

AK LEGISLATURE SPECIAL COMMITTEE FILES SCOMM 155 33082

## 6.0 Recommendations

There are many options and combinations of options that may have potential for Alaska with the development of ANGP and a spur pipeline. The relative merits of the options are complex and the long-term price forecasts for natural gas and oil and petroleum products on the world market always have a significant degree of uncertainty. Potential industries could be assessed on more detailed levels, with probabilistic analyses that account for cost and market risk to help provide additional insight into the complex interactions of options and economic benefits. Ultimately, these detailed analyses will likely be performed by serious investors. However, some over-reaching concepts are applicable to multiple industries and their integration, and thus may be best studied at an integrated level. Recommended integrated studies, include the following:

- A large-capacity spur pipeline will impact the design and operation of ANGP and could have significant economic impacts on that project. These issues were not analyzed in this study and could be more fully understood by running sensitivities to determine the impact of different-capacity spur pipelines on the value of ANGP.
- The uncertainties surrounding the completion of ANGP and consequently the spur pipeline are well understood. Alternative supply options exist, such as a smaller capacity bullet line from the ANS to Central Alaska. A comparative assessment of the alternative supply options would determine the costs and benefits of each supply option and help identify the optimal strategy for meeting natural gas demand.
- The potential location of various industries at North Slope or Central Alaska (e.g., GTL or petrochemical) may affect the desirability of further industry development in South Central. If industrial development at North Slope or Central Alaska is pursued further, the effects of industries located closer to the wellhead on state-wide industrial development may warrant further assessment.
- The results of this study suggest that the state of Alaska should explore the level of industry interest in investing in Alaska.

## Appendix A: Gas Composition of a Dense Phase, Wet Spur Line

The spur line will provide a means to deliver a portion of the stranded natural gas at Alaska North Slope to a market. While the primary component of this gas is methane, it also contains a significant amount of natural gas liquids (NGL), i.e., ethane, propane, butane, and pentane. The economics of sending the stranded Alaska North Slope natural gas to market may depend on the inclusion of NGL because these components have a higher value per volume than methane.<sup>3</sup> A non-traditional, high-pressure pipeline allows transport of NGL without development of a separate liquid phase in the line, avoiding the slug flows that occur when a low pressure line includes more NGL than found in dry gas. The pressure of a wet gas line is set based on the NGL composition.

The composition of natural gas components in a wet gas line can vary greatly depending on:

- **Gas source.** There are several different potential sources of natural gas at Alaska North Slope, each source has a different proportion of methane and NGL.
- **Volume of wet gas from which NGL are separated.** The recovered NGL are used to enrich the South Central Spur line.
- **Percent recovery of NGL.** This is determined by the separation technology used for enriching the Spur and used to remove NGL at the end of the Spur (i.e., Anchorage/Nikiski).

This update assesses each of the two gas compositions described in the Alaska Gasline Inducement Act (AGIA) Request for Applications (RFA), released in July, 2007. Separation efficiency assumptions are based on straddle separator plant efficiencies for recently designed plants in Canada, which have 95% separation efficiencies of ethane, and essentially 100% separation efficiencies of all other NGL. Based on recent designs, extraction of individual NGL from the liquid stream is assumed to be 100%.

The volume of gas from which NGL are separated is assumed to be the volume from which sufficient ethane would be removed to enrich the spur line with enough ethane to meet the demand of a world-class ethylene plant that uses ethane as a sole feedstock (i.e., 70,000 to 80,000 bpd ethane). The volume of raw gas that is transferred to the spur pipeline without processing by the straddle separator is assumed to be the volume that would allow the final spur line methane output to meet the projected dry gas demand for residential, commercial, and power sectors in addition to an industrial GTL complex. The propane and butane associated with the gas needed to meet the ethane and methane demand is the supply available for an LPG industry.

Calculations of spur pipeline composition are provided for both the "Rich" and "Lean" gas cases delineated in the AGIA RFA. Assumed demand includes South Central residential, commercial,

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<sup>3</sup> Michael Baker, Jr., Inc. 2005. Transport of North Slope Natural Gas to Tidewater. Submitted to the Alaska Natural Gas Development Authority (ANGDA), April, 2005.

and power sectors (a combined demand estimated to be 0.26 Bscfd), in addition to continued demand from the Agrium fertilizer plant, expansion of the ConocoPhillips LNG facility, and new development of GTL, petrochemicals, and LPG industries (a combined demand estimated to be 1.18 Bscfd).

Table A1 shows calculations of spur pipeline composition under the Lean Gas Case, in which 930 MMscfd is processed by a straddle plant separator with an ethane removal efficiency of 95%, and 100% removal efficiency of other NGL. Separated NGL are added as enrichment to a 1.4 Bcfd gas spur pipeline. This entire stream is processed by a second straddle separator in Anchorage/Kenai with efficiencies that are the same as those of the first straddle plant.

**Table D1: Lean Gas Case, Spur line gas composition and volume.<sup>1</sup> (Assumes ideal gas behavior at 60 F and 14 psia)**

| Raw Gas Component | Raw Gas* Mole % | 1st Straddle Input (930 MMscfd) |        | 1st Straddle NGL Output to Spur |        | Total Spur Input** |        | 2nd Straddle NGL Output |        |
|-------------------|-----------------|---------------------------------|--------|---------------------------------|--------|--------------------|--------|-------------------------|--------|
|                   |                 | MMscfd                          | bpd    | MMscfd                          | Bpd    | MMscfd             | bpd    | MMscfd                  | Bpd    |
| Methane           | 89.90           | 836                             | NA     | NA                              | NA     | 1,169              | NA     | 0                       | NA     |
| Ethane            | 5.80            | 54                              | 60,666 | 51                              | 32,150 | 127                | 79,457 | 120                     | 75,484 |
| Propane           | 1.70            | 16                              | 26,019 | 16                              | 10,038 | 38                 | 24,070 | 38                      | 24,070 |
| n-Butane          | 0.10            | 1                               | 2,254  | 1                               | 608    | 2                  | 1,459  | 2                       | 1,459  |
| i-Butane          | 0.20            | 3                               | 4,713  | 2                               | 1,387  | 4                  | 3,325  | 4                       | 3,325  |
| Pentanes          | 0.10            | 1                               | 3,189  | 1                               | 723    | 2                  | 1,733  | 2                       | 1,733  |

\* Raw gas mole % based on AGIA RFA, 2007.

\*\* Total spur pipeline input calculated as 1<sup>st</sup> straddle output plus 1.30 Bcfd gas directly from the main pipeline.

These spur line inputs and straddle plant efficiencies yield roughly 75,000 bpd ethane, meeting the needs of a world class ethylene plant. This line would also supply roughly 25,500 bpd of propane and butane for an LPG industry, and 1,700 bpd pentanes for sale to other users, i.e., for blending into gasoline.<sup>4</sup> In addition, the spur line would yield approximately 1.2 Bcfd dry gas to meet the dry gas demand of the South Alaskan residential, commercial, power and industrial sectors.

Table A2 shows calculation of spur pipeline composition under the Rich Gas Case scenario, in which 450 MMscfd is processed by a straddle plant separator with an ethane removal efficiency of 95%, and 100% removal efficiency of other NGL. Separated NGL are added as enrichment to a 1.4 Bcfd spur pipeline. This entire stream is processed by a second straddle separator in Anchorage/Kenai with efficiencies that are the same as those of the first straddle plant.

