CO_2 Capture from Fossil Fuel Based Hydrogen Production

A Special Applications Report from Union Engineering

The demand for hydrogen (H_2) is rapidly increasing in chemical and petrochemical industries due to the continued growth in demand for low sulfur fuels and to support unconventional oil sands development. Increased demand for hydrogen, while good for the industrial gas industry, leads to increased concern about CO_2 emissions, as most hydrogen is produced using methods that emit CO_2. This makes the capture and storage of CO_2 from hydrogen production an interesting option for the reduction of CO_2 emissions.

There are several ways to reduce greenhouse gases emitted from fossil fuel based plants including CO_2 capture. Today, the principal technology used for CO_2 capture from hydrogen plants is based on chemical absorption, but this process requires large amounts of energy thereby reducing its environmental benefit. And it is costly, currently in the range of EUR 30–40/ton of CO_2 captured.

Union Engineering (*www.union.dk*), a world leading supplier of CO_2 technology, has developed Flash CO_2 (Patented), an innovative way to capture CO_2. The technology significantly reduces the cost of CO_2 capture from fossil fuel based hydrogen production and enables liquid CO_2 to be produced at a direct operating cost of around EUR 20/ton, making CO_2 capture from hydrogen production significantly more attractive.

CO_2 Capture from Hydrogen Production with a FlashCO_2 Unit

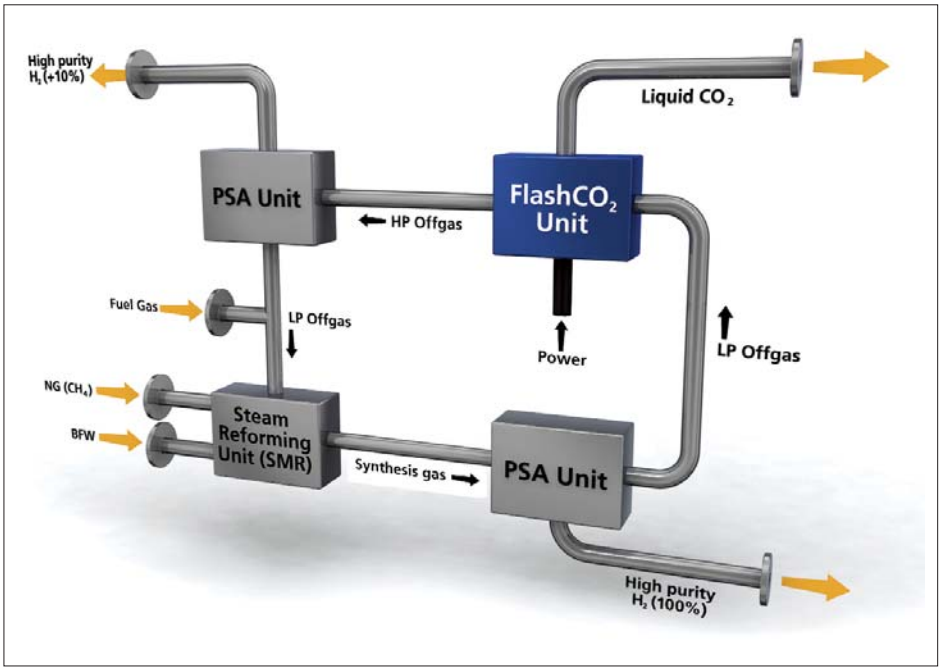

Figure 1 Source: Union Engineering

The Process

A typical hydrogen plant uses a PSA (pressure swing adsorption) for purifying the hydrogen product. Union Engineering's FlashCO_2 technology was developed to provide an attractive solution for the capture of CO_2 from the medium-rich CO_2 off-gas being purged from the PSA. By utilizing an innovative process of combining conventional physical absorption by means of chilled methanol (MeOH) and liquefaction technologies, the FlashCO_2 process eliminates the requirement for steam stripping and keeps power consumption at an attractive level (*see Figure 1*).

Utilizing the PSA off-gas means that the FlashCO_2 is an end-of-pipe solution, that is, it does not need direct integration with the hydrogen plant, which significantly reduces the risk of unwanted interruptions in hydrogen production.

In addition to the environmental benefits that FlashCO_2 technology offers in terms of carbon capture and storage in the longer term, this technology can be used today to produce food grade CO_2 for the merchant CO_2 market. Despite the fairly low CO_2 concentration in hydrogen PSA off-gas, the integrated double loop design of the FlashCO_2 technology makes the plant capable of producing food and beverage grade CO_2 at costs competitive with more conventional CO_2 sources, such as ammonia and bioethanol production plants.

A FlashCO_2 Plant in Chile

Recently, Union Engineering installed a FlashCO_2 plant with Indura SA (*www.indura.net*), a leading industrial gases company in Chile. In early 2005, Indura realized they needed to replace their existing CO_2 plant, which was based on combustion of fossil fuel for CO_2 production, with a more modern and sustainable production plant. Instead of burning fossil fuel only for production of CO_2, Indura wanted to utilize a by-product energy stream for their new CO_2 processing plant. The obvious choice, both in terms of location and attractiveness of the source, was PSA off-gas from a hydrogen production plant with Chile's major refinery ENAP, in Concepcion.

After having evaluated a range of existing amine-based technologies, Indura decided Union Engineering's FlashCO_2 technology was the best choice for their new food and beverage grade CO_2 processing plant. In addition to being the most attractive solution in terms of total cost of ownership, the FlashCO_2 plant provided other important benefits that influenced Indura's choice. For example, as an end-of-pipe solution, Indura was able to install the plant outside the refinery boundary thereby avoiding the need to follow ENAP's strict refinery procedures.

Also, using by-product stream as the energy source for CO_2 production with FlashCO_2 technology, instead of fossil fuels, allowed Indura to qualify for carbon credits under the Kyoto protocol. This was important to Indura's strategy to make their CO_2 production more environmentally friendly. Finally, the FlashCO_2 solution does not interfere with a hydrogen plant's fuel balance, since only CO_2 is removed from the PSA off-gas. The fuel gases in the PSA off-gas are returned to the reformer, and the hydrogen in the fuel gas can be recovered by ENAP. This made it easier for Indura to convince ENAP to allow them to capture the CO_2 from their production process.

FlashCO_2 Advantages

FlashCO_2 technology represents a large-scale option for long-term CO_2 emissions reduction and can reduce greenhouse gases emitted from fossil fuel based plants. Liquid CO_2 can be produced at low cost and units can be stand-alones. Other valuable fuel gas products can be recovered from the CO_2 process. Liquid CO_2 can be produced at high purity/high value levels and at food grade quality at low cost. In addition, when using the Flash CO_2 technology, total output from hydrogen production can be boosted to 110 percent at a low cost. No effluent treating is required and there is no liquid or solid chemical waste. The Indura example shows that Flash CO_2 technology provides a range of advantages, making it a very attractive solution for CO_2 capture from hydrogen plants in both the short and long term. ■

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The Indura CO_2 plant in Concepcion, Chile.