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Liquefied Natural Gas (LNG) and its Applications

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ABSTRACT

The risks of vaping include the possibility of combustion and asphyxiation. The liquefaction process involves the removal of some components that might create problems downstream, such as dust, acid gases, helium, water, and heavy hydrocarbons. Natural gas was assumed to be economically irrelevant anywhere gas-producing oil or gas fields were located distant from gas pipelines or offshore where pipelines were impractical. Because, unlike oil, there was no practical means to store or transport natural gas other than through pipes, which required that the same gas be utilized immediately by end customers, natural gas created was often flared.Cryogenic distillation, amine absorption, and membrane technology are the three primary methods used to remove carbon dioxide (CO2) from natural gas. When it comes to offshore platforms, membrane technology has several advantages. The majority of LNG is supplied by tankers known as LNG carriers in enormous, onboard super-cooled (cryogenic) tanks. LNG may also be transported in smaller ISO-compliant containers that can be transported on ships and trucks. LNG is particularly tempting for long-haul HDVs (both HPDI and SI) since it has a greater range potential than CNG; because LNG is denser than CNG, more energy can be stored in the same volume. Depending on the gas composition, LNG remains a cryogenic liquid at around -162°C at ambient pressure.

Keywords: LNG, Gas, Storage, Process, Methane, Carbon-Dioxide, Transportation, Application, Refrigeration

Introduction

Natural gas that has been cooled down to liquid form for convenience and safety of non-pressurized storage or transport is known as liquefied natural gas (LNG). LNG is made up primarily of methane, CH4, with a little amount of ethane, C2H6. It occupies around 1/600th of the volume of natural gas when it is gaseous (at standard conditions for temperature and pressure).LNG is odorless, colorless, non-toxic and non-corrosive. The hazards of vaping include the potential for combustion and asphyxiation. The liquefaction process involves removing certain components, such as dust, acid gases, helium, water, and heavy hydrocarbons, that can cause difficulty downstream. The natural gas is then condensed into a liquid at a pressure close to atmospheric pressure by cooling it to approximately -162 °C (260 °F).

The liquefied petroleum fractions (butane and propane), which may be kept in liquid form at relatively low pressure, and the lighter ethane and methane fractions are routinely separated from the gas stream. The majority of the LNG that is exported is created by liquefying these lighter methane and ethane components. Anywhere gas-producing oil or gas fields were far from gas pipes or situated offshore where pipelines were not practical, natural gas was thought to be economically insignificant. Since there was no practical way to store or transport natural gas, unlike oil, other than through pipes, which required that the same gas be used right away by end consumers, this normally meant that natural gas generated was typically flared.

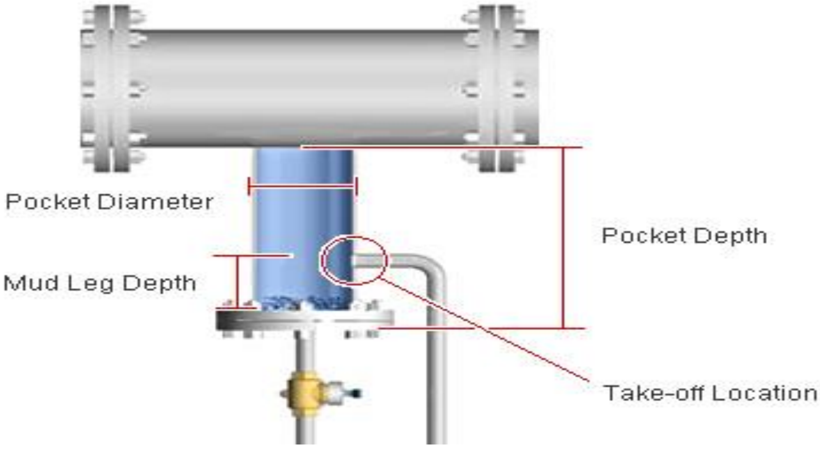
Treatment methods for LNG	**Processing steps**
1. Condensate removal	1. Refrigeration
2. CO_2 removal	2. Liquefaction
3. Dehydration	3. Storage & Loading
4. Mercury & H2S removal	4. Transportation & Marketing