<sup>4</sup> Pentane is also referred to as "natural gasoline" because it is a major component of gasoline.

**Table A2: Rich Gas Case, Spur line gas composition and volume.<sup>1</sup> (Assumes ideal gas behavior at 60 F and 14 psia)**

| Raw Gas Component | Raw Gas* Mole % | 1st Straddle Input (450 MMscfd) |        | 1st Straddle Output to Spur |        | Total Spur Input** |        | 2nd Straddle NGL Output |        |
|-------------------|-----------------|---------------------------------|--------|-----------------------------|--------|--------------------|--------|-------------------------|--------|
|                   |                 | MMscfd                          | bpd    | MMscfd                      | Bpd    | MMscfd             | bpd    | MMscfd                  | Bpd    |
| Methane           | 86.40           | 389                             | NA     | 0                           | NA     | 1,175              | NA     | 0                       | NA     |
| Ethane            | 7.10            | 32                              | 20,046 | 30                          | 19,043 | 127                | 79,626 | 121                     | 75,645 |
| Propane           | 3.60            | 16                              | 10,286 | 16                          | 10,286 | 65                 | 41,373 | 65                      | 41,373 |
| n-Butane          | 0.30            | 1                               | 883    | 1                           | 883    | 5                  | 3,552  | 5                       | 3,552  |
| i-Butane          | 0.40            | 2                               | 1,342  | 2                           | 1,342  | 7                  | 5,397  | 7                       | 5,397  |
| Pentanes          | 0.10            | 0                               | 350    | 0                           | 350    | 2                  | 1,406  | 2                       | 1,406  |

\* Raw gas mole % based on AGAI RFA, 2007.

\*\* Total spur pipeline input calculated as 1<sup>st</sup> straddle output plus 1.36 Bcfd raw gas.

These spur line inputs and straddle plant efficiencies yield roughly 76,000 bpd ethane, meeting the needs of a world class ethylene plant. This line would also supply roughly 50,000 bpd of propane and butane for an LPG industry, and 1,400 bpd pentanes for sale to other users, i.e., for blending into gasoline.<sup>5</sup> In addition to the NGL streams, the spur line would yield approximately 1.2 Bcfd dry gas to meet the demand for the South Central Alaskan residential, commercial, power, and industrial sectors.

<sup>5</sup> Pentane is also referred to as "natural gasoline" because it is a major component of gasoline.

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by Richard Petersen &  
Peter Tijm



# ANRTL PRESENTS AN ALASKA NORTH SLOPE GAS TO LIQUIDS (GTL) OPTION

## “A LEGACY DECISION for ALASKA”

PREPARED FOR LEGISLATIVE BUDGET & AUDIT COMMITTEE



THE COMPETITION AGIA PROMISED BUT DID NOT DELIVER

June 20, 2008

GTL - Gas to Liquids  
CTL - Coal to Liquids



## AGIA Response to GTLs

- Gas-to-Liquids (GTL) is a promising technology.
- However, various market, cost, and technological issues (as demonstrated in the Cook Inlet pilot project) make the future of GTL technology uncertain.
- Further evaluation will be needed as this technology advances.
- It is important to recognize that the AGIA process was designed as commercial vehicle for getting Alaska gas from the North Slope to market.

**PETER J. A. TIJM**

848 Golden Point Drive  
Golden, CO, 80401  
E-mail: Tijmp@aol.com

Residence: (303) 526-2869/0953  
Mobile: (303) 478-1694

**SUMMARY PROFILE**

Thirty years of diversified experience in technological and commercial management. Solid leadership, strong expertise in analysis, development and commercialization of synthesis gas conversion, Liquefied Natural Gas technology and commercialization, new design concepts, refinery technology, operations, scheduling, start-up, budgeting and project management. Proven success in building and managing highly motivated professional teams. Excellent communication skills and fluent in 7 languages: Dutch, English, German, French, Swedish, Norwegian and Danish. Understanding of Spanish. Author of over 70 articles and inventor/holder of 11 patent series.

**PROFESSIONAL EXPERIENCE****VICE PRESIDENT – CHIEF TECHNOLOGY OFFICER- 2002-present****PV Enterprises, Inc., Golden, CO**

- Director/Consultant in energy R&D and project development of multi client program.
- Successfully started multi million dollar R&D program and pilot plant facilities.

**DIRECTOR FOR PROJECT DEVELOPMENT****2000-2002****Rentech, Inc., Denver, CO**

- Manage project development, research and product quality aspects for the proprietary Rentech Fischer Tropsch technology.

**MANAGER MARKETING/RESEARCH SYNGAS CONVERSION SYSTEMS 1996-2000****Air Products and Chemicals, Inc. - Allentown, USA**

- Manage Air Products and Chemicals' research and development syngas technology programs, in particular Liquid Phase technology.
- Commercialize Air Products and Chemicals' proprietary Liquid Phase Methanol™ Technology.
- Program manager for the Air Products/Industry/University research and development Programs sponsored by the US Department Of Energy.

**MANAGER OF MARKETING AND RESEARCH 1992-1996****Shell International Petroleum Company, Ltd. - London, United Kingdom**

- Manage Shell International Gas' research and development programs in LNG production and storage, pipeline gas and gas conversion within Shell's Manufacturing Service Company and five laboratories. Annual Budget of U.S. \$10 Million.
- Conduct marketing, gas commercialization and power generation studies for Brunei, Malaysia, China Japan and Nigeria. Promote Shell's US\$850 Million gas conversion project (SMDS).
- Advise in contractual matters in LNG sales between Brunei to Japan and Nigeria to Turkey.
- Launched cost reduction studies in all elements of the LNG production chain, in gas conversion and in pipeline gas; results implemented obtained 15% improvements.
- Maintain and evaluate Shell's patent portfolio in gas conversion technology.
- Author and presenter of papers on Shell technology in gas conversion, LNG technology and cost reduction in world-wide conferences and professional training courses.

**GROUP LEADER COAL GASIFICATION****1990 - 1992****Shell Internationale Petroleum Maatschappij B.V. - The Hague, The Netherlands**

- Directed a 7 person team responsible for up scaling coal gasification technology intended for application in larger size, commercially available gas turbines.
- Initiated Shell/GE/Air Liquide studies into new coal gasification/power generation concepts leading to the successful development of a 450 MWe IGCC power station proposed for Japan.
- Co-ordinated the coal gasification R&D between Shell The Hague, Deutsche Shell, Shell Oil Company and Shell's research laboratories in Amsterdam (KSLA) and Houston, Texas, USA.
- Regular presenter of Coal Gasification technology at international conferences.

**PROGRAM MANAGER SHELL COAL GASIFICATION****1989-1990****Shell Oil Company - Houston, Texas, USA**

- Assisted in commercialisation of Shell Coal Gasification Technology through introduction of presentations to and communication with potential customers.
- Created, implemented and completed a R&D program at Shell's Coal Gasification Demonstration Plant which obtained all design information for the first commercial Shell Coal gasification plant now operational in The Netherlands. Span of control: ~100 people, budget US\$ 25 Million/year.
- Scheduled and agreed with the plant manager the runs on experimental conditions and coal types.
- Member of the EPRI/Shell Advisory Committee for coal gasification.

