QUARTERLY PROGRESS REPORT

Report Title: Field Demonstration of a Membrane Process to Separate Nitrogen from Natural Gas: Ninth Quarterly Progress Report

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Disclaimer

Abstract

The original proposal described the construction and operation of a 1 MMscfd treatment system to be operated at a Butcher Energy gas field in Ohio. The gas produced at this field contained 17% nitrogen. During pre-commissioning of the project, a series of well tests showed that the amount of gas in the field was significantly smaller than expected and that the nitrogen content of the wells was very high (25 to 30%). After evaluating the revised cost of the project, Butcher Energy decided that the plant would not be economical and withdrew from the project. Since that time, Membrane Technology and Research, Inc. (MTR) has signed a marketing and sales partnership with ABB Lummus Global, a large multinational corporation. MTR will be working with the company's Randall Gas Technology group, a supplier of equipment and processing technology to the natural gas industry. Randall's engineering group has found a new site for the project at a North Texas Exploration (NTE) gas processing plant.

The plant produces about 1 MMscfd of gas containing 24% nitrogen. The membrane unit will bring this gas to 4% nitrogen for delivery to the pipeline. The membrane skid is being built by ABB. NTE has ordered the required compressor and MTR is making the membrane modules. The membrane skid is scheduled to be completed by December 29. Our target is to have the unit installed and optimized by mid-January.

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Introduction

The natural gas specification for inert gases is less than 4%. On this basis, about 17% of known U.S. reserves of gas are subquality due to high nitrogen content. Some of this gas can be brought to pipeline specifications by dilution with low-nitrogen-content gas; some is treated by cryogenic condensation and fractionation. Nonetheless, about 1.0 trillion scf of known reserves are currently shut in.

This project covers the first demonstration of a new membrane technology to treat this otherwise unusable gas. The objective of this project is to develop a membrane separation process to separate nitrogen from high-nitrogen-content natural gas. To demonstrate the process, a proof-of-concept plant is being built at a North Texas Exploration (NTE) gas field in Texas/Oklahoma.

Additional test sites are also being explored.

Experimental

The membrane system was installed and started up at the NTE site. The client was expecting to get a minimum of 1 MMscfd of inlet gas but had been able to produce only about 0.6 MMscfd. The inlet gas is water saturated and this caused problems during compression. In this reporting period, these problems were actively pursued and fixed. The compression equipment is now operating in a stable range and we expect to have the site operating at 50% capacity shortly.

Results and Discussion

North Texas Exploration (NTE), ABB and MTR have signed an agreement, through which MTR/ABB will supply NTE with a fully-fabricated skid-mounted membrane unit including 28 eight-inch membrane inserts housed in eight pressure vessels. The process flow diagram of the proposed system is shown in Figure 1.

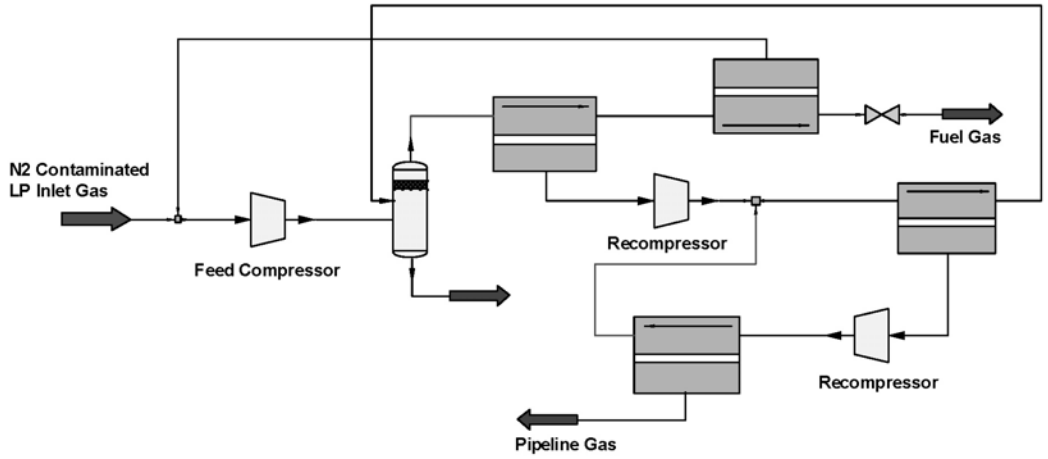

Figure 1. Process flow diagram from the NTE Pilot Plant System.