I.Condensate removal

Separating condensate from the air stream is the first stage in the removal process. A change in velocity, similar to the procedure in a cyclonic or impingement mechanical separator, or an air receiver, can separate materials. Coalescing filters can be used to further remove aerosols from the air. Additionally, once the compressed air has passed through the after cooler, air dryers are used to lower the amount of water vapor that is still in the air.

The second step is to use a method to automatically drain the condensate without wasting valuable compressed air.

- A manual is a guide that tells you how to do something. Operators can open valves to discharge condensate manually. Often, manual valves are left open for a long time, which allows air to escape and cause problems;
- Level-operated mechanical traps open when a certain level of condensed vapor is reached, and they come in two types – float-type traps and inverted bucket traps. Float-type traps use less air than other types of traps, but they often require more maintenance;
- Solenoid valves operated by electricity are common. Solenoid valves with timing devices have adjustable levels for when they will open, based on a preset time. There are no air-loss traps with reservoirs. The trap doesn't waste any compressed air during operation;



II. CO_2 removal

The three main technologies used to separate carbon dioxide (CO_2) from natural gas include cryogenic distillation, amine absorption, and membrane technology. Membrane technologies have many advantages when it comes to offshore platforms.

1) The method known as "cryogenic distillation" separates gaseous mixtures using straightforward distillation at high pressure and low temperature. Instead of separating a mixture of liquids, conventional distillation separates a mixture of gases based on the disparity in their boiling points.

2) To create a sweetened gas stream (i.e., a gas devoid of hydrogen sulfide and carbon dioxide) and an amine solution rich in the absorbed acid gases, the down flowing amine solution in the absorber absorbs H_2S and CO_2 from the up flowing sour gas.

3) Since H_2S and H_2O can also be removed, CO_2 separation membranes have been widely used in CO_2 removal applications. GENERON's CO_2 removal membrane systems provide high hydrocarbon recoveries, which is due to our high CO_2 / CH_4 selectivity membranes.

III. Dehydration

The removal of water vapor from a gas stream, known as gas dehydration, lowers the temperature at which water vapor will condense from the stream, or the gas's "dew point." One of the most significant materials employed as desiccant materials in commercial natural gas dehydration is regarded as being molecular sieves.The purpose of this work was to construct a pilot scale natural gas dehydration unit as a replica of an actual operational plant for the Egyptian Western Desert Gas Company. This work demonstrates a research of natural gas dehydration employing 3A molecular sieve as a form of solid desiccant materials. It was investigated how varied operating circumstances affected the dehydration of natural gas.

A gas heater was used to activate the molecular sieve bed in the experimental setup, which consists of a cylinder filled with 3A molecular sieve to create a fixed bed that is then passed through by natural gas with varying water vapor concentrations. The experimental setup is equipped with facilities to control the bed pressure, flow rate, gauge the amount of water vapor present in the gas, and measure the bed temperature.The effectiveness of dehydration decreases noticeably as the water vapor content in the incoming feed gas increases. As might be predicted, a larger natural gas intake flow rate reduces the effectiveness of dehydration. Higher feed pressure results in more effective dehydration.