**SECTION HEAD GASIFICATION AND HYDROCARBON SYNTHESIS****1987-1989****Koninklijke/Shell Laboratorium (KSLA) - Amsterdam, The Netherlands**

- Headed an R&D section tasked to develop the synthesis gas manufacture, coal gasification and hydrocarbon synthesis processes. Work force: ~ 40 people, annual budget of US\$15 Million.
- Established design parameters for new development in the Shell Middle Distillate Synthesis (SMDS) and coal gasification processes, currently operating in Malaysia and The Netherlands, respectively.
- Completed projects successfully through strong interface with the process development and engineering sections in Shell's Oil and Chemical Manufacturing Divisions plus the Catalyst Business.
- Active in recruitment and training of PhD's for Shell.

**REFINERY TECHNOLOGY MANAGER****1984 - 1987****Shell Raffinaderi Aktiebolag - Gothenburg, Sweden**

- Supervised refinery technology, product quality laboratory, refinery inspection and construction services departments. Annual budget of US \$60Million and a work force of 50 people.
- Successfully completed projects under tight schedules, including conversion of the refinery instrumentation system, refinery effluent treatment plants and improvements of the tank farm by installing internal floating roofs and radar level gauges. A very intriguing project was to construct a 80,000 m<sup>3</sup> cavern, next to an existing LPG cavern, under the fully operational refinery.
- Member of the refinery management team especially charged with environmental affairs, refinery concession, permits and external relations.

- Negotiated new contracts for district heat delivery from the refinery to Gothenburg Energy Works.

#### **SENIOR REFINERY TECHNOLOGIST – Shell, Gothenburg, Sweden 1981-1984**

- Co-ordinated various projects including Total Isomerisation Process, Residue Vacuum Flasher, Steam Boiler and refinery Low Temperature Heat Recovery.
- Performed refinery efficiency studies and long term master planning for the refinery.
- Guided junior technologists, trained new technologists and recruited Swedish engineers for SIPM.

#### **ASSISTANT PLANT SUPERVISOR/OPERATIONS TECHNOLOGIST 1978-1981**

##### **Raffinaderie de Cressier S.A. – Shell, Cressier, Switzerland**

- Analysed and recommended measures to improve the refinery availability.
- Implemented various improvements successfully which eliminated problems and/or reduced back-on stream time significantly.
- Handled shift supervision for the total refinery operations, product storage, rail and road car loading as a member of the "Refinery Management Team".
- Implemented and commissioned refinery projects such as the Total Isomerisation Process, Residue Vacuum Flasher and heat-integration.

#### **TECHNOLOGIST – Shell, Cressier, Switzerland 1977-1978**

- Conducted energy efficiency improvement studies for the refinery.
- Supervised optimum operation and technological aspects of refinery acid gas treating, hydro-treating, platforming processes and refinery environmental performance.
- Advised on catalyst replacement and supervised successful regeneration of the catalysts of hydro-treater, hydrodesulphurizers and platformer.

#### **DEVELOPMENT ENGINEER 1974-1977**

##### **Shell Internationale Petroleum Maatschappij B.V. - The Hague, Netherlands**

- Advising engineer to Shell's refineries in design/operation of hydro processes and catalytic reforming.
- Designed and developed gas treating processes including acid gas and mercaptans removal, molecular sieve/glycol drying and chloride removal.
- Participated in design teams of the North Scotland gas project and North West Shelf LNG project.
- Commissioned and debottlenecked treating processes in Germany, Pakistan and Venezuela.

#### **TRAINING/MILITARY SERVICE 1973-1974**

##### **Shell Internationale Petroleum Maatschappij B.V. - The Hague, Netherlands**

- Served as lieutenant in the Dutch Army charged with supervision of and advise on nuclear, biological, and chemical (NBC) material handling.
- Lectured in NBC matters at the Royal Military Academy of Breda and co-ordinated NBC research.

#### **EDUCATION**

Master of Science, Chemical Engineering, Delft Technical University (1973);

Bachelor of Science, General Economy, Erasmus University, Rotterdam (1974);

Chairman of Energy Frontiers International, 1996-1998

Author of over 70 articles and inventor/ holder of 10 patent series.

**PETER J.A. TIJM -- PUBLICATIONS**

- Tijm P.J.A.**, "Gas to Liquids, Fischer-Tropsch Catalysis, Reactors, Products and Process - The Twentieth Century And Beyond", 2005, available on website under [www.booklanddirect.com](http://www.booklanddirect.com)
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- Rogers D.V. and Tijm P.J.A.**, "Upgrading and Characterization of Rentech Iron Based Fischer-Tropsch Products", presentation at the AIChE 2002 Spring National Meeting, New Orleans, LA, March 10-14, 2002.
- Tijm P.J.A.**, "Analysing the commercial viability of GTL technology", presentation at the IBC Gas-to-Liquids Conference, London, UK, February 27-28, 2002.
- Tijm P.J.A., Waller F.J. and Brown D.M.**, "Methanol technology developments for the new millenium" contribution in Applied Catalysis A: General 5776 (2001) 1-8, Elsevier.
- Tijm P.J.A.**, 'Assessment of Different Feedstocks for Synthesis Gas Production and Fischer-Tropsch (F-T) Conversion', presentation given at the IBC Gas-To-Liquids, Viability, Economics and Strategy Conference, Houston, TX, October 29-31, 2001
- Chapman E.M., Boehman A.L., Tijm P.J.A., and Waller F.J.**, 'Emission Characteristics of a Navistar 7.3L Turbodiesel Fueled with Blends of Di-Methyl Ether and Diesel Fuel' paper presented at the Fall 2001 SAE Fuels and Lubricants Meeting, San Antonio, TX, September 24-27, 2001.
- Tijm P.J.A.**, 'The Viability of Gas-To-Liquids in The Middle East', presentation given at the 2<sup>nd</sup> Annual Middle East Oil and Gas Conference, Houston, TX, June 28-29, 2001.
- Hess H.S., Szybist, J., Boehman A.L., Tijm P.J.A., and Waller F.J.**, 'Impact of Oxygenated Fuel on Diesel Engine Performance and Emissions' paper presented at the 35<sup>th</sup> National Heat Transfer Conference, Anaheim, CA, June 10-12, 2001.
- Tijm P.J.A.**, 'Comparing Gas To Liquids Technologies: A Market For Everyone?', paper given at the CatCom2001 Conference, Houston, TX, May 14-15, 2001.
- Peng X.D., Toseland B.A., and Tijm P.J.A.**, 'Development and Status of the Liquid Phase Di-Methyl Ether Process (LPDME<sup>TM</sup>)', paper presented at the 6<sup>th</sup> Natural Gas Conversion Symposium, Girdwood, Alaska, June 17-22, 2001.
- E. C. Heydorn, P. J. A. Tijm, B. L. Bhatt, B.T. Smith and R. M. Kornosky**, Liquid phase methanol (LPMEOH) process Development, Energy 2000 Proceedings-US ISBN:1587160161
- Bond, R.E., Loth J.L., Guiler R.W., Clark, N.N., Heydorn E.C., and Tijm P.J.A.**, 'Lubricity Problems and Solutions for a Methanol Fueled Gas Turbine' paper presented at the IMECE conference, Orlando, FL, November 5-10, 2000.
- Tijm P.J.A.**, 'Status of the Sand Creek Fisher-Tropsch Fuels Conversion Project', paper given at the Energy Frontiers International Conference, San Francisco, CA, October 11-13, 2000
- Chapman E.M., Bhide S.V., Boehman A.L., Tijm P.J.A., and Waller F.J.**, 'Emission Characteristics of a Navistar 7.3L Turbodiesel fueled with blends of oxygenates and diesel' paper presented at the Fall 2000 SAE Fuels and Lubricants Meeting, Baltimore, MD, October, 2000.

