Flare Gas Capture for LNG Production

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The LNG-Pure Process Is Patent Pending

Flare Gas Capture

New technology has been developed to capture and monetize rogue gas emissions from oil production. Implementing these technologies on a wide scale provides an enormous positive environmental impact by reducing carbon dioxide and methane gas emissions with a large financial incentive to the oil producer.

Background

Shale oil production co-produces rich natural gas, known as associated gas. In remote shale oil fields there is often no pipeline infrastructure to transport the gas for further processing. Consequently, the industry is searching for cost-effective, portable systems that can be transported from well to well to capture the gas. The LNG-Pure process converts wasted gas into valuable, clean-burning fuels that displace the use of crude oil while snuffing out the flare.

Liquefied Natural Gas

Liquefied natural gas, or LNG, is natural gas that has been supercooled to minus 260 degrees Fahrenheit (minus 162 degrees Celsius). At that temperature, natural gas condenses into a liquid. When in liquid form, natural gas occupies 600 times less space than in its gaseous state, which makes it feasible to transport over long distances. Liquefied Natural Gas (LNG) offers many advantages over petroleum-based fuels. It is estimated that 85 years of natural gas reserves exist resulting from recent shale oil discoveries (EIA, 2014).

- In the form of LNG, natural gas can be shipped from the parts of the world where it is abundant to where it is in demand.
- LNG is an energy source that has much lower air emissions than other fossil fuels, such as oil or coal.
- LNG is odorless, colorless, non-corrosive and non-toxic. Its density is less than one-half that of water.
- The use of LNG is a proven, reliable and safe process, and it has been used in the United States since 1944.
- Natural gas is the world’s cleanest burning fossil fuel and it has emerged as the environmentally preferred fuel of choice.

Natural Gas Liquid

Associated gas also contains ethane, propane, butane and natural gasoline. These components can be removed from the associated gas and condensed. The resulting mixture is known as Natural Gas Liquid (NGL). NGL is commercially converted to plastic, propane fuel and butane fuel. The butane and natural gasoline are blended into gasoline to reduce our dependence on crude oil.

Associated Gas Flaring

The combination of horizontal drilling and fracking has caused a shale-oil boom across the United States. A prime example used for this paper is the Bakken oil field of North Dakota. Flaring from crude oil operations in the Bakken oil field of North Dakota has become an enormous economic and environmental issue. The horizontal drilling and fracking process co-produces natural gas. The co-produced gas is normally compressed and sent down a pipeline. However, in the Bakken, the pipeline infrastructure has failed to keep pace with drilling. Currently, 36% of the oil wells in the Bakken flare the co-produced gas because of a lack of pipeline infrastructure (Smith, 2014). The 2700 wells that are flaring gas in the Bakken have created a problem so severe that it can be seen from space (refer to Figure 1). Pending legislation to curtail flaring in the Bakken will also curtail oil drilling unless flaring alternatives are developed.

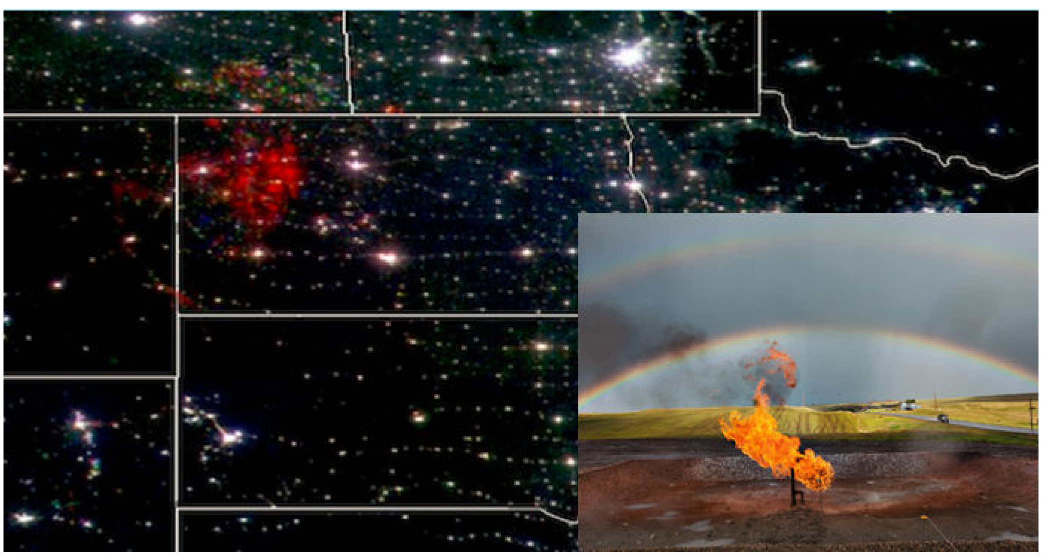

Figure 1: Flaring in the Bakken.

