ALASKA STATE LEGISLATURE
HOUSE RESOURCES STANDING COMMITTEE
March 2, 2007
1:04 p.m.

MEMBERS PRESENT

Representative Carl Gatto, Co-Chair
Representative Craig Johnson, Co-Chair
Representative Bob Roses
Representative Paul Seaton
Representative Peggy Wilson
Representative Bryce Edgmon
Representative David Guttenberg

MEMBERS ABSENT

Representative Vic Kohring
Representative Scott Kawasaki

OTHER LEGISLATORS PRESENT

Senator Charlie Huggins

COMMITTEE CALENDAR

PRESENTATION: GAS-TO-LIQUIDS (GTL)

- HEARD

PREVIOUS COMMITTEE ACTION

No previous action to record

WITNESS REGISTER

GODWIN A. CHUKWU, Ph.D., P.E.
Professor of Petroleum Engineering
Department of Petroleum Engineering
University of Alaska Fairbanks
Fairbanks, Alaska
POSITION STATEMENT: Provided a presentation of his findings regarding GTL technology.

PETER COOK
Sasol Chevron
London

POSITION STATEMENT: Provided a presentation regarding Sasol Chevron's use of GTL technology.

MICHAEL GRADASSI, Project Development Manager
BP Conversion Technology Centre
BP America, Inc.
Houston, Texas
POSITION STATEMENT: Provided statements regarding GTL technology.

ACTION NARRATIVE

CO-CHAIR CARL GATTO called the House Resources Standing Committee meeting to order at 1:04:13 PM. Representatives Gatto, Johnson, Roses, Seaton, Wilson, Edgmon, and Guttenberg were present at the call to order. Also in attendance was Senator Huggins.

PRESENTATION: GAS-TO-LIQUIDS (GTL)

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CO-CHAIR GATTO announced that the only order of business would be the presentation regarding gas-to-liquids (GTL). He then clarified that liquid natural gas is at minus 280 degrees or otherwise it boils away, while GTL is a liquid at room temperature.

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GODWIN A. CHUKWU, Ph.D., P.E., Professor of Petroleum Engineering, Department of Petroleum Engineering, University of Alaska Fairbanks (UAF), reviewed the work being done at UAF since 1997. The work has been performed in two phases, the first of which was to check the possible modes of transportation of GTL through the Trans-Alaska Pipeline System (TAPS). The aforementioned work was completed in 2001-2002 and funding was obtained to continue working on identifying the problems that would exist if GTL were transported through TAPS. The aforementioned work is complete and the final report is being developed.

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DR. CHUKWU directed attention to the PowerPoint titled, "Operational Issues in Gas-to-Liquid (GTL) Transportation through the Trans Alaska Pipeline System (TAPS)", specifically slide 4, titled "ANS Gas Resources". Dr. Chukwu pointed out that the proven and recoverable conventional natural gas reserves range from 37-40 trillion cubic feet (tcf), which illustrates that Alaska has tremendous amounts of recoverable natural gas reserves. Those reserves include Prudhoe Bay and Point Thomson, to name just a few. There are also possibilities of gas in the Arctic National Wildlife Refuge (ANWR), Alaska North Slope (ANS) gas hydrates, as well as coal-bed methane.

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DR. CHUKWU moved on to slide 5, which reviews ANS gas utilization options. The options are as follows: building a new gas pipeline, using gas as a miscible injectant for enhanced oil recovery, building a natural gas based petrochemical complex, burning natural gas to generate steam for potential thermal recovery options, and chemical conversion to GTL products and transport through TAPS. The later is the discussion for today. Dr. Chukwu continued with slide 6, which relates the problem. Dwindling oil production on the ANS has created some burdens on the transportation of crude on the throughput through TAPS. In the face of dwindling production, the question becomes how can TAPS continue to operate economically in the future. A further question is what can be done with such vast gas resources when the domestic gas market is far away from ANS, there's very small local demand, and limited natural gas use in enhanced oil recovery (EOR) and other operations. Dr. Chukwu, referring to slide 7, discussed a possible solution. He suggested that the vast natural gas resources on the ANS can be converted to GTL products using the Fischer-Tropsch process that dates back to World War II. The aforementioned GTL products can be used to fill TAPS with crude oil. Dr. Chukwu questioned whether it's possible to transport the GTL given the environmental and operational conditions.

