COMPRESSORS TO TARGET THE ENERGY TRANSITION

Across the globe, there is a growing trend for decarbonisation and the reduction or elimination of greenhouse gas emissions. Many companies are committed to long-term strategies to achieve these lower emissions. For LNG, plant owners are applying environmentally-friendly measures while utilising renewable energy to decrease harmful emissions into the environment.

Mitsubishi Heavy Industries Compressor Corporation (MCO), headquartered in Hiroshima, Japan, is a leading manufacturer of compression systems, including compressors, drive turbines, and their related mechanical units and electrical systems. The company provides dependable compressor solutions to maximise overall plant efficiency and LNG production across the globe. MCO group manufacturing and testing facility for the North American market, Mitsubishi Heavy Industries Compressor International (MCO-I), delivers innovative technology to help customers reduce capital expenses and lower the carbon intensity of LNG.

MCO offers main refrigeration compressor packages designed exclusively for the LNG market for a cleaner, gas-based society. The main refrigeration compressor package, which ultimately leads to lower cost of ownership, is driven by the H-100 gas turbine provided by Mitsubishi Heavy Industries (MHI). The H-100 gas turbine is a 2-shaft, 120 MW heavy-duty machine that allows variable speed operation. While single-shaft gas turbines require the use of a large starter motor, the H-100 engine on the compressor package can start

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COVER STORY

from settle-out pressure condition without the need of a large starter motor. This package eliminates the need for other, costly supporting electrical infrastructure associated with a large motor, including (but not limited to) a power generation facility.

The robust design of the turbine provides operational flexibility and requires less plot space for the owner or EPC contractor. The H-100 gas turbine and compressor package effectively increases efficiency and reduces carbon dioxide emissions along with lowering capital expenditures when compared to conventional LNG solutions driven by heavy-duty machines.

In order to provide even higher efficiency and production, MCO has been conducting single string H-100 studies with prominent LNG process licensors to design main refrigeration packages capable of producing more than 3 million tpy of LNG. This package includes one H-100 gas turbine and three compressor bodies – with no helper-motor or gear for maximising LNG production in a small footprint.

The company has additional experience in the LNG market by providing main refrigeration compressor packages driven by other gas turbines as the prime vendor.

MCO has also provided compressors for other LNG auxiliary services, such as feed gas, residue gas, off gas, regeneration gas, end-flash gas, and boil-off gas on a global front.

Along with the main refrigeration and other compressor packages, MCO strives to maximise overall plant efficiency

and LNG production while meeting market demands for significant reductions in capital and operational expenditures, shorter delivery and site construction times, and lowered carbon intensity.

Confirming system reliability

MCO is constructing a string test bench for the H-100 gas turbine and compressor package to confirm the mechanical and aerodynamic reliability of the system. Slated for spring 2024, the test bench will allow the operation of gas turbine solo runs and up to 110-MW load run, based on ambient conditions.

In addition, gas turbine performance tests can be conducted in accordance with PTC-22. LNG is utilised to supply fuel to gas turbines and procured from local gas suppliers. MCO's LNG tank and vaporiser is able to operate at full-load condition for a minimum of four hours.

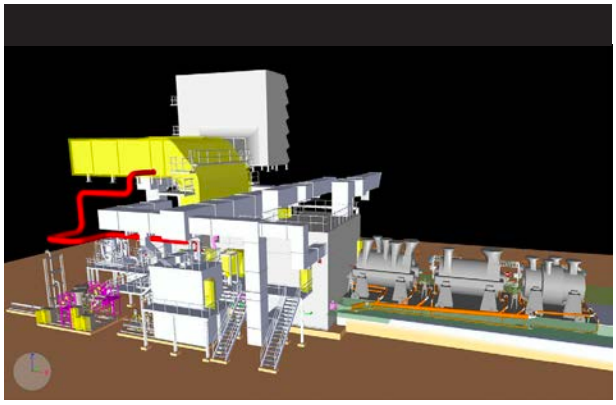

Figure 1. Single string H-100 in APCI C3MR process.

Figure 2. MR LP compressor – gas turbine string on test stand in Indonesia.

Figure 3. H-100 test bench under construction.

The test bench features shop air filters and ducts as permanent installations, while the gas turbine enclosure and ventilation system can be utilised for both string test and gas turbine solo mechanical running tests. These shop items help to minimise total lead time.

To keep noise levels within limits, the test bench includes silencers in gas turbine intake and exhaust ducts, sound insulation on piping, and soundproof walls surrounding the test bench.

The test bench is designed to allow both top and bottom compressor nozzle orientation through the installation of a gas turbine and compressor string on cement-filled steel blocks. These are then analysed in rotor dynamic calculation models to have enough support rigidity.

Compressor test gas will be carbon dioxide, nitrogen, or other options based on conditions, depending on the site compressor gas property. Compressor test piping consists of a closed loop with gas coolers. High-pressure gas coolers are permanently installed next to the test bench to be used with minor modifications on test gas piping arrangements, based on the configuration.

MCO leverages measurement systems equipped with test bench to evaluate gas turbine and compressor mechanical performance in real time – including temperature monitoring and vibration analysis.

The company also has string test capabilities for motor-driven compressor strings. Depending on the electric power specifications, MCO can apply job electric equipment such as motor, variable frequency drive, and transformer. It has also performed full-load string tests for 37 MW motor compressor strings.

