materials

Both levels of government can also support and encourage manufacturers to start researching and developing the types of steel, stainless steel, and plastic pipes most suitable for transporting hydrogen-natural gas blended gas. This initiative will contribute to a zero-energy environment by mitigating the risks associated with hydrogen embrittlement and corrosion in current pipeline materials.

OSPE's Perspective on Hydrogen Utilization

In summary, government support for these pilot projects and research initiatives is vital for the advancement and sustainability of hydrogen-natural gas blending. By fostering innovation and encouraging scientific exploration, Canada can lead the way in creating efficient, reliable, and environmentally friendly energy solutions.

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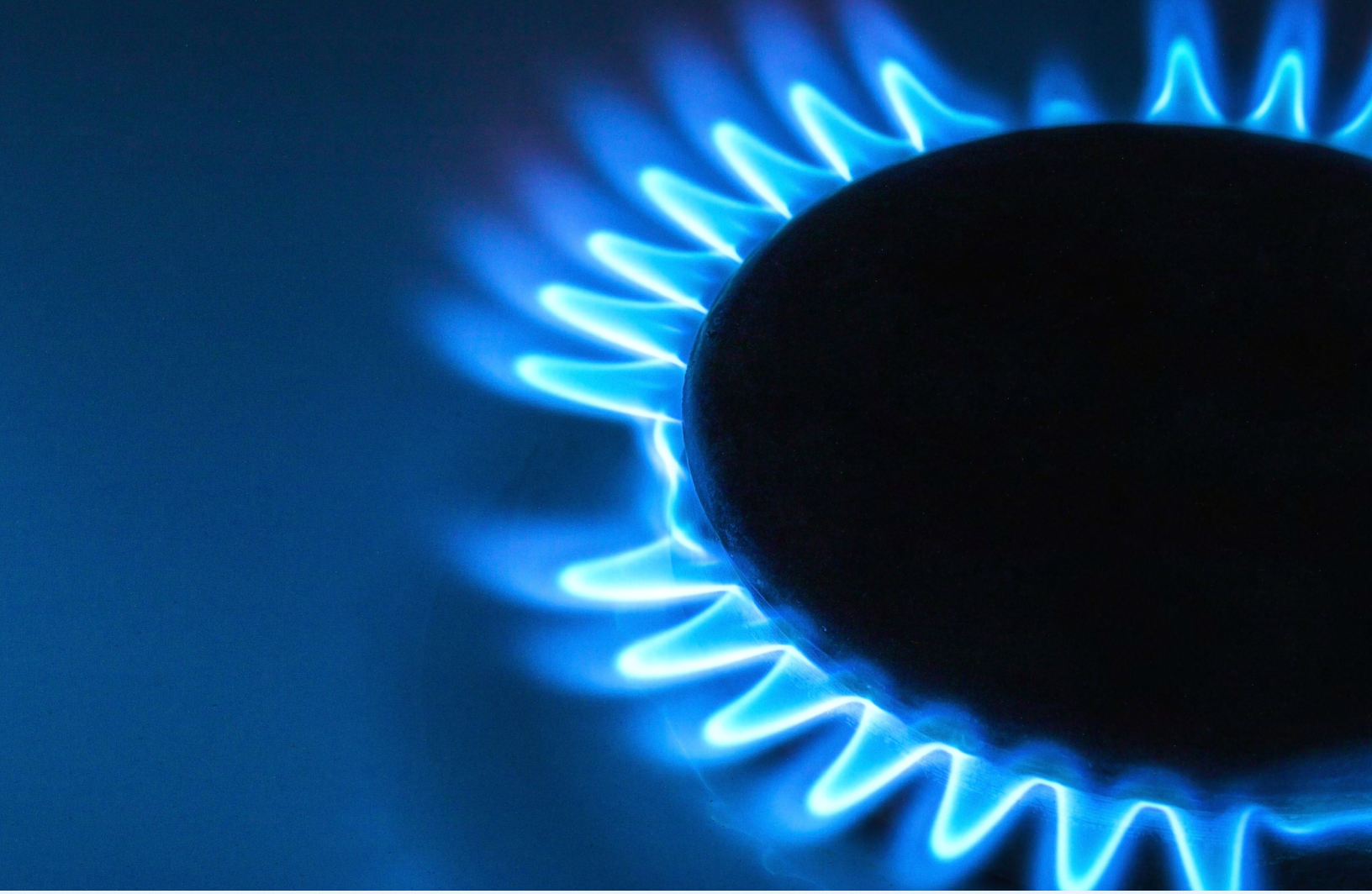

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