Flaring in the Bakken is a microcosm of a much bigger problem globally (World Bank, 2004). Many Third World countries have a grossly inadequate electrical grid. The coping mechanism is huge megawatts of household-sized diesel generators. Meanwhile, pollution from the diesel generators combined with the flaring, darkens the skies (refer to Figure 2).

Figure 2: Flaring in Nigeria (Source: World Bank).

Meanwhile, 140 billion cubic meters of gas is flared annually -- enough to produce 750 billion kWh of power which is more than the continent of Africa's power consumption (World Bank, 2014). The World Bank continues to explain the flaring problem *and* the opportunity eloquently (World Bank, 2014):

> *Billions of cubic meters of natural gas is flared annually at oil production sites around the globe. Flaring gas wastes a valuable energy resource that could be used to support economic growth and progress in oil-producing countries. It also contributes to climate change by releasing millions of tons of CO2 to the atmosphere. The World Bank is working with governments, oil companies, and other development institutions to stop wasting this gas, and to create markets in which to sell it and put it to productive use.*
>
> *Gas flaring happens for multiple reasons. Sometimes energy markets are under-developed and functioning poorly, which can discourage investments in flare elimination. In other cases the legal, regulatory, and operating environment is not conducive for investment. Furthermore, oil production often takes place in remote areas where long distances to consumer markets requires substantial new infrastructure in the form of new gas pipelines or power networks.*

Even with these barriers, utilizing associated gas is in most cases an investment rather than a cost. Often the best utilization solution involves connecting the gas to a network or converting it to power in a gas-fired power plant. However, as technology evolves, "self-contained" solutions are expected to play a larger role, such as converting the gas into diesel, synthetic crude oil, fertilizers, and other liquids.

LNG-Pure Process Advantages

The LNG-Pure process produces LNG and NGL without the use of antifreeze additives used by conventional processes. The heat and cooling integration of the process also separates unwanted ethane from both liquids. Removal of ethane is critical if LNG is to be used as a motor fuel. Ethane is notably present in shale gas and is particularly difficult to separate from methane. The associated gas from the Bakken, for example, contains 19% ethane. Consequently, simply liquefying the residue gas from conventional NGL recovery systems is inadequate to provide a motor-fuel grade LNG (Cummins, 2014). The stranded, rich gas requires a simple, portable process that will produce motor-fuel grade LNG while co-producing NGL (Wocken, 2013). The LNG-Pure process also produces a methane/ethane residue gas mixture that can be used to power drilling equipment or generate local power, thereby providing a total gas flaring solution.

LNG-Pure Process Overview

The LNG-Pure process produces motor-fuel grade LNG and NGL from the associated gas in four steps. The first step is a multi-stage reciprocal compression system. Second, most of the NGL and 97% of the water is removed downstream of the compressor with the NGL Pro process. Details of the NGL Pro process are available at www.aspenesco.com/ngl-pro. A flow diagram for NGL Pro appears in Appendix A. Third, the residue gas flows into the NGL-Pure process where ethane is controlled to the desired LNG specification and the remainder of the NGL is removed. Fourth, the purified methane stream is liquefied in one of several conventional LNG cryogenic processes. A block diagram of the process is shown below (refer to Figure 1). The cooling requirement for LNG-Pure and LNG liquefaction are shared to minimize capital and operating expenses. A simulation flow diagram for the LNG-pure process appears in Appendix B.