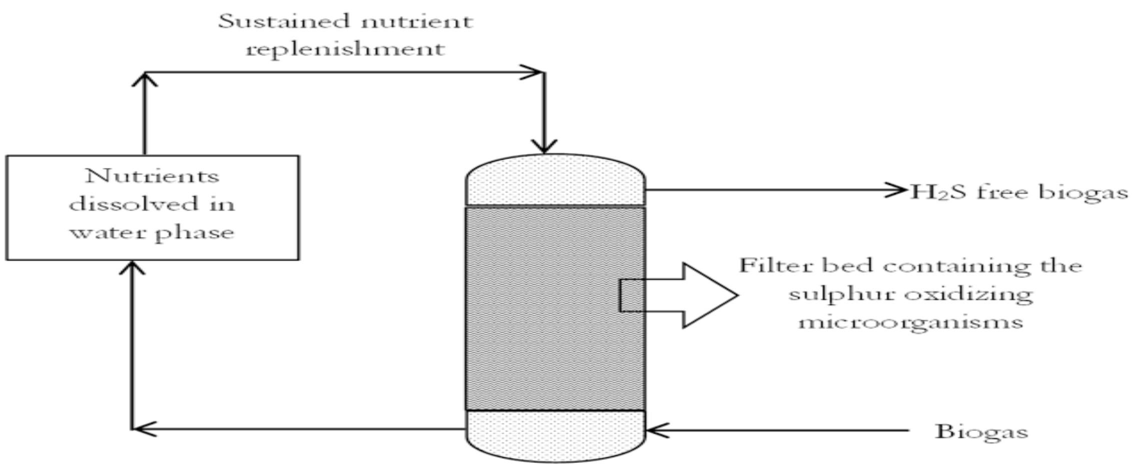
IV. Mercury & H_2S removal

Both non-regenerative and regenerative adsorbents can be used to extract mercury. In both situations, hydrocarbon gas enters an adsorption tower at the top and exits the bottom for further processing or sale after passing through the adsorbent where the mercury is adsorbed.

From the wellhead on, sour gas is an annoyance. To polish the treated gas to satisfy pipeline specifications, membranes can be used with downstream facilities to remove H_2S in large quantities upstream. To unload downstream sweetening and sulfur production facilities, upstream bulk removal can be paired with H_2S re-injection. MTR's SourSep™ devices perform a straightforward, single-stage bulk removal of H_2S from pressured sour gas. An extremely sour low pressure permeate gas produced by bulk removal can be reinjected. The system is simple, processes just gas, lacks any absorbents or adsorbents, and has no moving components. Neither liquids nor solids are created or utilized. The entering high pressure sour stream is divided into a low pressure H_2S-rich reject stream and a somewhat sweetened high pressure product stream. Reinjection or alternative direct H_2S to S conversion methods can be used in conjunction withSourSep™ bulk H_2S removal for H_2S disposal. Using lightly loaded conventional amine units with existing Claus facilities, somewhat sweetened product gas may be polished.

Benefits

- Straightforward bulk H2S reduction to 200–300 ppm;
- Low hydrocarbon and water dew point product gas;
- High H2S concentration membrane performance that is reliable and proven;
- Trucks can quickly transport and install skid-mounted equipment.;



(A)

1. Refrigeration

In gas plants, heat is removed from some process streams via the refrigeration process. In the process of processing natural gas, refrigeration serves a dual dewpoint control purpose. It is utilized to produce residual or sales gas that meets both the hydrocarbon and water dew point requirements.

2. Liquefaction

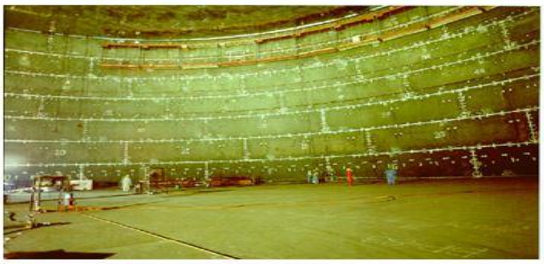
The process of converting a gaseous material into a liquid is known as liquefaction. Physical conditions like temperature, pressure, and volume change as a result of this shift. Thomas Andrew was the first to investigate how carbon dioxide transforms from a gas to a liquid. In order to store and transport gas in its liquid state, it must be cooled to a temperature lower than its boiling point. Cryogenic temperatures, which must be reached by a sophisticated set of industrial scale procedures, are extremely low temperatures.

