Gas/Liquid Membranes For Natural Gas Upgrading

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ABSTRACT

Efforts this quarter have concentrated on field site selection. ChevronTexaco has nominated their Headlee Gas Plant in Odessa, TX for a commercial-scale dehydration test. Potting and module materials testing were initiated. Preliminary design of the bench-scale equipment continues.

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INTRODUCTION

Gas Technology Institute (GTI) is conducting this research program whose objective is to develop gas/liquid membranes for natural gas upgrading to assist DOE in achieving their goal of developing novel methods of upgrading low quality natural gas to meet pipeline specifications.

Kværner Process Systems (KPS) and W. L. Gore & Associates (GORE) gas/liquid membrane contactors are based on expanded polytetrafluoroethylene (ePTFE) membranes acting as the contacting barrier between the contaminated gas stream and the absorbing liquid. These resilient membranes provide much greater surface area for transfer than other tower internals, with packing densities five to ten times greater, resulting in equipment 50 – 70% smaller and lower weight for the same treating service.

The scope of the research program is to (1) build and install a laboratory- and a field-scale gas/liquid membrane absorber; (2) operate the units with a low quality natural gas feed stream for sufficient time to verify the simulation model of the contactors and to project membrane life in this severe service; and (3) conducted an economic evaluation, based on the data, to quantify the impact of the technology. Chevron, one of the major producers of natural gas, has offered to host the test at a gas treating plant. KPS will use their position as a recognized leader in the construction of commercial amine plants for

building the unit along with GORE providing the membranes. GTI will provide operator and data collection support during lab- and field-testing to assure proper analytical procedures are used. Kværner and GTI will perform the final economic evaluation. GTI will provide project management and be responsible for reporting and interactions with DOE on this project.

EXECUTIVE SUMMARY

The cofunding agreement with ChevronTexaco continues under discussion. ChevronTexaco's Chinchaga Gas Plant in Alberta, Canada will not be increasing capacity as planned. Since they do not have a commercial need for the contactor, they have withdrawn that site and are seeking another suitable location. We continue seeking alternative hosts and sites as a backup. A meeting was held with ChevronTexaco in Denver last quarter to identify potential locations. Most of their needs are outside the North American market. They have asked for a test unit design for a West African site. Discussions have begun for a potential application at their Carter Creek Plant in Wyoming. This site handles a high-pressure natural gas stream with 16% H_2S requiring treatment to bring it to 4 ppm.

This quarter, ChevronTexaco identified a potential test site in West Texas. The application here is for a full-scale dehydration unit, similar in size as originally proposed, but for a different natural gas processing application. A meeting was held with ChevronTexaco, GTI and KPS at the Headlee Gas Plant in Odessa, TX, to investigate testing, contract terms, schedules, and responsibilities. Key issues and decisions are described below.

1. Membrane module design basis - The original plan was that the module skid would be designed for a new offshore Nigeria platform and would have a capacity of 100 MMSCFD. Only one 50 MMSCFD membrane module would be installed on the skid for the field test. Since it cannot be determined at this time which of several offshore Nigeria platforms would be the final destination of the skid, it was decided to modify the design basis of the membrane module. The initial membrane module would be based on the largest diameter module that Kvaerner feels comfortable fabricating. Currently, this is about 72 cm. The design conditions for the module (temperature, pressure, water content, TEG quality, water removal requirements) were provided to Kvaerner. The nominal capacity is 50 MMSCFD for the 72 cm diameter module at the design conditions.

2. The proposed skid connection plan was reviewed prior to a tour of the plant. After the tour, a few changes to the plan were suggested and adopted. a) It was decided to move the gas flow bypass valve off of the skid. This has the advantage of designing the valve and bypass line for a lower pressure. b) A booster pump may be required on the lean TEG stream.

3. The current average flow through the TEG contactor is about 65 MMscfd. Due to field production operating system, the flow may vary by plus or minus 15 MMscfd over an hour period.

4. Cliff Lowe will serve as ChevronTexaco's contact point for technical issues, while Karl Gerdes will be the contact point for commercial issues, and Barry Sparkman is the plant engineer.

5. The critical path for the project is obtaining an agreement on the purchase contract.

6. PFD's, P&ID's were supplied to Kvaerner.

7. A lean TEG sample was provided to GTI for analysis.

8. Kvaerner Norway will provide a draft of the project schedule.

EXPERIMENTAL

ChevronTexaco module:

The modified simulation program has been used for designing a 50 MMscfd membrane contactor module for industrial scale dehydration testing. ChevronTexaco wants to demonstrate the technology in Odessa, Texas for possible subsequent utilization at a new planned platform outside the west coast of Nigeria.

The design pressure and temperature is 83 barg and 115 F. The gas has to be dried from saturated (76 lbs/MMscf) to 7 lbs/MMscf. To dry the actual gas volume to the specification, a membrane contactor of diameter 720 mm and active membrane length of 3800 mm has been estimated. The gas velocity will be approx.1 m/s and the active membrane area is 1235 m^2.

Potting project:

The present potting material has its limitation in the casting of larger diameters due to high exothermic peak and subsequent cracking of cured material. Therefore, a search for a new thermosetting material was initiated.

Resin survey:

Ten resin systems were chosen for initial screening. The following parameters were tested and evaluated:

- exothermic heat
- viscosity
- infiltration behavior (distribution around membranes and spacers)
- flexibility
- adhesion to the membrane (peeling tests)

The six most promising systems were chosen for the chemical immersion test to evaluate chemical resistance.

The resins include room temperature curing PU-systems (polyurethane), EP-systems (epoxy) and high temperature curing epoxy-system (80°C) from four different suppliers.

Chemical immersion test:

The most common gas treatment absorbents were picked out for the test where resin samples (including membrane and spacer) are exposed for 24 weeks at 60°C. The following solvents were chosen:

- TEG
- MEA
- MDEA
- aMDEA (highly activated from BASF)
- Morphysorb
- Selexol/Genosorb

As a measure for chemical resistance, the adhesion between membrane/PTFE and resin was chosen in addition to swelling of sample. Chemical resistance test will be performed after 6, 12, and 24 weeks. The test will be finished in beginning of June 2003.

Parallel to the chemical testing the following activities will be performed:

- potting simulations, i.e. study of the rheological behavior of approx. 3 kg samples of the various resins in a plexiglass mould of length/diameter 720 mm which is filled with membrane sheets and spacer material
- building dummies of the full size diameter and thickness (approx. 40 kg resin), both to see the rheological behavior and the curing performance in full scale
- the new potting material will be ready in July 2003

RESULTS AND DISCUSSION

No results have been achieved at this point.

CONCLUSION

No conclusions have been reached at this point.

REFERENCES

None