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DR. CHUKWU turned to slide 8, titled "Gas-To-Liquid (GTL) Technology". He explained the three-step Fisher-Tropsch chemical process for converting natural gas to synthetic crude. The result is the direct production of diesel, naphtha, and kerosene. Slide 9 illustrates what GTL technology is all about. This project isn't geared toward the kinetics of GTL technology but rather reviews the transportability of GTL through the existing infrastructure provided by TAPS. Slide 10 illustrates how natural gas can be converted to a usable liquid. Slide 11 then illustrates how the GTL technology works. Oxygen, methane, and steam combine to form carbon monoxide and hydrogen. The type of catalyst used differentiates the type of product from GTL. In response to Co-Chair Gatto, Dr. Chukwu clarified that refined oxygen is necessary.

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DR. CHUKWU continued with slide 12, which points out that GTL technology has been a worldwide event because of the significant worldwide volumes of stranded gas reserves. Despite the high costs, everyone believes that this is technology that should be looked into. Furthermore, this technology produces environmentally friendly fuel. There have been advances in this technology that have significantly reduced capital costs. The reason this technology should be introduced in Alaska is because currently Alaska has no economic gas utilization option, he explained. All potential options must be investigated in order to continue the operation of TAPS, which requires a significant increase in throughput. The benefits of GTL products is that it's an attractive way to utilize ANS gas resources, a clean source of energy, and it makes use of the existing TAPS infrastructure. Ongoing work is occurring with regard to using GTL as a diluent in future diverse throughput of ANS heavy oils. These heavy oils produced on the North Slope need to be transported. Mixing them with GTL will reduce the pumpability of the GTL crude mixture.

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DR. CHUKWU moved on to slide 14, which reviews the features of TAPS. He highlighted that TAPS was designed for 2.2 million barrels per day (BPD) of throughput. However, TAPS is experiencing declining throughput with current throughput at less than 800,000 BPD. Therefore, continued operation of TAPS will require a significant increase in throughput. Slide 15 focuses on the transportation of GTL through TAPS. In doing so, one must consider the problems and challenges the introduction of GTL products will pose to the operation of TAPS. He said he anticipated the following problems: gel formation, vapor formation, altered pumping pressure requirements, and solids precipitation and deposition. The last problem is the major area of focus since it can lead to pipe failure.

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DR. CHUKWU pointed out that slides 16-17 review the proposed modes of GTL transportation through TAPS. Batch flow, also know as "slugging," is when alternate batches or slugs of crude oil and GTL are moved through TAPS. There is also commingled flow in which the GTL and crude oil are premixed and transported through the pipeline as a single phase fluid. He explained that there are three types of transportation modes: as-is batching, batching with pigs, and modern batching. As-is batching is a do-nothing case in that it's investment free. However, as-is batching will require manual operations to switch from one battery to another. He then explained that in batching with pigs, pigs are used as a spacer between the GTL crude stream. The modern batching is a situation in which probes are installed along the line that are tied to automatic control valves to divert fluid to the respective tanks. The aforementioned is referred to as the distributed control system.

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DR. CHUKWU focused on the as-is batch mode as discussed on slide 18. Under the as-is batch mode, batch slugs of GTL and crude oil let physics control slug movement in TAPS. The as-is batch mode requires the pipeline to be built from the GTL plant to the TAPS inlet. This will require extra storage facilities for products that are waiting to be batched. He noted that the as-is batch will require minimal additions to capital and labor. He then pointed out that this mode will experience increased levels of mixing between slugs, which will create an interfill zone. At this point, there isn't any systematic model that can specify the length of the interfill zone. Dr. Chukwu highlighted that although there is a model, it can't be verified unless a fueled test is run. He said that the interfill zone would, theoretically, run about 300-500 feet inland. The final length of the zone would depend upon the viscosity, velocity, and the density differences.

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DR. CHUKWU then drew the committee's attention to slide 19, regarding batching with pigs. He related that traditional batching with pigs physically separates the oil from the GTL. The number of pigs that have to be run depends upon the optimal size of the slugs. Large or very long slugs will require an increased amount of pigs. He noted that the pig sensors can detect product movement, which is an advantage because it can possibly determine the length of the interfill. The aforementioned knowledge is necessary for all modes of transportation for batching. Under this mode, the pigs must be transitioned between pump stations, which may be problematic between the slugs.