## PETER J.A. TIJM

- Hess H.S., Boehman A.L., Tijm P.J.A., and Waller F.J.,** 'Experimental Studies of the Impact of CETANER™ on Diesel Combustion and Emissions' paper presented at the Fall 2000 SAE Fuels and Lubricants Meeting, Baltimore, MD, October, 2000,. SAE Technical paper series, 2000-01-2886.
- Peng X.D., Toseland B.A., and Tijm P.J.A.,** 'Qualitative Analysis of the Syngas-To-DME Reaction System.' Paper presented at the 3<sup>rd</sup> China/USA Joint Chemical Engineering Conference, Beijing, China, Sept. 25-28, 2000.
- Hess H.S., Szybist, J., Boehman A.L., Tijm P.J.A., and Waller F.J.,** 'The Use of CETANER™ for the Reduction of Particulate Matter Emissions in a Turbocharged Direct Injection Medium-Duty Diesel Engine' paper presented at the Seventeenth Annual International Pittsburgh Coal Conference, Pittsburgh, PA, September 11-15, 2000.
- Heydorn E.C., Tijm P.J.A., Bhatt B.L., Smith B.T. and Kornosky R.M.,** 'Liquid Phase Methanol (LPMEOH™) Process Development' paper presented at the GlobeEx 2000 - The Global Energy Exposition, Las Vegas, NV, July 23-28, 2000.
- Moore R.B. and Tijm P.J.A.,** 'Liquid Phase Reactor Technology', Workshop on Polygeneration Strategies Based on Oxygen-Blown Gasification, Beijing, China, May 11-12, 2000.
- Frye, C. A., A. L. Boehman and P. J. A. Tijm.** A Comparison of CO and NO Emissions from Propane, *n*-Butane, and Dimethyl Ether Premixed Flames. *Energy & Fuels*, 13, 650-654 (1999).
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- Tijm P.J.A., et al** 'Particulate Matter Emissions Reduction with CETANER™ as a Blend Component for Diesel Fuels with Low Cetane Levels' paper presented at the Windsor Workshop in Toronto, Canada, November, 1999.
- Tijm P.J.A., Armor J.N., Dyer P.N., Waller F.J. and Brown D.M.,** "An overview of Air Products' New Technology Programs in Syngas Generation and Conversion" paper presented at the EFI Gas Conversion Conference in San Francisco, CA, October 20-22, 1999.
- Tijm P.J.A., Heydorn E.C., Diamond B.W., Street B.T., and Kornosky R.M.,** 'Liquid Phase Methanol (LPMEOH™) Project: Operating Experience Update' paper presented at the 1999 Gasification Technologies Conference in San Francisco, CA, October 17 - 20, 1999.
- Bhatt B.L., Heydorn E.C., Tijm P.J.A., and Kornosky R.M.,** 'Direct Applications of Stabilized Methanol from the Liquid Phase Methanol (LPMEOH™) Process' presented at the 16<sup>th</sup> Annual International Pittsburgh Coal Conference in Pittsburgh, PA, October 11-15, 1999.
- Hess, H. S., J. A. Chiodo, A. L. Boehman, P.J.A. Tijm and F.J. Waller.** The Use of CETANER™ for the Reduction of Particulate Matter Emissions in a Turbocharged Direct Injection (TDI) Diesel Engine. Sixteenth Annual International Pittsburgh Coal Conference, Pittsburgh, PA, October 11-15, 1999.
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## PETER J.A. TIJM

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**Peng X.D., Toseland B.A., and Tijm P.J.A.**, 'Kinetic Understanding of Chemical Synergy in LPDME™ Process' paper presented at the 15<sup>th</sup> ISCRE in Newport Beach, CA, September 13-16, 1998.

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**Hess, H. S., M. A. Roan, S. Bhalla, S. Butnark, V. Zarnescu, A. L. Boehman, P.J.A. Tijm, F. J. Waller.** Reduction of Particulate Emissions from a Single-Cylinder IDI Engine with Oxygenated Diesel Fuels. In ACS Preprints, Division of Petroleum Chemistry, 43(4), pp. 593-596 (1998).

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**Tijm P.J.A.**, 'Overview of CETANER™ For Diesel Fuel and AET Study of CETANER™ Blended With Low Cetane Diesel Fuel' paper presented at the Windsor Workshop in Toronto, Canada on June 8-10, 1998.

**RICHARD J PETERSON**

310 K Street, Suite 200  
Anchorage, Alaska 99501  
E-mail: [rpeterson@angtl.com](mailto:rpeterson@angtl.com)

Office: (907) 264-6709  
AK Mobile: (907) 360-0909  
CA Mobile: (310) 480-0909

**AREAS OF QUALIFICATION**

Mr. Peterson has spent the last 30 years in the energy business as a CTL/BTL/GTL project developer, an engineer/marketer, including 4 years as a consultant and has worked on projects as diverse as a coal gasification plant using Sasol/Lurgi technology in North Dakota; establishing a market presence in the US and Canada for new gas ventures; developing power generation projects in the US and Central America; and developing GTL, electric power plants, iron ore reduction plants and pipeline distribution systems for commercial gas markets in South Africa.

Mr. Peterson is currently the President of Alaska Natural Gas to Liquids Company in Anchorage, Alaska; a company he formed late 1996 to pursue gas to liquids (GTL), and President of Alaska Natural Resources To Liquids a LLC formed in 2005, to pursue coal to liquids (CTL) and bio-mass to liquids (BTL) opportunities to produce Fischer-Tropsch diesel (FTD) in Alaska. ANGTL/ANRTL evaluate specific project locations, financing options and fuel supply, and then evaluate the best available technology for that specific location. The North Slope GTL project that ANGTL proposed 6 years ago using Sasol GTL technology still remains one of the best options to develop the stranded North Slope gas reserves.

ANRTL is in the early engineering phases for three separate CTL and BTL projects in Alaska using Sasol's, Shell's and CHOREN's gasification technology to produce the syn gas for the F-T diesel process. The first project will use bio-mass, dead or dying spruce trees as a feed stock while the second will be a bio-mass/coal gasification/combined cycle electric generation facility located on the western shores of the Cook Inlet. The third project will site a 500 bbl/d BTL plant on the Yukon River.