The low pressure N2 contaminated gas will be compressed to about 800 psia and will be introduced into the membrane skid after passing through a filter coalescer. The gas will pass through a set of membranes in two steps. In the first step (8 membrane inserts) partially enriched natural gas will be produced as a permeate gas and will be routed after compression to a second stage for further purification. The non-permeate from the first step will enter the second step (8 membrane inserts), in which further methane recovery will be affected. This permeate stream will be routed to the inlet compression. The non-permeate from the second step will be routed to fuel for the compression. The partially purified gas from the first step will be further purified two more stages of membrane, one containing 8 membrane inserts and the second containing four membrane inserts. To produce the final pipeline quality natural gas.

The membrane skid fabrication was completed and is shown in Figure 2.

Figure 2. Membrane skid for NTE pilot test.

A photograph of the system being installed in the field is shown in Figure 3.

Figure 3. Membrane system being installed at Green Ranch, TX.

Additional Field Sites

MTR signed a leasing contract, shipped the unit and had it installed at the Louisa, KY site in June. The system was started up under MTR supervision and within hours of installation and startup was producing pipeline quality gas. The process design for this test unit is as shown in Figure 4.

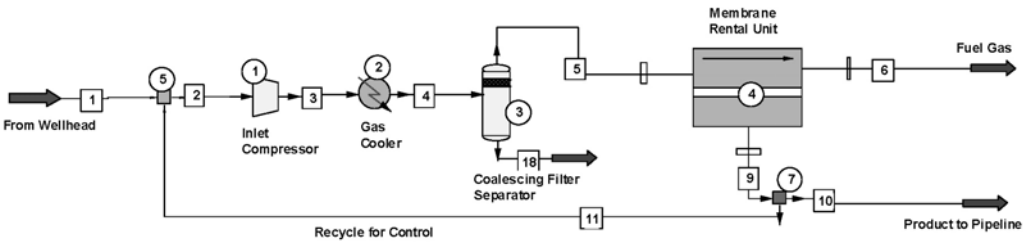

Figure 4. Process flow diagram for system at Louisa, KY.

The gas from the wellhead will be compressed to a minimum of 300 psia and will pass through a cooler to reduce the temperature to a maximum of 120°F. The gas will then pass through a filter coalescer/separator to remove any entrained water or hydrocarbon liquids and mist. The aerosol-free gas will then enter the membrane skid. The gas will pass through a scrubber and enter the membrane cartridges. Methane and other hydrocarbons will preferentially permeate the membrane and will be removed as product gas. The non-permeated stream will exit the membrane skid at about the same pressure as the inlet and will be throttled down in a valve to the fuel gas pressure. Any excess gas will be flared/vented. The product gas line will go through a T junction. One arm of the T-junction will be piped into the suction side of the compressor after passing through a regulator valve. The other arm of the T-junction will be routed to the pipeline entry point. This pipe may also need a regulator valve to control flow and pressure.

The expected performance of the Louisa, KY membrane system is shown in Table 1.

Table 1. Expected Feed and Products Streams

Stream No.	1	5	6	11	10
Stream Name	Feed	Membrane Feed	Fuel Gas	Recycle	Pipeline
Temp F	76	120	91.3867	105.6933	105.6933
Pres psia	30	300	282	45	45
Vapor mole fraction	1	1	1	1	1
Total lbmol/h	5.49	9.59	0.48	4.10	5.01
Total lb/h	109.62	191.63	9.36	82.02	100.25
Total std L gpd	907.37	1594.84	66.83	687.60	840.40
Total std V MMscfd	0.05	0.09	0	0.04	0.05
Component mole %					
Helium-4	0.00	0.00	0.00	0.00	0.00
Carbon Dioxide	0.03	0.03	0.00	0.03	0.03
Oxygen	0.21	0.21	0.17	0.21	0.21
Nitrogen	5.67	4.77	27.72	3.57	3.57
Methane	79.00	79.34	70.90	79.78	79.78
Ethane	9.42	9.76	1.07	10.21	10.21
Propane	4.23	4.40	0.13	4.62	4.62
I-Butane	0.28	0.29	0.00	0.31	0.31
N-Butane	0.73	0.76	0.00	0.80	0.80
I-Pentane	0.11	0.11	0.00	0.12	0.12
N-Pentane	0.11	0.11	0.00	0.12	0.12
N-Hexane	0.21	0.22	0.00	0.23	0.23

The Louisa., KY test system has been operating since installation and has been producing pipeline quality gas. We are now negotiating the sale of a full commercial unit which is expected to be ordered in the 3rd Quarter 2004.

Conclusions

Several initial teething issues have been resolved and the system is now under stable operation as far as compression is concerned. The complete system will be commissioned and product gas will be produced by the end of September. NTE, the company hosting this test site/pilot plant will be drilling additional wells to increase inlet flow rate. The system is expected to be fully operational continuously in September, 2004.

References

None cited.