3. Storage & Loading

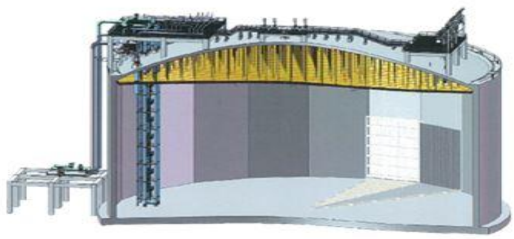
LNG carriers transport LNG to receiving terminals, which convert it to a gaseous form. Unloading and storage facilities, as well as LNG regasification infrastructure, are all part of LNG terminals. OSL has vast expertise in the design and engineering of loading/unloading facility equipment. We have been involved in the comprehensive design of port facilities in collaboration with our main partner SPT:

- LNG Carrier Berth operations
- LNG Pipelines
- Transfer System (Loading/Offloading Arms or Hoses)
- Jetty Top Works
- Loading arm bypass system (earthquakes)

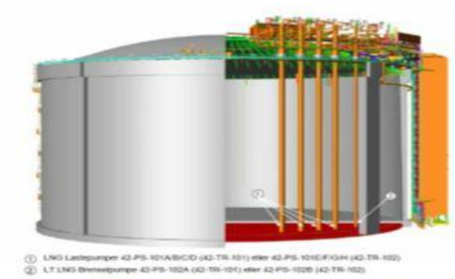
Full Containment LNG Storage Tanks



Inside the LNG Tank (9% nickel-steel plates)



Cross Section View of a Typical LNG Tank

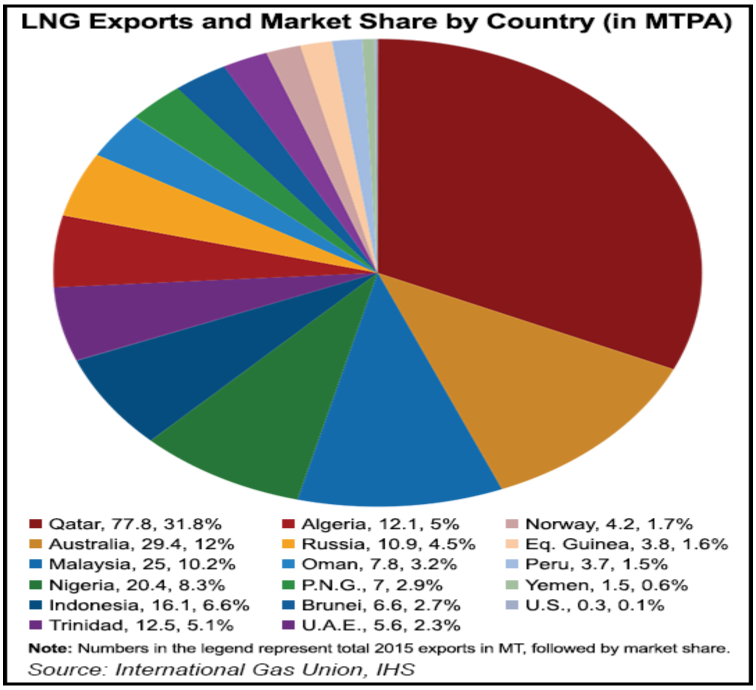


LNG Tank Vertical Pump Columns

4. Transportation & Marketing

The majority of LNG is delivered in massive, onboard super-cooled (cryogenic) tanks by tankers known as LNG carriers. LNG may also be carried in smaller ISO-compliant containers that can be placed on ships and lorries. LNG is especially appealing for long-haul HDVs (both HPDI and SI) since it has a longer range potential than CNG; because LNG has a higher density than CNG, more energy can be stored in the same volume. LNG remains a cryogenic liquid at roughly -162°C at ambient pressure, depending on the gas composition.