**EMPLOYMENT HISTORY**

- President Alaska Natural Gas To Liquids Company, Anchorage, AK, 1997 to present
- Senior Consultant, Hagler Bailly Consulting, Inc., Houston, TX, 1997
- Consultant/Vice President of Business Development, McAlister Enterprises, New Braunfels, TX, 1995-1997
- Manager of Supply, Southern California Gas Company, Los Angeles, CA, 1993-1995
- Proprietor, Peterson & Associates, Woodlands, TX, 1991-1993
- Vice President of Marketing, North Canadian Marketing, Ltd., Houston, TX, Orange, CA, Calgary, Alberta, 1991
- Vice President of Marketing, Enserch Gas Company, Houston and Dallas, TX, 1989-1991
- Manager of Marketing, Anadarko Petroleum, Houston, TX, 1981-1989
- Various Supply and Engineering Positions, Natural Gas Pipe Line Company of America, Chicago, IL and Houston, TX, 1975-1981

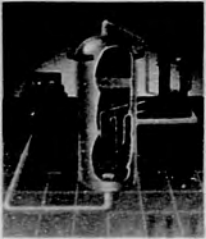
**EDUCATION**

- The University of North Dakota, MS, Mechanical Engineering, 1975
- The University of North Dakota, BS, Mechanical Engineering, 1974



## AGIA Response to GTLs

- Alaska Gasline Inducement Act does not dictate market destinations or the use of particular technologies, but allows for these issues to be decided by the market.
- Does anyone see the irony in this statement?  
“The Alaska GASLINE Inducement Act does not dictate the use of a particular technology”.
- Then why not call it the Alaska Gas Development Inducement Act.



## The main points we will make:

- It is important for the Legislature to know that there are other options for monetizing North Slope gas than with a gas pipeline, and that GTLs may well result in:
  - a much higher wellhead value for gas than a pipeline,
  - more long term jobs for Alaskans and
  - a larger tax base in Alaska.
- A GTL plant would most likely be built in stages, which has several important advantages.
- From the standpoint of Alaska employment and economic development the construction would be spread over a minimum of 14 years.



## The main points we will make:

- The plant would require a substantial construction workforce. Although not as large as that needed for a gas pipeline, the construction workforce would be employed in Alaska for many more years.
- The GTL plant operations workforce would be much more substantial than that for a gas pipeline.



## The main points we will make:

- All of the liquids remain in Alaska for marketing.
- Natural gas liquids can be transported through the TAPS pipeline along with GTL products.
- While a GTL project could use 2, 3, 4, 5, 6 billion cubic feet of gas/day or more if desired, the plant can be sized to use less gas, leaving gas production that could be transported south through a smaller “bullet” pipeline.



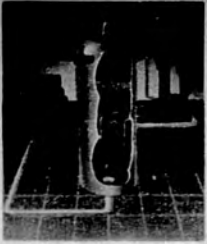
## The main points we will make:

- If you are going to tax the Producers natural gas at a quasi crude oil price equivalent the Producers might as well convert their natural gas to a liquid product and actually receive a premium price above crude oil.
- We believe the GTL option gives Alaska high value transportation fuels badly needed in the U.S. along with economic benefits and flexibility not offered with a just gas pipeline.



# Abbreviations

- GTL - Gas to Liquids
- CTL – Coal to Liquids
- BTL – Biomass to Liquids
- F-T – Fischer-Tropsch
- NGLs - Natural gas liquids ( $C_3 +$ )
- LNG – Liquefied Natural Gas
- CNG – Compressed Natural Gas



# Abbreviations

- KW – 1,000 watts of electric power
- KW-HR – 1,000 watts for 1 hour
- Heat Rate - Btu's needed per kilowatt hour of power produced  
(example 8,500 btu's will produce 1,000 watts of electricity for 1 hour)
- Vapor Pressure – pressure a product exerts at a specific temperature
  - Butane ( $C_4H_{10}$ ) has a vapor pressure of 47 psig at 110°F
  - Propane ( $C_3H_8$ ) has a vapor pressure of 204 psig at 110°F
  - Ethane ( $C_2H_6$ ) has a vapor pressure of 850 psig at 110°F



# Abbreviations

- 1 cubic foot of natural gas has 1,000 Btus
- 1 MCF of natural gas has 1 million Btus
- 1 Barrel of Crude Oil has ~ 6 million Btus
- Crude Oil Price Equivalent
  - Multiply the value of 1 MCF of gas by 6 or
  - Divide the value of 1 barrel of crude oil by 6
- 1 Barrel of F-T products has ~ 5.3 million Btus
- F-T Price Equivalent
  - Multiply the value of 1 MCF of gas by 5.3 or
  - Divide the value of 1 barrel of F-T by 5.3



# **CONVERTING NORTH SLOPE NATURAL GAS RESERVES INTO**

**"PROVEN"**

**F-T TRANSPORTATION FUELS  
&  
PETROCHEMICAL FEED STOCKS  
WHILE SEQUESTERING CO<sub>2</sub>**

**"GREEN AS IT CAN BE"**



---

# **A GTL/CTL PLANT PRODUCES FISCHER-TROPSCH (F-T) TRANSPORT FUELS**

**SOME OF THE CLEANEST FUELS IN THE WORLD**

**BUT WHAT IS THE F-T PROCESS?**



# The Fischer-Tropsch Synthesis



Okay, don't let the  
chemistry scare you!

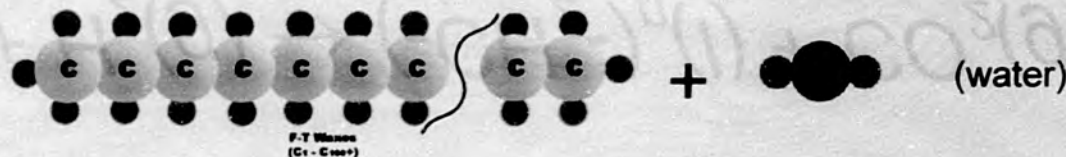
Let's take a look.....



## Three Steps in GTL/CTL/BTL Refining to make F-T Fuels

GTL/CTL/BTL Processes use 3 distinct steps, all commercially proven to convert a gas, liquid or solid into synthetic transport fuels:

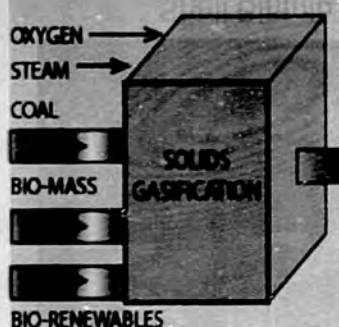
- Step 1 - Syn-Gas generation ( $H_2$  & CO)  + 
- Step 2 - The F-T reaction (long paraffin chains  $\rightarrow$  wax)



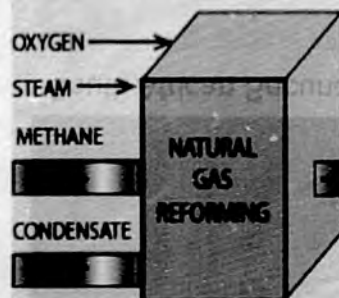
- Step 3 - Product upgrading (hydrocracking of the long chain F-T paraffin to produce the desired end product – similar to a crude oil refinery)

|                                  |                                  |                                 |                                  |                                 |
|----------------------------------|----------------------------------|---------------------------------|----------------------------------|---------------------------------|
| Kerosene                         | – Diesel                         | – Gasoline                      | – Jet Fuel                       | – Naphtha                       |
| C <sub>10</sub> -C <sub>13</sub> | C <sub>14</sub> -C <sub>20</sub> | C <sub>5</sub> -C <sub>10</sub> | C <sub>10</sub> -C <sub>13</sub> | C <sub>4</sub> -C <sub>10</sub> |

Note: Although the Sasol F-T reactor is illustrated here, the Shell F-T technology (SMDS) is also commercially proven



#### STEP 1 - SYN GAS GENERATION



#### STEP 2 - F-T CONVERSION

The Fischer-Tropsch Process (F-T) has three main processing steps shown here, all of which are commercially proven.

