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February 2016

Guest: Single cycle refrigeration for small-scale LNG plants

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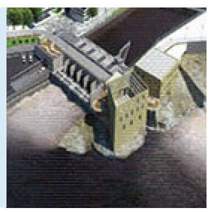

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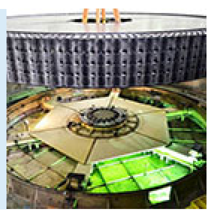

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Single cycle refrigeration for LNG production

By Robert Sammon, Gas Processing Sales Manager, GE Oil & Gas

As a multitude of applications adopt LNG as a new fuel source, the optimization of LNG logistics and the integration of LNG into existing operations present new challenges. While these aspects are crucial to the success of any LNG project, often overlooked in the economic equation is the impact of the liquefaction technology on plant CAPEX, OPEX, operability, and maintainability.

Liquefaction technologies for large-scale LNG plants typically utilize a mixed refrigerant (MR) technology. This "cocktail" of refrigerants is developed to optimize the process of cooling and liquefying the specific project gas—the largest OPEX cost in making LNG. The combination of different refrigerants allows for a highly efficient process, realizing significant OPEX savings over time. For the larger plants, it is an easy calculation to determine the additional CAPEX requirement versus the OPEX savings. The challenge arises when trying to look at alternative solutions in an attempt to minimize overall project CAPEX, while also optimizing project OPEX. It's not simple when there are many manufacturers offering different liquefaction technologies, with no easy way to make a comparison. Thus, it becomes the responsibility of the developer (or plant owner/operator), to understand the different technologies that are available—and more important—the pros and cons of each.

As plant capacity requirements diminish, single refrigerant cycles tend to be favored over mixed refrigerant cycles. Reasons for choosing a single refrigerant cycle vary, but often include: a desire to minimize CAPEX, past experience with the given process technology, perceived ease of operation, and a more favorable permitting environment.

Two choices exist for single refrigerant cycles: nitrogen (N_4) or methane (CH_4). Both cycles work by compressing and then expanding the refrigerant to provide the cooling necessary to produce LNG. Unfortunately for the project developer, many technology providers only offer a N_2 process, often due to their internal technology limitations and experience base. Thus, it's important for developers to understand the tradeoffs between N_2 and CH_4, and how each can help or hinder their project.

An N_2 refrigeration cycle is a "closed-loop" system, meaning that once operational, the refrigerant is constant, only requiring "make-up" refrigerant to replenish losses. The amount of losses primarily depends on the seal technology of the refrigeration compressor. Since the N_2 is usually re-supplied externally, this can create significant OPEX.

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25,000 – 50,000 pre-cooled mixed refrigerant cycle LNG plant

On the positive side, some permitting jurisdictions consider a N_2 refrigeration cycle as “safer” than CH_4, since it is an inert gas and thus extremely stable. However, this is more perception than reality, since both types of processes have an ample flow of hydrocarbons. Nevertheless, it’s often cited as an advantage of N_2.

A N_2 cycle also offers another benefit in terms of rotating equipment. If the plant requires only a modest amount of LNG storage, a N_2 cycle requires only a small boil-off gas (BoG) compressor, or may eliminate it entirely by using sub-cooling to lower the pressure and condense the vapor from the tank.

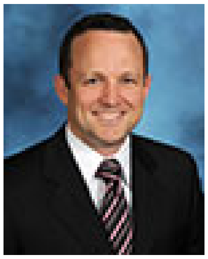
In contrast to N_2, a CH_4 refrigeration cycle utilizes the natural gas source itself as the refrigerant, usually via the BoG and flash gas created in the process. This is an “open-loop” system, meaning that refrigerant is constantly added and removed to prevent a buildup of N_2 in the LNG storage tank. No externally supplied refrigerant is required, which can provide significant OPEX savings relative to a N_2 cycle. However, the BoG compressor for a CH_4 cycle typically requires more horsepower, since the BoG provides a significant refrigerant stream.


120,000 GPD, CH_4 refrigeration cycle LNG plant

In the CH_4 process, the refrigerant removed from the system can be used as fuel gas, re-liquefied or sent to a flare for disposal. The option to use this process stream to drive the liquefaction train mechanically, by a gas engine or turbine, makes the CH_4 process quite attractive in remote locations where external refrigerants are scarce or expensive, or where electricity is unreliable or expensive.

A CH_4 process can also provide a significant efficiency advantage over N_2, meaning fewer kilowatts per gallon of LNG produced. In a sample process comparison of 200,000 gallon-per-day electric-drive liquefaction trains, the CH_4 process was 9% more efficient with atmospheric storage and nearly 14% more efficient with pressurized storage (due to less horsepower required for the BoG). Assuming \$0.8 kwH electricity cost and 350 operating days per year, this results in annual OPEX savings of more than a quarter million dollars annually.

Clearly, the choice of refrigeration cycle will have a significant impact on the project CAPEX and OPEX. Each of the refrigeration technologies present tradeoffs, which the project developer (or owner/operator), must evaluate to determine what is “optimal” for their particular project goals. Choosing an experienced LNG technology provider that can customize a refrigeration process is an important first step.



For more information on GE Oil & Gas' LNG solutions, please contact Robert Sammon at robert.sammon@ge.com

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