The worldwide LNG market was worth USD 30.34 billion in 2020 and is predicted to be worth USD 66.13 billion by 2027, growing at a CAGR of 6.92 percent between 2022 and 2027. The worldwide liquefied natural gas market was valued at USD 109.48 billion in 2021 and is predicted to increase at an 8.1 percent compound annual growth rate (CAGR) from 2022 to 2030. Growing demand for electric power generated by sustainable energy sources is expected to drive market expansion in the coming years.Japan has been the world's largest LNG market for as long as most people can remember. The country's utilities and trading firms supported decades of LNG supply expansion by signing long-term contracts that served as the industry's foundation. The industry of liquefied natural gas (LNG) is suffering low pricing and oversupply. Even before the COVID-19 epidemic, the LNG market was on track for oversupply in 2020 and 2021, as new projects continued to expand capacity well beyond consistent demand growth.



Conclusion

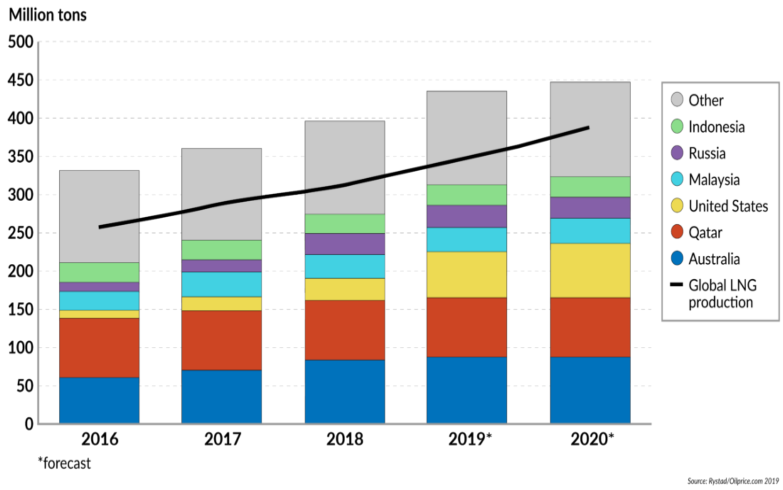
The following are the advantages of researching LNG cold energy use at LNG receiving terminals and data centers. First, cold energy from the LNG regasification process may be utilized instead. to lower the electricity expenses in the cooling system of a traditional cooling system data centers by more than 79.25 percent Furthermore, it promotes power generation, resulting in a reduction in emissions. reduction in the use of fossil fuels as a result, it is advantageous since data centers may be run. For at least 15 years, efficiently and adequately under long-term situations.

Second, using LNG cold energy can increase data center power efficiency and competitiveness by lowering the PUE from 2.00 to 1.36, which is close to the PUE of data centers in Ireland (1.15-1.40). The regasification procedure provides a free cooling time of 12 months per year for cold usage in data centers. Third, the "exergy efficiency," which is 43.38 percent, may be used to assess the quality of LNG cold energy use. This outcome improves the competitiveness of Thailand's LNG business.

Fourth, the use of LNG cold energy may minimize CO2 emissions from data center power usage as well as waste cold energy discharged into the ocean during the regasification process, which can enhance sustainability and reduce hazards to the environment and society.

Fifth, the economic feasibility and commercial studies for income from LNG cold energy use for a data center show a payback duration of 7 years and an IRR of 13% for the LNG receiving terminal and a payback period of 2.21 years and an IRR of 45 percent for digital firms.

Finally, this research is for the world's first data center that leverages free cooling from LNG cold energy utilization in the LNG receiving port. This study can be expanded to include the average and maximum PTTLNG send-out rates of 5.0 and 11.5 MTPA, respectively, making LNG cold energy of 135 and 300 MW available for data center capacities of 16,000 and 36,800 racks, as well as reducing CO2 emissions by 223,842 and 497,427 t of CO2 per year.



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