FLNGs - the dawn of a new era

Utilisation of LNGFPSOs (FLNGs) to develop gas reserves that are remote from existing infrastructure is imminent*.

Current LNG supplies fall short of demand and high LNG prices continue as demand for gas in Japan, South Korea, US, Europe, China, India and other developing nations grows. The industry has the technology to make FLNGs work and project developers are rapidly evaluating markets, costs and risks to put together commercially viable projects.

Developers, engineers, owners, financiers, and operators must make key decisions during the development phase of an FLNG design to minimise costs and risks. These include choices in the inlet gas processing and pre-treatment equipment, choices between various liquefaction technologies, and process facilities options. Engineering companies, such as Mustang Engineering are developing innovative LNG liquefaction process designs along with the balance of the topsides facilities.

Mustang Engineering has recently completed pre-FEED studies for two FLNG projects, one for Teekay and the other for BW Offshore. A scan of recent headlines reveals high FLNG activity by several leading players, such as Shell, which has invited tenders for a FLNG; Golar LNG and PTTEP uniting to develop FLNG projects; INPEX tender for Australia, FLEX LNG partnership with Mitsubishi for a FLNG project in Nigeria and the same concern pursuing another with Rift in Papua, New Guinea.

KEY DRIVERS

Choices in the design process are driven by several key drivers that are explained below.

Floating LNG as a concept has been contemplated for years, but it appears that the time is right for the industry to respond with the first viable FLNG projects to meet a short supply of LNG resulting from the increase in demand, delays in completing current LNG projects and postponement of authorisation of new onshore LNG plants. The planned LNG supply projects do not fill the forecasted LNG demand. Offshore liquefaction promises to be less costly and quicker to develop because it does not require the jetty and harbour infrastructure, have as much LNG storage, or face the labour cost escalation, or geo-political and permitting constraints of land-based projects.

FLNG hull and LNG containment construction takes place in the structured environment of a shipyard and topsides facilities are competitively bid to fabrication yards to get the best prices and deliveries. FLNG costs are reported to range from $450 to $1,000 per mtpa capacity, compared with $1,300 to $1,500 for base load onshore facilities.

Mustang believed the timing is right and that project developers can get gas reserves and finances in place to support these FLNG projects. The company said that it feels that the inlet gas processing and LNG liquefaction processes are ready. New liquefaction processes developed over several years have played a significant role in mitigating the technical risks and enhancing the appeal of FLNGs.

The FLNG design starts with establishing a design philosophy which prioritises design drivers that may conflict with one another or that challenge to achieve to the desired level.

FLEX LNG is working with Kanfa Aragon's liquefaction technology; SBM with Linde's Multi-Stage-Mixed-Refrigerant process; Hoegh has licensed CBI-Lummus' niche LNG, and Teekay and BW Offshore have opted for the LNG Smart® Nitrogen Dual Expander (NDX-1) technology developed by Mustang.

Design of the LNG liquefaction facilities for the floating application requires a mental shift from onshore LNG facilities design. The FLNG design starts with establishing a design philosophy which prioritises design drivers that may conflict with one another or that challenge to achieve to the desired level. Mustang uses the following design philosophy to guide its FLNG liquefaction design process.

SAFETY

Liquefaction facilities should be designed to the highest safety standards and meet or exceed class society standards and approvals. A simple refrigeration process that minimises inventory of flammable refrigerants is a good example. The nitrogen refrigerant liquefaction technologies are particularly well-suited for use on FLNGs, since they are not subject to the fire risk associated with storing and processing pure or mixed hydrocarbon refrigerants.

SIMPLICITY

The nitrogen dual expander liquefaction process is simple, has a low equipment count and is easy to operate in an offshore environment. The complex, multiple refrigeration loop and multi-refrigerant processes used for large onshore LNG facilities may not be as well received by the owners or operators.

RELIABILITY/AVAILABILITY/ MAINTAINABILITY

High reliability and availability of the LNG process means more LNG production and better economics for the project. Simplicity of design contributes to higher run times. Another way to reduce downtime and minimise maintenance is to choose equipment that is already proven in offshore service, such as gas turbine drivers on known compressors, robust inter-stage coolers and brazed aluminium main heat exchangers. Mustang's approach is to standardise the liquefaction train and recommends using multiple trains to increase reliability and availability of the process even during maintenance periods.

COST & SCHEDULE

Costs for liquefaction facilities are controlled by keeping the LNG process simple, eliminating pieces of equipment, benchmarking with known oil and gas processing FPSOs and competitively bidding to fabrication yards. Costs are also controlled by matching up drivers, compressors, coolers, expanders and heat exchangers at their optimum performance levels and then repeating the design to get the capacity required. Schedule is controlled by the same tools. To date, the schedule for topsides has not been on the critical path when compared to hull and containment schedules.

CAPACITY/SCALABILITY

Most of the FLNGs being engineered now are in the mid-scale liquefaction range of between 0.5 and 3 mtpa. Output capacity is one of the largest contributors to the commercial viability of a FLNG project and should be maximised to the fullest deliverability of the producing field. The nitrogen and open cycle turbo expander liquefaction processes being developed are scalable within the mid-scale liquefaction range. Onshore peak shaver plants have used these processes up to 0.33 mtpa and Mustang has standardised a 0.5 mtpa liquefaction train that can be multiplied to achieve the desired capacity.

FLEXIBILITY

Given the worldwide variations in gas composition and reservoir sizes, it is important for FLNGs to be adaptable to different feed gas conditions. A flexible process design that can handle a range of rich or lean gas compositions will allow the FLNG to service multiple clients. Flexibility can be designed in for future modifications so that the FLNG can be relocated to different fields with relatively easy modification. In addition, provisions for LPG fractionation, LPG and condensate storage and offloading can also increase the FLNG's flexibility.

EFFICIENCY

The dual expander nitrogen liquefaction processes approach the 90% thermally efficiency. Efficiencies can be further improved by using gas turbine driven compression and waste heat recovery. This minimises fuel gas usage and related emissions.

ENVIRONMENTAL

Offshore liquefaction allows associated gas that would otherwise be re-injected or flared to be captured, processed and liquefied. According to the Earth Report, flaring alone contributes over 350 mill tonnes of CO2 emissions per year, not including the additional NOX and SOX that is also produced. Billions of dollars of otherwise useable fuel is currently "going up in smoke." Small and mid-scale LNG offers a real solution to this wasteful practice.

MODULARITY

Standardised liquefaction modules can be designed for installation on converted LNGCs, converted VLCCs, or new hulls. Other topsides facilities may also be modularised and they include inlet gas compression, amine treating, dehydration, LPG recovery and fractionation and utility modules.

While large-scale onshore base load facilities have an important place in the LNG supply chain, they are restricted to locations with world-class gas fields, accessible ports, and a favourable political climate. Now there are viable mid-scale liquefaction technologies that work well on LNGFPSOs and offer the ability to tap into gas reserves in fields that had previously been considered too small or remote to monetise and at a lower cost per mtpa capacity than onshore facilities. The companies that are most innovative and entrepreneurial in spirit will pave the way for the rest. ■

This article was written by Brad Hubbard, midstream technology development manager, Mustang Engineering.