A modularised approach

As the desire for modulisation in LNG plant designs and construction takes centre stage, MCO's new Mitsubishi Compressor Smart Packaging (MPAC) design for compressors provides a modularised approach to reduce site work, lower labour costs, and limit nonconformities.

MPAC is applicable for motor-driven packages ranging up to 20 MW and under investigation to expand to the 30 MW class, while taking design parameters into account – such as string configuration.

The design benefits the contractor through a reduction in the number of installed items due to the integrated single skid. This allows for a total footprint reduction, along with lower installation and commissioning fees. MPAC is designed for a skid-mounted equipment arrangement where the main components, such as the compressor, drive motor, gear, lube oil (LO) console, and gas seal module (GSM), are integrated as a single skid. Packaging work on the skid is completed before shipment as long as physically allowed and site work can then be reduced. The main component is arranged on a single skid, allowing the shipment of the compressor package after completion of oil flushing, thus shortening the oil flushing duration on site by several weeks depending on the system arrangement.

In order to install major equipment on a skid mount with limited space, MPAC incorporates both the LO system and the GSM.

- The LO system: The LO tank is integrated to the baseplate by bolts to accomplish a compact single skid

design. This arrangement eliminates drain header piping, and minimises the drain piping from the compressor to the LO tank. Centrifugal pumps are used in MPAC to minimise required components, which do not necessitate safety valves and spill-back pressure control valves at the downstream of the pump. In addition, MCO applies both a plate cooler and an emergency oil pump, which can be installed on the LO tank depending on owner/contractor preference.

Figure 4. Compressor for pipeline – 37 MW motor-compressor string on test stand in Norway.

Figure 5. Compressor-applied Mitsubishi Compressor Smart Packaging concept in the Gulf Coast.

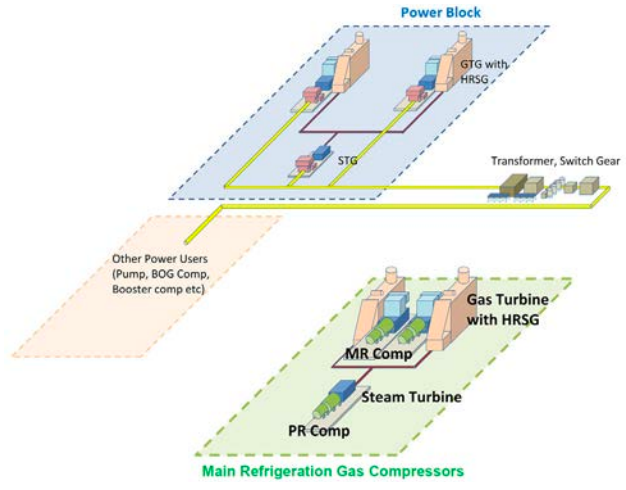

Figure 6. Simple schematic of hybrid combined cycle LNG.

- The GSM: The GSM incorporates orifice control for the primary seal gas supply line instead of differential pressure control. By doing so, a minimum footprint is achieved without compromising the required function of the seal gas control system. Interconnecting piping between the compressor and GSM runs low level on the compressor baseplate, while utilising the bottom space of compressor casing. This unique piping arrangement allows for additional space for operability and maintenance.

MPAC delivers an optimised layout for site operations and maintenance work after the plant is in operation. The company utilises its technical expertise to further investigate the operability and maintainability of skid components through 3D review.

Through MCO-I's Houston facility, MPAC can also be packaged while utilising MCO-I's compressor mechanical running test. With no sea shipments required, customers can take advantage of MPAC's uniquely designed package, suitable for inland trailer transportation.

Decarbonising LNG plants

As the original equipment manufacturer, MCO has introduced hybrid combined cycle (HCC) for decarbonisation in an LNG plant. HCC is a system for reducing the carbon footprint through the recovery of thermal energy.

The HCC LNG concept incorporates heat recovery that is used for both power block gas turbines and main refrigeration gas compressors drive gas turbines in LNG plants.

In Figure 6, the refrigeration gas compression system shown in the green box area is independent from the power block gas turbines in the blue box area. The generated steam from the main refrigeration compressor drive gas turbines is used for operating another main refrigeration compressor.

In the HCC LNG concept, energy transmission loss from the power grid to main refrigeration gas compressors is minimised, when compared to e-motor drive main refrigeration gas compressors sourced by power grids. The HCC concept, which can be integrated with additional technologies, such as carbon capture and storage or hydrogen combustion, can provide significant advantages on improving thermal efficiency, boosting capacity and reducing carbon intensity per tonne of LNG produced.

Conclusion

MCO has provided main refrigeration compressors and other compressors in LNG projects on a global front. The company strives to maximise overall plant efficiency and LNG production while meeting market demands for significant reductions in CAPEX and OPEX, shorter delivery and site construction times, and lowered carbon emissions.

MCO has load string test capabilities for both gas turbine-driven and motor-driven compressor strings for confirming system reliability before shipment.

MCO's new MPAC design for compressors provides a modularised approach to reduce site work, lower labour costs and limit nonconformities while the HCC LNG concept can provide significant advantages on improving thermal efficiency, boosting capacity and reducing carbon intensity per tonne of LNG produced. LNG