Sour gas processing in Canada

H2S SPLITTING TO PRODUCE HYDROGEN FROM SOUR GAS

LNG shipments from the Middle East and north America to Europe and Asia are at an all-time high as Central Europe is switching gas supplies from Russia to other sources. Sustained LNG demand and high gas prices will stimulate investment in sour gas field.

Sour gas is rich in carbon dioxide (CO_2) and H_2S. Sweet natural gas has low levels of these 'sour' compounds. To enable gas distribution by pipeline, the H_2S must be removed to avoid corrosion of the gas transmission assets. If the gas is to be converted to LNG, then CO_2 must also be removed LNG to avoid blocking the liquefaction equipment with solid CO_2.

LNG will have strong demand in Europe and Asia for many decades

CO_2 and H_2S removal are achieved using a double-tower absorption and stripping process in which an amine solution absorbs these sour gases. The process operates in the same way that CO_2 is cleaned from post combustion flue gases in carbon capture and storage schemes.

Elimination of H_2S emissions to the atmosphere has been mandated for decades to avoid the problem of acid rain. H_2S is generally removed after the amine treatment using the Claus process. In the Claus plant, the mixture of CO_2 and H_2S leaving the amine treatment system is burned in air and H_2S is oxidised to SO_2. The SO_2 is then reacted with more H_2S over a catalyst to produce elemental sulphur.

Residual H_2S or SO_2 tail emissions can be eliminated prior to the flue gas being released to air or processed in a carbon capture and storage scheme.

A paradigm shift: hydrogen sulphide as an energy resource

Refinery and gas processing Claus plants produce more than 50 million tonnes of sulphur each year. They account for most of the sulphur production worldwide.

Despite there being some value for the recovered sulphur, H_2S removal has become a waste gas disposal problem. As the world begins to embrace hydrogen as an energy vector, the time has come to take a fresh look at H_2S: a molecule laden with hydrogen. Water (H_2O), also a hydrogen-loaded molecule, is processed in electrolysers to release hydrogen gas. Methane (CH_4), another hydrogen carrier, is reformed to release its hydrogen content. Using the right technology, H_2S can be split to yield solid sulphur and hydrogen.

Splitting molecules with plasma and microwaves

Turquoise hydrogen is produced by splitting the methane molecule in a high energy, high temperature environment such as a plasma. Plasma and microwaves can also be used to split the H_2S molecule. These technologies have also been demonstrated at pilot scale. Work at the Orenburg gas plant in Russia during the 1980s was conducted using 1MW of power input to the plasma zone. About 10 years later, research at a refinery near Lviv in western Ukraine used a 50 kW microwave to produce 50 m^3 per hour of hydrogen from H_2S.

Sulphur emissions to air cause acid rain

These trials explored the relative economics of H_2S decomposition versus the Claus process. They could also generate hydrogen for use on the refinery for desulphurisation and hydrotreating of refined products. The Argonne National Laboratory in the USA has also researched H_2S splitting with a view to improving the economics of sour gas processing.

Sulphur is produced from sour gas processing

Excellent economic potential

Based on recent natural gas prices in Europe, the cost of blue hydrogen from steam methane reforming is in the order of 5 USD per kg. The cost of green hydrogen production using electrolysis fed with renewable power is in a similar range.

The Claus process requires very little energy input. Once the plant has been built and paid for, the operating costs are low. On the other hand, H_2S splitting with plasma or microwaves requires electrical power. The payback comes from the generation of hydrogen in addition to solid sulphur.

The thermodynamics of H_2S splitting, plus an allowance for balance of plant power requirements, requires circa 15 kWh / kg of hydrogen produced. The cost of hydrogen would be around 2 USD/kg of hydrogen.

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