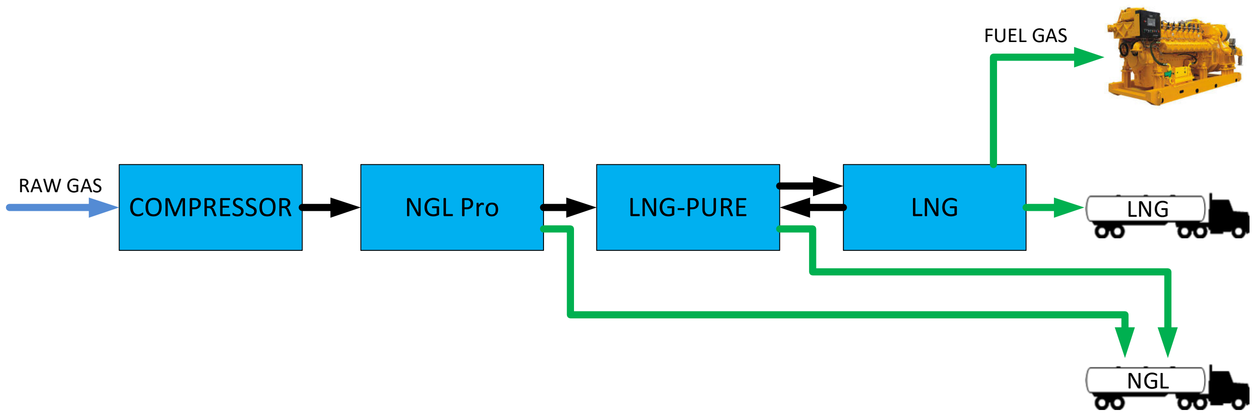

Figure 1: LNG-Pure block flow diagram.

Conclusion

The patent-pending LNG-Pure process is a new and unique process to the industry, providing a cost-effective solution to capture flare gas. The captured gas is converted to valuable Natural Gas Liquid and Liquefied Natural Gas, suitable for motor-fuel or power generation. The LNG-Pure process offers the following features:

1. Motor fuel-grade LNG and NGL are co-produced from rich natural gas.
2. The ethane composition of LNG and NGL can be controlled to any level.
3. No additives or glycol systems required to prevent freeze-up.
4. No turboexpander is required.
5. The compression and cryogenic systems of the LNG process are integrated into the front end cleanup process, providing a cost-effective LNG solution.
6. LNG-Pure is an ideal flaring solution.

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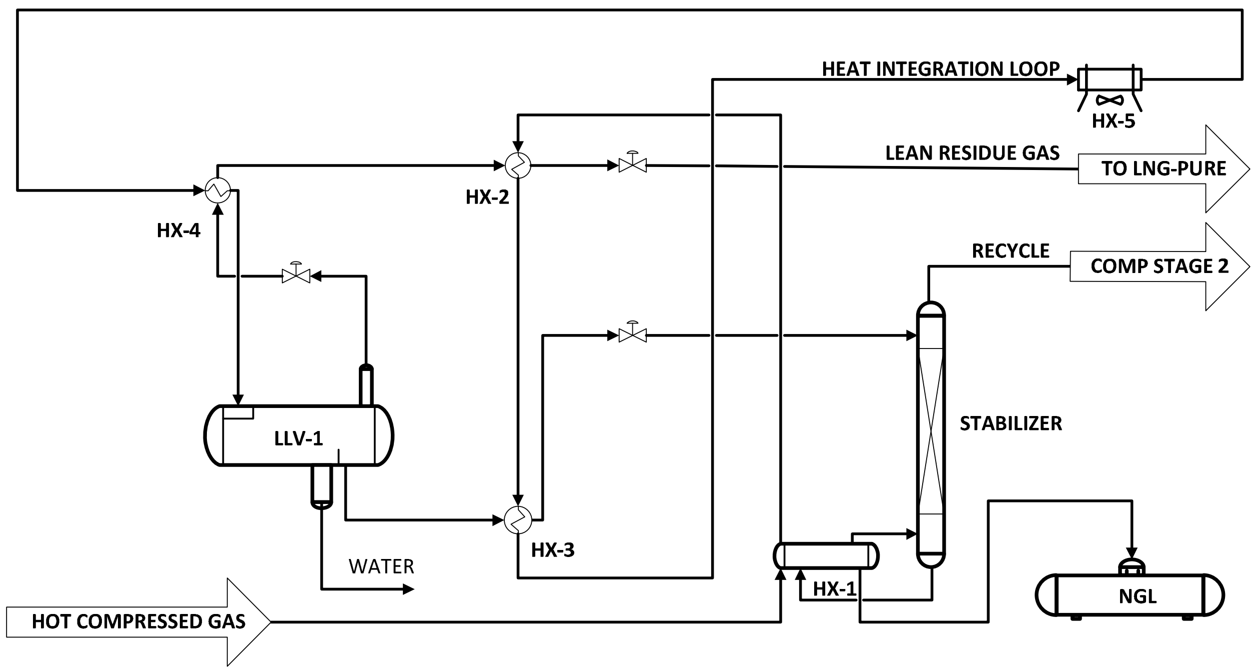
Appendix A: NGL Pro Process Flow Diagram