STEP 1, SynGas Generation represents - 50+% of the total cost  
STEP 2, F-T Conversion - 25% of the total cost  
STEP 3, Product Upgrading - 15% to 25% of the total cost

The type of SynGas Generation, gas reformation or gasification of solids, depends upon the raw material or feed stock available. Around the world stranded Natural Gas is the choice; however, in the US with the exception of North Slope Natural Gas, coal, bio-mass (garbage), bio-renewables (trees and plants) represent the majority of available feedstock for a US based F-T program!

## F-T FUELS THE ONE FUEL FOR OUR FUTURE

The first step converts natural gas, coal or bio-mass into synthesis gas, a mixture of carbon monoxide (CO) and hydrogen (H<sub>2</sub>) - syngas.



This mature process technology has been used in many commercial facilities as the first step for producing ammonia, hydrogen, methanol.

Sasol and Shell, the recognized world leaders in F-T technology use both gas reformation and coal gasification to produce syngas for its F-T production, called Gas-to-Liquids (GTL) and Coal-to-Liquids (CTL) respectively

methane, alcohols and diesel

WAXY HYDROCARBON PRODUCTS - C<sub>3</sub> +

CHOREN, a German company has been operating a bio-mass gasifier to produce syngas for methanol and electric production since 1998. This plant is considered the world's first bio-renewable energy gasifier and has the distinction of producing fuels and electricity with a net zero impact on the world's CO<sub>2</sub> and called Biomass-to-Liquids (BTL)

Step two, the Fischer-Tropsch conversion, discovered by the Germans in the 1920's, upgrades the syngas into a waxy hydrocarbon. Simplified this reaction is:

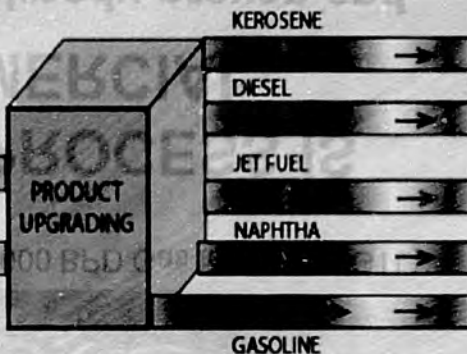


The length of the hydrocarbon chain (x) is determined by the composition (or ratio of H<sub>2</sub> to CO) of the syngas, the catalyst selectivity and the reaction conditions.

Sasol has pioneered several types of F-T conversion technologies to produce over 150 different products from their F-T plants in South Africa alone. The hydrocarbon stream (xCH<sub>2</sub>) is sent to product workup and the water (H<sub>2</sub>O) is sent to the water recovery unit.

F-T FUELS - THE SENSIBLE SOLUTION FOR A NEW GENERATION OF ULTRA CLEAN ENVIRONMENTALLY FRIENDLY DIESEL FUELS

#### STEP 3 - HYDROCRACKING - PRODUCT WORKUP



The third step, Product Upgrading:

Upgrading can produce a wide range of commercial products from gasoline to diesel to candle wax. For a US based F-T program we would recommend middle distillate fuels: kerosene, diesel and naphtha.

This process makes use of standard hydrocracking and hydroisomerisation processes commonly found in the refinery world. As with the First Step of syngas production, suitable technology is widely available from several licensors around the world.

The F-T process produces sulfur free fuels that contain essentially no aromatics or ring chain hydrocarbons that are toxic and harmful to the environment. The CTL/GTL/BTL process does produce CO<sub>2</sub>, but it is in a pure stream and is easily contained for sale to third parties or can be sequestered for injection into underground wells.

F-T Fuels, clean fuels for our future that will reduce US dependence on foreign crude oil and products.



South African Secunda 150,000 BPD Coal to Liquids (CTL)



South African Mossgas 47,000 BPD Gas to Liquids (GTL)



Shell Bintulu 15,000 BPD Gas to Liquids (GTL)

## THE F-T PROCESS IS COMMERCIAL

**260,000 bbl/d already proven and  
operational in South Africa & Malaysia**

**500,000 bbl/d coming soon to Qatar**

**230,000+ bbl/d coming soon to China**

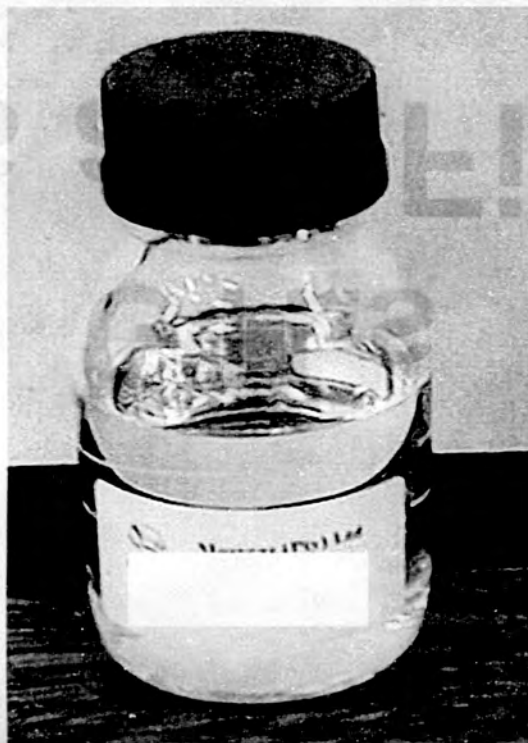
**China and India proposing 1+ million  
bbl/d in new CTL plants**



# SYNTHETIC DIESEL

**F-T DIESEL  
AS CLEAN AS CNG**

**U.S. EPA\*  
APPROVED  
NON-TOXIC**



**ZERO SULFUR  
ZERO AROMATICS  
>70 CETANE  
 $PM_{10} \leq CNG$**

\*EPA Water Docket, EB 57 located at 401 M Street SW Washington DC, 20460 Reference Docket No. W-98-26 in UNOCAL data file 4.A.a.3, Vol 13



# GTLs

## Facts and Fiction



# GTL FACTS and FICTION

- Majors not pursuing F-T technology
- F-T Process not Efficient
  - Value vs Efficiency
- Costs of F-T too high
- TAPS - Batching/Pigging can't be done
- American needs natural gas (market)
- Value of Alaska Natural Gas
  - Do the people know Alaska gas isn't going to be cheap?



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# WHERE ARE THE MAJORS ON GTLs?

1. In December 2003 ConocoPhillips and in July 2004 ExxonMobil both signed agreements to build 160,000 bbl/day and 150,000 bbl/day GTL plants in Qatar.