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CO-CHAIR GATTO opined that the aforementioned would be a significant issue if there is cavitation of the pumps.

DR. CHUKWU noted his agreement, and said he would address it when he discusses the cavitation.

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DR. CHUKWU moved on to slide 20, which discusses modern batching. Modern batching uses new technology for interface detection and tracking product movement. This batch mode has been tried by a company in Canada. Dr. Chukwu explained that until the flow loop is tested, he won't be able to confirm the practicality of this system. Once a flow loop is constructed and built, there will be a densitometer. A densitometer measures the specific gravity of the product in the pipeline, which can dictate the product densities along the pipeline. Again, it's necessary to know where to install these densitometers. Sound velocity interface detectors also need to be installed in order to detect changes in the sound velocity of the product, which allows monitoring of what is moving where in the pipeline. The colorimeter sensor detects the color changes of the pipeline product, which means that samples must be collected in between lines and then check the type of product that's on line. There is also the distributive control system that will be installed at the receiving end between the refinery and the tank farm. The aforementioned will optimize the control of the product movement and will help allocate the crude to the various tank batteries.

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REPRESENTATIVE WILSON asked if the modern batch mode would be cost effective.

DR. CHUKWU related that two graduate students are running the economic numbers, which indicate that [the modern batch mode] is very expensive comparatively.

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DR. CHUKWU pointed out that one advantage of the modern batch mode is that it helps to maintain the GTL purity. Again, the length of interface is a measure problem. The lesser the length of interface, the better for the batching mode. However, currently there isn't a model that can specify the interface lengths. Dr. Chukwu reiterated that this is complex technology, although it's effective.

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CO-CHAIR GATTO pointed out that although this technology is expensive, it results in a product that's very valuable.

DR. CHUKWU noted his agreement. The economics, he pointed out, depend upon the volume of throughput. With a test run of about 40,000 BPD of clean diesel one would have to determine whether the initial cost of the technique is justified. Therefore, [the economics] are being run at 25,000 BPD increments in order to determine how the volume of throughput impacts the cost.

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DR. CHUKWU, moving on to slide 21, highlighted the capital investments required if following the batching mode. There would have to be new holding tanks on the Slope and at the terminal. The tanks could be new or refurbished to meet the conditions for the new product. Other capital investments are the installation of distributive control systems and accessories at the inlet and outlet points in order to automatically empty in the storage tanks. Relief tanks at pump stations need to be installed. There also needs to be additional piping from the GTL facility to TAPS and pigs must be used as needed. Dr. Chukwu emphasized the need for a contingency plan in which capital is set aside to combat emergencies and ensure that there's no prolonged shutdown, particularly in the winter months.

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DR. CHUKWU continued with slide 22 regarding the commingled mode, which requires minimal capital and labor since the two products have to be premixed and then moved to TAPS. Low grade GTL can be produced at the North Slope and thus hydrocracking isn't necessary. The problem, he pointed out, is that the GTL purity is fully lost, although there is higher output of diesel and gasoline at the downstream end, after refining. Based on using available infrastructure in place, the decision was made to run more tests on the commingled mode. Therefore, the remainder of his presentation would speak to the commingled mode of transportation.

DR. CHUKWU, referring to slide 23, began to address why he chose the commingled mode. He related that in reviewing the commingled mode the following was reviewed:

> The expected loss of purity of the product mixture and a trade-off between loss in product value due to contamination and cost of keeping the product pure at the terminal.
>
> Flexibility of using existing infrastructure with minimal addition to capital cost for transportation.
>
> The commingled mode of transportation does not require additional facility because the present relief tanks system is capable of handling the crude oil-GTL blend product.

DR. CHUKWU mentioned that although the [U.S. Department of Energy (DOE)] sponsored this project, Alyeska Pipeline Service Company (Alyeska) supplied all of the crude oil for analysis and BP supplied the GTL for the analysis.

