Air Products' patented technology enables the world's largest LNG trains

News that Air Products had supplied Qatargas' Ras Laffan trains with its patented AP-X® LNG process, prompted Technical Editor, Ian Cochran to ask the company for a description of the technology

AP-X® LNG process achieves not only high capacity in a single train, but can also incorporate high LPG recovery, lower LNG heating value for new markets, and maximum efficiency, the company explained.

This range of applications demonstrates that the process brings significant economies of scale to the industry, reducing capital cost while maintaining the efficiency, flexibility, and reliability of the proprietary AP-C3MR™ (propane pre-cooled, mixed refrigerant) process.

Air Products' AP-X® liquefaction process cycle, as depicted in Figure 1 below, employs the C3MR cycle using propane for pre-cooling and a mixed refrigerant for liquefying natural gas and then adds a reverse Brayton nitrogen cycle to shift the entire sub-cooling duty to a separate nitrogen refrigeration loop.

The LNG enters the nitrogen expander cycle at around -115 deg C, where it is sub-cooled to a final temperature of about -150 deg C. By using a separate cycle for LNG sub-cooling, the mixed refrigerant system is de-bottlenecked, reducing the mixed refrigerant flow by 40% per unit LNG produced.

The first six AP-X® trains were commissioned over a decade ago in Qatar, each with a design capacity of 7.8 mill tonnes per annum.

Four additional AP-X® trains will be delivered to Qatar for the first phase of Qatar Petroleum's North Field East (NFE) project. Each of the four new LNG process units, will also have a design capacity of 7.8 mill tonnes.

These trains will become operational in 2025, liquefying natural gas from Qatar's North Field, claimed to be the largest offshore non-associated natural gas field in the world. The production capacity from each of these AP-X® trains is significantly larger than any other LNG train in operation, the company said.

Air Products' equipment provided with the AP-X® liquefaction technology includes main cryogenic heat exchangers (MCHEs), sub-cooling heat exchangers (SCHEs), nitrogen economiser cold boxes and Rotoflow® turbo-machinery companders. Rotoflow® is an equipment division of Air Products and works closely with the LNG equipment and cycle experts to develop a highly efficient, optimised liquefaction process.

Air Products will build the AP-X® LNG heat exchangers at its Port Manatee, Florida manufacturing facility. Typically, an LNG heat exchanger can be as large as over 5 m in diameter and 55 m long. A completed unit can weigh as much as 500 tonnes.

Air Products' AP-C3MR™ and AP-X® process technologies are in operation at the 14 existing LNG trains located in Ras Laffan, Qatar

Technological advancements

Combining the AP-X® cycle with currently available CWHE (coil wound heat exchangers) and machinery advancements enable LNG trains with production capacities of over 10 mill tonnes per annum.

Frame 9E gas turbines were first used for mechanical drive service for the original six AP-X® trains in Qatar. Since then, additional driver options have become available for the mechanical drive service.

One of the technology developments to become available since the commissioning of the original AP-X® trains is the use of multi-shaft gas turbine configurations for heavy duty frames in mechanical drive service. The multi-shaft options offer several advantages, such as:

1) Large helper motors are usually not required.
2) Compared to single shaft gas turbines, multi-shaft gas turbines can be started under load, reducing or eliminating the need for flaring, and loss or recovering of refrigerant components upon restart.
3) Multi-shaft gas turbines offer the option of using a wide speed control range for additional process control and turndown capability.

In scaling up the liquefaction process, refrigerant compressor aerodynamic and mechanical design considerations can become limiting. Specifically, compressor flow coefficients and Mach numbers may be beyond proven or feasible ranges.

One solution to this problem is to use parallel compressor strings to reduce the aerodynamic constraints on the refrigerant compressor design. With parallel compressor strings, the propane and mixed refrigerant compression can be arranged on the same shaft (eg, two compression strings, each with 50% propane and 50% mixed refrigerant compression). This allows the power split between propane for pre-cooling and mixed refrigerant for liquefaction to automatically adjust with changing process conditions, such as ambient temperature, ensuring the driver power can be fully utilised. This is particularly useful in colder climates where the seasonal variation of ambient air temperature is large.

Another area of development to consider in refrigeration compression driver technology is the installation and commissioning of large electric motor drives for baseload LNG facilities. The largest electric motor drives in the LNG industry have recently been commissioned at the Freeport LNG facility with three liquefaction trains producing around 15 mill tonnes per annum.

In summary, the company explained that the AP-X® LNG process is a hybrid of two proven refrigeration processes, a C3MR process for pre-cooling and liquefaction followed by a reverse Brayton cycle for LNG sub-cooling.

The process is very flexible and can be implemented using single shaft gas turbines, multi-shaft gas turbines or electric motors as main drivers for the refrigeration compressors to achieve capacities in excess of 10 mill tonnes. It can also be configured for LPG recovery using a variety of approaches depending on the feed, the desired recovery, and owner preference. ■

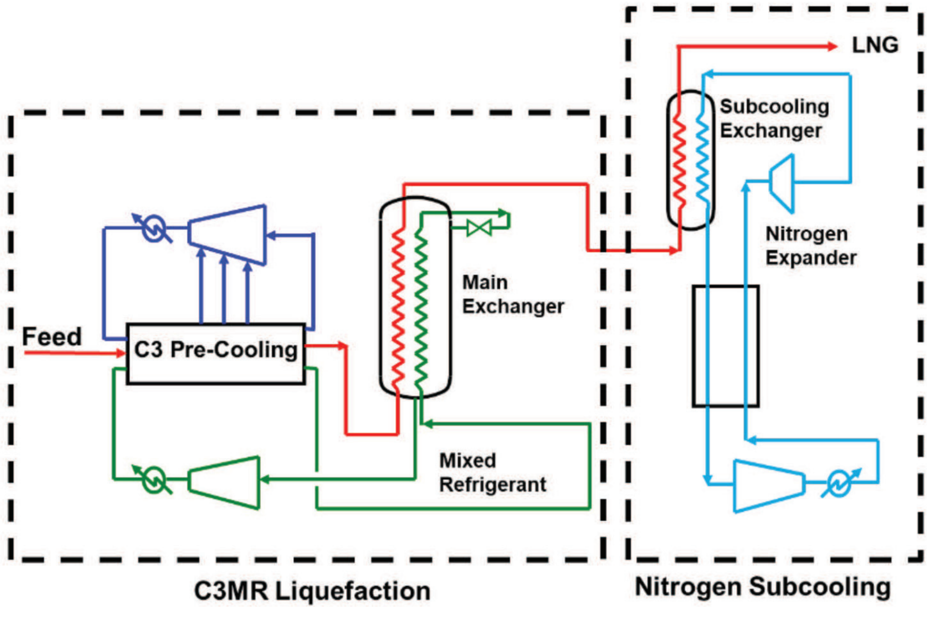

Figure 1: AP-X® Process. Source: Air Products

For more information, please contact Air Products at + 1-610-481-4861 or email us at info@airproducts.com