They would not have made these commitments if they did not believe in GTLs and possess the skills to build world-scale GTL plants.

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2. Shell, a new player in Alaska, has a 15,000 bbl/d GTL plant in Malaysia, is building a 140,000 bbl/d GTL plant in Qatar as well as designing a 70,000 bbl/d CTL plant in China.
3. Chevron, Sasol's world wide GTL partner, is building a 34,000 bbl/d GTL plant in Nigeria and had proposed a 130,000 bbl/d GTL expansion with Sasol and a new 120,000 bbl/d GTL plant both in Qatar.
4. Marathon completed a pre-FEED study for a 120,000 bbl/d GTL plant in Qatar in 2003.
5. BP and Statoil are working on barge mounted GTL plants.

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4. Marathon completed a pre-FEED study for a 120,000 bbl/d GTL plant in Qatar in 3rd quarter 2003.
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5. BP and Statoil are working on barge mounted GTL plants.

Clearly, the North Slope majors possess all the skills necessary to build GTL (F-T) plants worldwide including in Alaska.



# GTL FACTS and FICTION

- Majors not pursuing F-T technology (E-T)
- F-T Process not Efficient
  - Value vs Efficiency
- Costs of F-T too high
- TAPS - Batching/Pigging can't be done
- American needs natural gas (market)
- Value of Alaska Natural Gas
  - Do the people know Alaska gas isn't going to be cheap?





# PROCESS EFFICIENCY

Some say the GTL process is not efficient with only 65% of the energy contained in the natural gas reaching the end market in the form of transportation fuels.

Like any manufacturing process that “adds value” to its products, the transportation fuels resulting from a GTL plant have a higher value.

Also of importance is that the “lost” 35% really isn’t lost.

It is captured as waste heat and is used to generate electricity, heat buildings and run other processes that need heat, saving valuable natural gas for other purposes.

# **GTL vs LNG**

## **VALUE (\$) VS EFFICIENCY**

IS THE LNG PROCESS MORE EFFICIENT - WITH 80 % OF THE WELL HEAD ENERGY REACHING THE MARKET ?  
IS THE GTL PROCESS LESS EFFICIENT - WITH 65 % OF THE WELL HEAD ENERGY REACHING THE MARKET ?  
TECHNICALLY, LNG IS A MORE EFFICIENT PROCESS IF YOU JUST LOOK AT DELIVERED ENERGY TO THE MARKET  
IT IS HOWEVER TOTALLY FALSE IF YOU LOOK AT THE **VALUE (\$)** OF THE DELIVERED ENERGY IN THE MARKET

LNG BEGINS LIFE AS NATURAL GAS  AND ENDS LIFE AS NATURAL GAS 

GTL BEGINS LIFE AS NATURAL  AND ENDS LIFE AS A REFINED PRODUCT SUCH AS DIESEL 

WHILE BOTH ARE CARBON BASED, THEIR **VALUES (\$)** ARE TOTALLY DIFFERENT

AS AN EXAMPLE:

A LUMP OF COAL AND A DIAMOND ARE BOTH CARBON BASED. UNDER TREMENDOUS PRESSURE AND HEAT (A MANUFACTURING PROCESS), A LUMP OF COAL CAN BECOME A DIAMOND. WHICH HAS MORE VALUE, A LUMP OF COAL OR A DIAMOND? DOES IT MATTER THAT A DIAMOND IS A FRACTION OF THE SIZE OR WEIGHT OF THE ORIGINAL LUMP OF COAL?

IF GTL PRODUCED DIESEL IS MORE VALUABLE THAN LNG DERIVED NATURAL GAS SHOULD YOU CARE IF THE GTL PROCESS IS LESS EFFICIENT IN CONVERTING ENERGY SO LONG AS THE VALUE RECEIVED FOR THE ORIGINAL ENERGY IS GREATER.

**WHICH WOULD YOU PREFER ?**

**A LUMP OF COAL**



**OR A DIAMOND**



**LNG PRODUCED NATURAL GAS** 

**OR GTL PRODUCED DIESEL** 

**THE CHOICE SHOULD BE SIMPLE  
GO FOR THE HIGHER NETBACK VALUE (\$)**



# GTL FACTS and FICTION

- Majors not pursuing F-T technology
- F-T Process not Efficient
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## GTL PROJECT COSTS?

- 2003 estimate \$25,000/installed barrel
- 2007 actual cost \$32,000/installed barrel
- 2008 Shell Pearl GTL plant \$60,000/ installed barrel (under construction today)
- ANRTL completed a \$1.5 million Pre-Feasibility study for an 80,000 bbl/d CTL project for the Cook Inlet in February 2008. Cost estimates have risen from \$4.6 to \$12 billion from 2005-08.
- The CTL project still pencils out because product prices have risen even more.



# GTL PROJECT COSTS?

- Some of the estimated costs of this Cook Inlet CTL project were derived from the \$250 million Sasol/China engineering study completed in late 2007.
- North Slope GTL plant ~300% higher than the recently completed Sasol GTL plant in Qatar – we use a \$92,000/ installed barrel cost.
- If anything, we believe the projected costs of a North Slope GTL plant program are high.

# MINIMUM INFORMATION REQUIRED TO DEVELOP ESTIMATES

| ESTIMATE CLASS        | I                  | II                      | III                | IV                 |                                                                  |
|-----------------------|--------------------|-------------------------|--------------------|--------------------|------------------------------------------------------------------|
| ESTIMATE TYPE         | PRELIMINARY        | FEASIBILITY<br>BANKABLE | DEFINITIVE         | DETAILED           |                                                                  |
| ACCURACY RANGE        | +40%<br>To<br>-40% | +30%<br>To<br>-20%      | +15%<br>To<br>-15% | +10%<br>To<br>-10% | X = Info Required to Obtain Stated Accuracy Range                |
| PURPOSE               | Screen             | Study                   | AFE                | AFE                |                                                                  |
| GENERAL PROJECT SCOPE | X                  | X                       | X                  | X                  | Project Scope, Design Basis, and Execution Strategy              |
|                       | X                  | X                       | X                  | X                  | General Geographic location and Site Requirements                |
|                       | X                  | X                       | X                  | X                  | Special Considerations that Impact Project Costs                 |
|                       | X                  | X                       | X                  | X                  | Utilities and Other Infrastructure Requirements                  |
|                       |                    |                         | X                  | X                  | Detailed Project Schedule                                        |
| PROCESS               | X                  | X                       | X                  | X                  | Block Flow Diagrams w/Primary Flow Steams and Utilities          |
|                       |                    | X                       | X                  | X                  | Preliminary PFDs w/Heat & Material Balance                       |
|                       |                    | X                       | X                  | X                  | Engineered PFDs w/Heat & Material Balance, and Preliminary P&IDs |
|                       |                    |                         | X                  | X                  | Engineered P&IDs                                                 |



# GTL FACTS and FICTION

- Majors not pursuing F-T technology
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# BATCHING / PIGGING