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DR. CHUKWU moved on to slide 24 regarding GTL transportation issues. He pointed out that TAPS is designed for a specific type of crude oil, which calls into question the GTL flow behavior through TAPS and the effect of cold temperatures on the crude oil-GTL blends during a cold restart of the pipeline. He opined that one must also need to review the phase behavior of the GTL products and any vapor pressure concerns. He mentioned that with cavitation, flashing is a possibility. Therefore, the conditions under which there is a single phase and a two phase pipeline must be determined. Another question to consider is in regard to the effects of solids precipitation. Discussions with Alyeska have led to the understanding that wax deposition is a major problem, and thus the wax deposition must be determined for crude oil-GTL.

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DR. CHUKWU continued by reviewing slide 25, titled, "Operational Challenges". He explained that knowing the type of fluid present will help determine what kind of force will be necessary to move that fluid. For example, a more gel-like fluid requires more force than a water-like fluid. The relationship between the force of movement and the velocity of flow determines the pumping horsepower requirements.

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DR. CHUKWU moved on to slide 26 which discusses the effect of gel strength. He related that a mixture of the crude oil-GTL in four different ratios were reviewed. The best cases were GTL and crude oil stand-alone. The crude oil utilized was from TAPS. After running some experiments to determine the butanol structure of the mixture, it was discovered that the fluid gel strengths generally don't pose a problem at normal pipeline temperatures. The experiment had to go with a subzero temperature to simulate a shutdown. With a higher ratio of GTL in the crude oil, it was found that the gelling ability was very much reduced even at temperatures of 20°F below zero. The potential for cold re-start problems after a prolonged winter shutdown of the pipeline increases as fluid gel strengths increase. Therefore, as the amount of GTL in the mixture increases, the gel strength is reduced. However, as the amount of GTL is decreased, the gel strength is increased. The aforementioned is problematic.

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DR. CHUKWU continued with slide 27 regarding the effect of density. The density of each of the samples was measured at different temperatures. The density values decrease with an increase in temperature, which is normal. Dr. Chukwu turned attention to the reference to Alaska GTL (AKGTL), which is the GTL we obtained from BP that was manufactured in Alaska. It was found that the addition of AKGTL caused a reduction in density because of the light end. He then turned to slide 28, which relates to the effects of rheology. Rheology, he explained, is the relationship of the force of movement to the velocity of flow. The aforementioned is used to classify the type of fluid that will flow in the pipeline under various conditions. It was discovered that AKGTL shows pseudoplastic behavior, which means that it's an elastic type of flow and thus will require less horsepower to flow within the temperature range of -4°F to 122°F. At temperatures of 68°F and above, crude oil shows Newtonian behavior while it's more like Bingham Plastic, ketchup, and difficult to pump at temperatures below 68°F. When AKGTL and crude oil were blended, they showed a more

Pseudoplastic behavior at higher temperatures while behaving more Newtonian behavior at room temperature and more like Bingham Plastic at freezing or below. The Bingham Plastic stage is problematic because it requires higher pumping power to restart the pipeline after a shutdown during low temperatures. Pipeline designers and mechanical engineers have to keep the aforementioned in mind.

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DR. CHUKWU moved on to slide 30 titled, "Effects of Vapor Pressure". He related that the vapor pressure increased with the addition of AKGTL, but not to a level of concern. As long as it's below the minimum TAPS operating pressure, it's a single-phase flow and thus only liquids are flowing and there's no cavitation. He expressed the need to be sure that the blends would flow through TAPS as compressed liquids from inception to discharge. Therefore, as the blends are transported vapor formation in the pipeline isn't possible. Dr. Chukwu related that under current TAPS operating conditions and for all blended ratios considered in the study, the fluid will always exist as a single phase liquid through out the pipeline conditions. The aforementioned is an important conclusion, he emphasized.

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DR. CHUKWU continued with slide 31 regarding the effects of solids deposit. He informed the committee that asphaltene flocculation and deposition is a potential major problem in the transportation of the blends through TAPS. He further informed the committee that he found that asphaltenes are stable in pure TAPS crude oil, and therefore the crude oil can retain asphaltene in solution in TAPS. However, when GTL was added, there was asphaltene precipitation, which is a major concern. This asphaltene flocculation occurred in a blend containing as little as 5.7 percent by volume of AKGTL. Therefore, dispersant would be necessary to treat the problem from the onset. If the deposition is left untreated, it might settle and then cause corrosion, especially along welded areas and joints.

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DR. CHUKWU, referring to slide 32, related the discovery that the gel strength isn't a significant factor of concern. Furthermore, the Bingham fluid flow characteristics indicated that a high pumping power would be required during prolonged shutdown situations.

