STUDY OF TRANSPORTATION OF GTL PRODUCTS FROM ALASKAN NORTH SLOPE (ANS) TO MARKETS

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DISCLAIMER

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ABSTRACT

The Alaskan North Slope is one of the largest hydrocarbon reserves in the United States where Gas-to-Liquids (GTL) technology can be successfully implemented. The proven and recoverable reserves of conventional natural gas in the developed and undeveloped fields in the Alaskan North Slope (ANS) are estimated to be 38 trillion standard cubic feet (TCF) and estimates of additional undiscovered gas reserves in the Arctic field range from 64 TCF to 142 TCF. Transportation of the natural gas from the remote ANS is the key issue in effective utilization of this valuable and abundant resource. The throughput of oil through the Trans Alaska Pipeline System (TAPS) has been on decline and is expected to continue to decline in future. It is projected that by the year 2015, ANS crude oil production will decline to such a level that there will be a critical need for pumping additional liquid from GTL process to provide an adequate volume for economic operation of TAPS. The pumping of GTL products through TAPS will significantly increase its economic life. Transporting GTL products from the North Slope of Alaska down to the Marine terminal at Valdez is no doubt the greatest challenge facing the Gas to Liquids options of utilizing the abundant natural gas resource of the North Slope.

The primary purpose of this study was to evaluate and assess the economic feasibility of transporting GTL products through the Trans Alaska Pipeline System (TAPS). Material testing program for GTL and GTL/Crude oil blends was designed and implemented for measurement of physical properties of GTL products. The measurement and evaluation of the properties of these materials were necessary so as to access the feasibility of transporting such materials through TAPS under cold arctic conditions. Results of the tests indicated a trend of increasing yield strength with increasing wax content. GTL samples exhibited high gel strengths at temperatures as high as 20°F, which makes it difficult for cold restart following winter shutdowns.

Simplified analytical models were developed to study the flow of GTL and GTL/crude oil blends through TAPS in both commingled and batch flow models. The economics of GTL transportations by either commingled or batching mode were evaluated. The choice of mode of transportation of GTL products through TAPS would depend on the expected purity of the product and a trade-off between loss in product value due to contamination and cost of keeping the product pure at the discharge terminal.

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EXECUTIVE SUMMARY

The Alaskan North Slope is one of the largest hydrocarbon reserves in the United States where Gas-to-Liquids (GTL) technology can be successfully implemented. Gas-to-liquids (GTL) conversion technology, where natural gas is chemically converted to transportable liquid products, is an emerging technology that is expected to reach commercialization within the next decade. The proven and recoverable reserves of conventional natural gas in the developed and undeveloped fields in the Alaskan North Slope (ANS) are estimated to be 38 trillion standard cubic feet (TCF) and estimates of additional undiscovered gas reserves in the Arctic field range from 64 TCF to 142 TCF. Currently, only a small portion of the produced natural gas of the North Slope of Alaska is used in the oil-field operation, such as gas lift and power generation, and in local sales. The unused portion is injected back into the reservoir for pressure maintenance and oil production. It is expected that as crude oil production on the North Slope continues to decline, approximately 26 TCF of ANS natural gas will become available for gas sales, transportation and/ or conversion to GTL products. This equates to over 4 billion barrels of oil equivalent.

Transportation of the natural gas from the remote ANS is the key issue in effective utilization of this valuable and abundant resource. The throughput of oil through the Trans Alaska Pipeline System (TAPS) has been on decline and is expected to continue to decline in future. Currently, 4 of the 12 pump stations have been shut down due to decline in the TAPS throughput. It is projected that by the year 2015, ANS crude oil production will decline to such a level (200,000 to 400,000 bbl/day) that there will be a critical need for pumping additional liquid from GTL process to provide an adequate volume for economic operation of TAPS. The pumping of GTL products through TAPS will significantly increase its economic life. Transporting Gas to Liquids products from the North Slope of Alaska down to the Marine terminal at Valdez is no doubt the greatest challenge facing the Gas to Liquids options of utilizing the abundant natural gas resource of the North Slope.

The primary purpose of this study was to evaluate and assess the economic feasibility of different products through the Trans Alaska Pipeline System (TAPS). Material testing program for GTL and GTL/Crude oil blends was designed following discussions with John Hackworth (UAF consultant on GTL studies) and Alyeska Pipeline Service Company.