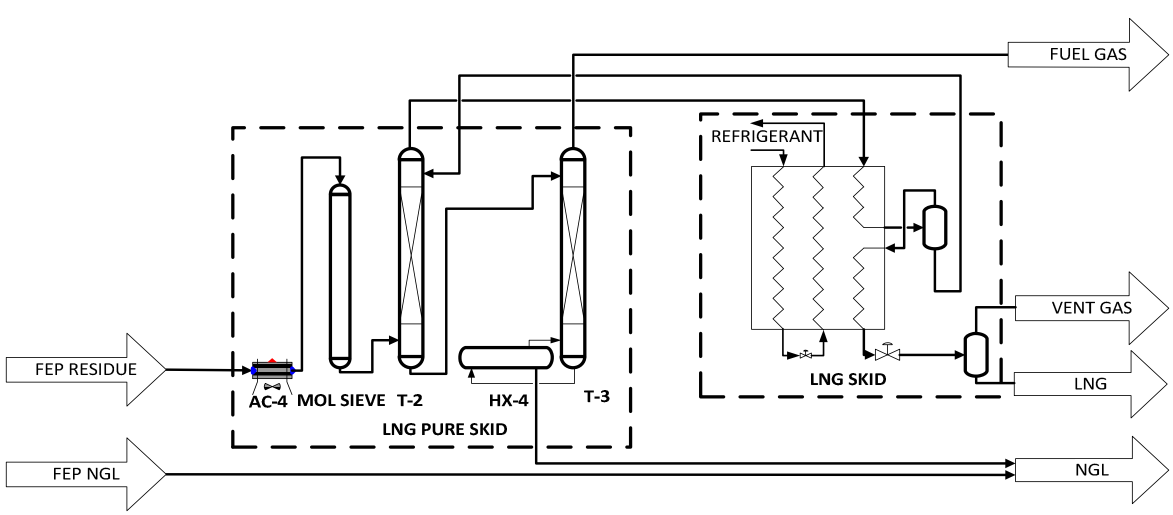
Appendix B: LNG-Pure Simulation Report and Flow Diagram

	FEP Feed Gas Mol %	Fuel Gas Mol %	Vent Gas Mol %	LNG Mol %	NGL Mol %	NGL bbl/day	NGL Recovery
N2	2.9%	0.6%	14.0%	0.7%	0.0%	0.0	
CO2	1.2%	0.0%	0.0%	0.0%	0.0%	0.0	
C1	46.7%	25.6%	78.7%	96.2%	0.0%	0.0	
C2	18.8%	64.3%	0.8%	3.2%	2.6%	10.6	4%
C3	14.5%	8.9%	5.0%	0.0%	43.5%	183.9	77%
IC4	1.7%	0.2%	0.3%	0.0%	6.2%	31.1	94%
NC4	6.0%	0.4%	1.0%	0.0%	22.2%	107.1	95%
IC5	1.3%	0.0%	0.1%	0.0%	5.0%	27.9	98%
NC5	2.1%	0.0%	0.1%	0.0%	7.9%	43.9	98%
C6	1.6%	0.0%	0.0%	0.0%	6.2%	39.1	100%
C7	1.6%	0.0%	0.0%	0.0%	6.3%	44.0	
C8	0.0%	0.0%	0.0%	0.0%	0.0%	0.0	
H2O	1.6%	0.0%	0.0%	0.0%	0.0%	0.0	

	Feed	Fuel Gas	Vent gas	LNG	NGL
Flow, bbl/day				275	488
Value, $/month				$ 163,012	$ 490,984
C3+ Value Recovered					91%
True Vapor Pressure, psig					96
Reid Vapor Pressure, psig					86
Temperature, F	95	-5	-151	-260	127
Pressure, psig	35	150.00	1	1	138
MSCFD	2,500	667	450		
Net Heating Value	1,573	1,498	772	926	
Gross Heating Value	1,718	1,639	857	1026	

Ambient Temperature, F	50
Produced Water, bbl/day	5.32

Compressor	Stage 1	Stage 2	Stage 3	Total
Adiabatic Efficiency, %	65	65	65	
Pressure Ratio	3.1	2.1	2.0	
Discharge Pressure, psig	140	300	600	
Horsepower	218	170	157	545



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