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REPRESENTATIVE WILSON asked if the pipe can withstand the high pumping power required after a long shutdown under cold temperatures.

DR. CHUKWU clarified that the pipe can withstand the high horsepower requirement, it's just that high horsepower pumps are necessary. He noted that those pumps are a higher cost.

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CO-CHAIR JOHNSON asked if this could be done on a seasonal basis.

DR. CHUKWU said that if this is done seasonally, in the summer, the costs will quadruple and the process will have to start over again in the winter.

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DR. CHUKWU, in response to Representative Seaton, clarified that the crude oil [without GTLs] will illustrate Newtonian behavior, like water at low temperatures. Therefore, there's not much problem with gelling.

REPRESENTATIVE SEATON posed a situation in which there is heavy mixture of crude and a prolonged shutdown at -20°F or below, and asked if the power requirement for a mixed GTL crude is going to be higher or lower than cold crude oil only in the pipeline.

DR. CHUKWU answered that the power requirement for the mixture will be higher.

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DR. CHUKWU concluded with slide 33. He related that the phase behavior studies show that the GTL-crude oil mixture will flow as a single fluid system at all four blend ratios. Therefore, the cavitation problem is minimized. He reminded the committee that the mitigation of solids deposition remains a major problem that has to be reviewed. Under the commingled flow profile, there is a decrease in throughput in TAPS, which can result in faster and more deposition of these solids along the pipe wall. The long-term result will be corrosion, he said.

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REPRESENTATIVE WILSON surmised then from the presentation that the less product passing through the pipe, the more corrosion will occur.

DR. CHUKWU noted his agreement that there would be corrosion some time in the future if there aren't enough dispersants to address the solid deposition.

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REPRESENTATIVE WILSON surmised then that the less the volume, the more expense it will be due to the need for increased pigging.

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DR. CHUKWU said that's not what he meant. He explained that decreasing throughput in TAPS results in faster and more deposition of solids along the pipe wall. Therefore, if the throughput is reduced by reducing the amount of GTL in the amount of crude oil in TAPS, the solids will build faster than when there is higher throughput. The higher the throughput, the faster movement of the solids occur.

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REPRESENTATIVE WILSON related her understanding that keeping things as they are currently will create more problems as the volume decreases.

DR. CHUKWU pointed out that currently there is only crude oil. He clarified that he isn't commenting on what is happening right now but rather what would happen with a crude oil-GTL mixture.

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CO-CHAIR JOHNSON inquired as to what dispersants can be added and are they derivatives of petroleum products that can be distilled on the North Slope.

DR. CHUKWU responded that he's referring to something that will not allow the solids to get together. He noted that different companies will have different dispersants, but none are manufactured on the North Slope. In further response to Co-Chair Johnson, Dr. Chukwu said he wouldn't be able to specify any volumes of dispersants at this point because it would depend upon the formulation.

2:08:11 PM

PETER COOK, Sasol Chevron, drew the committee's attention to a PowerPoint titled, "Sasol Chevron and GTL - an overview". Mr. Cook reviewed the slide titled, "Partnerships: Enhancing value". He explained that essentially there are the following three steps: natural gas reforming, the Sasol proprietary step called the Fischer-Tropsch conversion, and a Chevron proprietary product upgrade.

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CO-CHAIR GATTO inquired as to what percent of a gallon of GTL is wax.

MR. COOK explained that the wax is fully broken down or hydrocracked, which results in a very nice diesel coming out the other end. Therefore, there's no wax left in the final diesel product if product upgrading is performed. Mr. Cook related that Sasol's work has determined that some form of stabilization and mild hydrotreating is necessary in order to produce a synthetic crude that can flow.