The measurement and evaluation of the properties of these materials were necessary so as to access the feasibility of transporting such materials through TAPS under cold arctic conditions. Crude oil samples were supplied by Alyeska Pipeline Service Company and two GTL samples designated as GTL1, which is a solid wax sample from LaPorte, and Fischer-Tropsch (FT) diesel or light hydrocarbon GTL (designated as GTL2) were

supplied by USDOE for this study. The 20% cut of the wax distillate from GTL1 was mixed with samples of GTL2 in different proportions, which were then blended with crude oil samples in three different blend ratios. The density, viscosity and gel strength of these samples were measured. Results of the tests indicate:

- Trend of increasing yield strength with increasing wax content.
- High gel strength of GTL samples at very low temperatures as low as 20°F, which makes it difficult for cold restart following winter shutdowns.

Simplified analytical models were developed to study the flow of GTL and GTL/crude oil blends through TAPS in both commingled and batch flow models. Commingled flow involves the blending of the GTL product and the crude oil to form a commingled homogenous liquid mixture. Batch flow involves pumping alternate slugs of GTL products and crude oil. It can be achieved by three different techniques, namely:

- Uncontrolled or traditional batching of products, termed batch mode A
- Controlled batching using physical barrier such as pigs and spacers, termed batch mode B

Controlled batching using modern batching technique, which entails pumping alternate slugs of GTL and crude oil while fluid movement is monitored by interface detection devices to minimize the loss of product value. The pressure gradients and related hydraulic flow parameters for each transportation mode were determined and compared.

The economics of GTL transportations by either commingled or batching mode were evaluated. The choice of mode of transportation of GTL products through TAPS would depend on the expected purity of the product and a trade-off between loss in product value due to contamination and cost of keeping the product pure at the discharge terminal. Tables 1 and 2 show the basic economic assumptions and the parameters used for rate of return analysis for the different transportation modes

TABLE I Economic Assumptions

Conversion @ 60% efficiency	9.67 MScf / bbl
Plant Uptime Efficiency	95%
Project Life	20 years
Plant Capacity	100 MBPD
Taxes:	
State Income	9.4%
Federal CIT	35.0%
Property Tax	2%
Depreciation	Modified Accelerated Capital Recovery Scheme

TABLE II Model Parameters for ROR

Cost Estimates

- Plant Cost ranging from $ 20,000/BPD to $ 35,000
- Gas cost based on net back of 20%
- Annual Operating and Maintenance cost of 5.6% of Plant Cost
- Transportation and storage estimated with Tariff estimates. Capital investments are amortized over the project life and worked out per barrel of product.

Revenue Estimates

ROR calculation based on $21.00 per barrel crude price.
GTL products given a premium of 1.4 times Spot Oil price
Batch Transportation efficiency of 95%

SENSITIVITY ANALYSIS

Key Parameters in the rate of return analysis were modified to identify those with the greatest influence on the results. The parameters include:

- Capital Expenditure was varied between $20,000 per daily barrel and $35,000 per daily barrel to accommodate speculated range of plant costs and possible North Slope scale up factor.
- The crude oil price was varied between $21.00 per barrel and $35.00 per barrel
- For the batching operation, installing new storage and relief tanks at the terminal and pump stations respectively versus refurbishing some old tanks to accommodate production of storage.

CONCLUSION

The modern batching operation consistently gave the highest return in investment and it is recommended for transportation of the Gas-to-Liquid products from the North Slope of Alaska to Valdez. The major concern with batching is the length of mixing zone or interface and the purity of GTL products as they arrive the marine terminal in Valdez. Since experience shows that the length of this interface is independent on volume pumped, it becomes an optimization issue to find the optimum holding capacity on the North Slope that can give the minimum number of batches at any given production period. The optimum fluid velocity in pipeline should be determined with reasonable accuracy based on the density and viscosity difference of the two products to be transported to ensure minimum interface.

RECOMMENDATIONS

This study indicates that even the light GTL (LaPorte type) or FT diesel can pose problems for transportation through TAPS from the cold restart point of view. Rigorous studies are needed to identify the upper limit on the quantity and nature of the paraffins in GTL that can be accepted for transportation through TAPS.

Although modern batching technique appears to be the transportation mode of choice at this time, batching GTL products through the same pipeline that carries crude oil is likely to create significant problems of GTL product contamination. Wax, sulfur, asphaltene and other assorted solid deposits on the inside walls of the pipeline can potentially re-dissolve in the slug of pure GTL. Since GTL is a clean, zero sulfur fuel, this type of contamination could defeat the very purpose of gas to liquid conversion. Further studies are necessary to investigate the effect of GTL contamination from the pipe-wall residue.

After studying the operational issues, it will be necessary to re-visit the economics of GTL transportation. For example, the economics of batching mode could potentially include an additional cost of purifying contaminated GTL products. The blending mode, on the other hand, may make it feasible to have a cheap GTL plant producing low grade GTL, thus reducing capital expenditure.