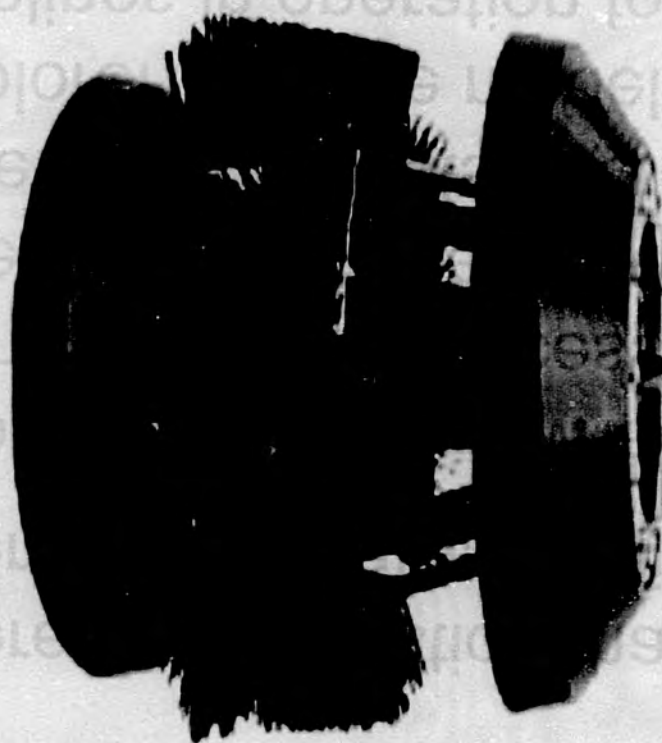
## Facts and Fiction

- Batching – Won't work - You can't pig in TAPS
- Batched products will be contaminated
- NGLs with high vapor pressure can't be moved in TAPS
- Ethane – what do you do with it?



# BATCHING / PIGGING

## ■ YOU CAN'T PIG IN TAPS



Typical cleaning Pig

## ■ THEY RUN PIGS IN TAPS TODAY



## BATCHING / PIGGING

- There is no question that the TAPS line can be operated as a dual/multi products/crude pipeline.
- Explorer Pipeline, owned by several major oil companies has successfully operated a 1,400-mile large diameter pipeline carrying a full slate of refined products and crude oil. In fact the Explorer Pipeline model is used in many pipelines in operation today.
- Explorer Pipeline has offered to bring their expertise to Alaska to assist with the design and conversion of TAPS.



# BATCHING / PIGGING

- Batching F-T products and NGLs (Products) without a physical separation between the Products and the ANS crude oil will not work. Further batching of the Products without a physical separation between individual products is not recommended.



## “THE PIG TRAIN”

- Physical Pigging will allow batch shipping of Products from the North Slope to Valdez.
- The outstanding question is how far can you batch/pig down the TAPS before you need to replace the pig due to wear?



## BATCHING / PIGGING

- TAPS line can remain viable for moving crude oil produced on the North Slope to Valdez for 50 to 100 or more years.
- GTLs will provide the minimum throughput volumes to keep the TAPS line flowing.
- Incremental GTLs and NGLs will help lower the TAPS tariff resulting in a higher netback price and a higher revenue stream to the State.



## BATCHING / PIGGING

- Once TAPS is modified to carry both crude oil and products, the currently recycled gas stream can be processed to extract additional NGLs for batching to Valdez.
- This allows for the receipt of this NGL revenue stream within a few years, certainly long before a GTL plant could be on line or a gas line to the lower 48 could be built.



## BATCHING / PIGGING

- It is our opinion that the market for North Slope NGLs will be considerably higher at Valdez than at ACEO in central Alberta if for no other reason than the tariff on TAPS is at least 1/3 of the cost to ship on the proposed AGIA gas line.
- TAPS tariff \$5/bbl (83.3¢/million btu)
- AGIA tariff \$3/million btu (\$18/bbl)
- AGIA tariff \$4/million btu (\$24/bbl)



# BATCHING / PIGGING

- The interior of Alaska operates on a liquid energy economy.
- Batching products down TAPS will provide Interior Alaska with the opportunity to receive lower cost fuels at new delivery points along the pipeline without having to replace their existing energy infrastructure.



## BATCHING / PIGGING

### **Batched products will be contaminated**

- One of the biggest advantages with a TAPS batching /pigging program is that butanes have been extracted from the gas stream and spiked into the crude oil stream since first flows.
- This same volume of butane will be placed in the front end of the pig train and used to clean the pipe walls of contaminants.



# BATCHING / PIGGING

## **Batched products will be contaminated**

- The “dirty” butanes will be blended with the ANS crude oil at Valdez.
- If any batched products behind the “cleaning” butanes are also contaminated, the batching program will provide for additional processing at Valdez to remove sulfurs and color.



## BATCHING / PIGGING

**NGLs with a high vapor pressure can't be transported in TAPS**

- The lightest products we would recommend for shipping on the TAPS would be propane  $C_3H_8$ . Propane has a vapor pressure of 207 psig at 110°F. This is far below the operating pressure of TAPS.
- Keep ethane in the natural gas as there is no petrochemical industry on the US West Coast. Ethane will be converted into F-T products.



# BATCHING / PIGGING

Batching / Pigging in TAPS could benefit the AGIA gas line if a gas line is the best option

- Modifying the TAPS line to batch crude oil and products will eliminate the need to transport liquids in the gas line.
- This will reduce the cost of the gas pipeline and make its operation easier, plus make delivery of in-state gas less complicated as you are not dealing with a dense phase gas.



# GTL FACTS and FICTION

- Majors not pursuing F-T technology
- F-T Process not Efficient
  - Value vs Efficiency
- Costs of F-T too high
- TAPS - Batching/Pigging
- America needs natural gas (market)
- Value of Alaska Natural Gas
  - Do the people know Alaska gas isn't going to be cheap?





# OIL & GAS NEEDS IN THE U.S.

- The need for imported (additional) natural gas in the U.S. pales in comparison to the need for reducing imported crude oil and adding refining capacity.
- Natural gas has historically sold at a discount to the value of crude oil. Today that disparity is wider.
- Diesel has historically sold at a price at or below regular gasoline. Today diesel sells at a premium to gasoline.
- F-T diesel has in addition to the higher value of crude oil, the value of the refining margin plus a lower tax rate resulting in a market price premium of between \$33 to \$55/bbl over the value of crude oil. (*\$6.2 to \$10.3 / mcf*)



## OIL & GAS NEEDS IN THE U.S.

- Virtually anyone we talk to has a different opinion on the volumes of natural gas, crude oil and refined transportation products produced, consumed or imported in the U.S. For the purposes of this report, we use information gathered from independent two sources.
- U.S. Energy Information Administration ([www.eia.doe.gov/](http://www.eia.doe.gov/)); and
- The BP Statistical Review of World Energy June 2007 ([www.bp.com/productlanding.do](http://www.bp.com/productlanding.do)).

*This latter document is an excellent summary of world energy and BP should be commended for providing this public service update each year.*



## OIL & GAS NEEDS IN THE U.S.

- If we look at the six month period from August 2007 through January 2008 (the latest EIA numbers) the U.S. on average produced slightly more than 5 million barrels per day of oil. (note: the EIA data does not include NGLs in the crude oil).
- During the same time period the U.S imported over 10 million barrels per day of crude oil and another 3 million barrels per day of refined products.
- The significance of the latter number is that the nation lacks over 3 million barrels per day of refining capacity to meet current U.S. transportation fuel demands.