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Carbon-Negative Hydrogen Production

Merging proven technical skills with a demand for low-carbon energy

As the energy industry continues its transition to lower-carbon systems, various solutions will be required in order to meet our environmental & emission reduction targets, while at the same time providing a secure & sustainable source of energy. Hydrogen (H_2) is definitely considered a key part of the solution, both in terms of its cost and as a carbon-free energy source. To elaborate on this concept and to further define the potential role of H_2 in the near & long-term future within the overall energy equation, CSUR invited Grant Strem, Chair & CEO of PROTON Technologies Canada, to provide his & his organization's vision going forward. PROTON Technologies is a Calgary-based energy transition company, providing innovative & novel solutions to the global industry.

To begin the session, Grant talked about H_2 as not only a clean, low-cost energy source, but also in terms of a potential solution to reducing or eliminating air pollution from current energy sources. He also provided an overview using the Resource Pyramid / Triangle Concept, utilized by various industry professionals including George Mitchell, a pioneer in horizontal well hydraulic fracturing, to illustrate and classify petroleum reservoirs & energy systems. In terms of cost and technology, the speaker classified H_2 near the top of the triangle, which indicates cost effective and can be produced with existing technology. In fact, H_2 from petroleum reservoirs is not a new concept. Enhanced hydrocarbon recovery projects such as SAGD (Steam Assisted Gravity Drainage) and CSS (Cyclic Steam Stimulation) have been in use for decades now and are prominent drivers in various projects across Western Canada.

The most common processes used currently for H_2 production are either by natural gas reforming (endothermic reaction) or via electrolysis of fresh water. PROTON's in-situ project (CSS) in Saskatchewan is based on the former process as it provides the ability to simultaneously trap the carbon in the reservoir while producing H_2 to surface. In fact, it would be possible to design a system that allows for injection of Carbon Dioxide together with Oxygen to enable an overall Carbon-Negative scenario. Given the current and future carbon tax burdens, these schemes would provide the added crucial benefit of mitigating the greenhouse gas emissions into the atmosphere via de-carbonization.

Finally, PROTON's patented technology can be applied to depleted reservoirs via active wells or by re-purposing abandoned projects for clean hydrogen production. PROTON is an active organization within various global, Canadian and Alberta H_2 Strategy initiatives and overarching energy transition narrative.

SUMMARY

The energy industry is adapting to standards that require a lower carbon intensity for both on and off-grid power. Amongst many solutions, hydrogen (H2) has emerged as a transitional option for both economic and environmental considerations. At its point of use, hydrogen as an energy carrier has no carbon emissions. It is also commercially produced and traded for industrial purposes such as bitumen upgrading. For these reasons, its proliferation in the energy industry is being closely considered and developed across its supply chain as an accessible, carbon-free fuel solution.

Currently most hydrogen is produced by steam reforming of methane or electrolysis of fresh water. Alternatively, hydrogen can be generated by in situ gasification of hydrocarbons. Proton Technology's objective is to optimize and commercialize hydrogen generation by in situ gasification from bitumen reservoirs. In situ gasification of oil sands is potentially more energy efficient, further reducing emissions to the atmosphere since gases are sequestered to some extent in the reservoir. Water usage is lowered and heavy metals and sulfur compounds in the reservoir tend to remain downhole since the main product is gas.

The Marguerite Lake in-situ combustion project based on a Cyclic Steam Stimulation (CSS) well configuration, was designed and compared with conventional Steam-assisted gravity drainage (SAGD) based on energy investment, emission to atmosphere and water usage. The results show that the amount of energy produced per unit of energy invested for the in-situ gasification process was greater than the steam alone recovery process with less than half the water usage. The cyclic injection of steam and oxygen as compared to steam injection alone can permit design of oil-alone to oil + syngas production processes.

This approach is most notable in its carbon intensity rating per kg of hydrogen produced. In contrast to other methods, the lower carbon intensity process allows for a long-term proliferation of said technology due to the ever-expanding carbon credit and taxation economy. But this competitive advantage is one of a few properties of in situ gasification that allows for an advantageous development. The additional considerations of the current energy landscapes existing infrastructure, skills and markets are also accredited in this unique approach to commercialize large scale production of low-carbon intensity hydrogen gas.

PRESENTER: *Grant Strem, Chair and Chief Executive Officer - PROTON Technologies Canada Inc.*

Born and raised in Calgary, Alberta, Canada, Grant Strem has a B.Sc. in Geology and an M.Sc. in Reservoir Characterization, both from the University of Calgary.

Grant considers himself an explorationist and worked for various producers including Paramount, Burlington Resources, ConocoPhillips, Total E&P, and Husky. Grant also worked as a Reserves Evaluator for GLJ Petroleum Consultants, and as a

Research Analyst at TD Securities covering the oil sands sector. He also started his own oil company focused on light oil, helium, and geothermal resources.