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MR. COOK then continued with the slide titled, "Matching the GTL challenge". This slide discusses the joint venture of Sasol and Chevron, which began in 2000. Sasol is a global driver for cleaner fuels and has proven GTL technology as well as a large level of operating and maintenance experience and technology commercialization and GTL marketing experience. Chevron has an international presence with marketing and E&P experience, as well as its hydroprocessing technology. The aforementioned forms the base of the Sasol Chevron joint venture. Sasol Chevron's overall drive and strategy is to build, own, operate, and market GTL facilities around the world. The next slide titled, "Locations for GTL" illustrates where in the world the reserves of gas are found as well as the ready-made GTL markets. The GTL markets are the United States, Brazil, Europe, Southeast Asia, and Australia. The slide shows four blocks that represent Sasol Chevron and its first endeavors, the first of which was the Oryx plant in Qatar. Sasol Chevron also has a plant in Escravos, Nigeria, and is looking to develop projects in Australia and Algeria. He then drew attention to the slide with photographs of the Oryx plant, from which its first shipment will take place weeks from now. The Oryx plant, he related, is a 34,000 barrel per day (BPD) facility.

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REPRESENTATIVE WILSON surmised that the main reason that [Sasol Chevron] doesn't have the problems faced in Alaska is because of the temperature at its locations.

MR. COOK answered that it isn't as simple as that. Mr. Cook said, "It depends on what final product one decides to take out of the plant."

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CO-CHAIR GATTO asked if it's fair to say that when [Sasol Chevron] makes GTL it's already at the destination and doesn't need to be commingled with any crude.

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MR. COOK related:

> The value of the final products, particularly the diesel, of which is about 70 percent of the output of our plants, so much above crude. The uplift above crude price is in effect so big that it is effectively one of the major drivers and enablers of this technology. So, to commingle it with crude, in ... whatever form, unless you can get the product back out down the other end of the pipeline and make use of the high quality, which is essentially zero sulfur, high cetane, ... you actually destroy a lot of value. ... it's a product which you can run a diesel engine on ... without adding anything to it.

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MR. COOK then drew attention to the next slide, which is a depiction of the Escravos, Nigeria project (EGTL). The Escravos project is the same size as the Oryx project, 34,000 BPD. At this point there are site activities, the engineering is complete, and procurement and early construction is advancing. The EGTL project is due for startup in 2009.

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MR. COOK continued with the slide titled, "Market scale: diesel demand growth". He informed the committee that one benefit of low temperature Fischer-Tropsch conversion technology instead of getting many products out of a GTL facility, two products are produced. Both of these end products, diesel and naphtha, are excellent. The diesel is very high quality, low sulfur, low cetane, and an excellent blend to upgrade poorer quality crude within a refinery or neat fuel. Currently, the diesel market is huge at 13.5 million barrels, as depicted by the large sphere on the slide. In contrast is the smaller sphere that represents the Oryx GTL diesel product that delivers 23,000 barrel per day of diesel, which is about 65-70 percent of the throughput. The slide illustrates the cumulative growth of diesel over the next 10 years, which is 4.6 million [barrels] in comparison to Sasol Chevron's projected capacity of 300,000 barrels as well as the projected GTL capacity of the world. The projected GTL capacity of the world would only amount to 4 percent of the demand or 13 percent of the new total demand.

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MR. COOK, referring to the slide titled, "GTL diesel market channels", pointed out that there are two market channels. The blend stock route uses the excellent properties of the diesel and allows a conventional refiner to optimize the refinery by potentially digging deeper in the barrel or running heavier crudes while being able to deliver diesel on spec. This [type of diesel] would go to premium auto and truck markets. The aforementioned is the route that the Oryx product is utilizing. In the future, neat applications such as a dedicated bus fleet within large polluted cities could run and show huge benefits as a result of reductions in various air qualities, which is depicted in the slide titled, "Meeting new air quality demands". The graph illustrates the percentage of change of various emissions. The dark bar is pure GTL, while the light bar is a mixture of GTL diesel and 50 percent EU diesel baseline. The graph illustrates significant hydrocarbon reduction emissions, carbon monoxide emissions and reductions in nitrous oxide, particulate matter, and carbon dioxide. He pointed out that the fuel consumption moves slightly in the negative direction as the GTL diesel is a lighter density than conventional diesels. Therefore, the fuel consumption in the miles per gallon results in a small penalty on conventional engine. Mr. Cook related the belief that further optimization of the engine could almost result in the eradication of the negative movement in fuel consumption.

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CO-CHAIR GATTO inquired as to what is occurring in Europe regarding emissions and air quality demands/standards. He further inquired as to whether GTL is a superior product if those demands increase.

MR. COOK stated that the European market is where most of the [GTL] product will find itself. The European market is leading the move in reducing sulfur and GTL has essentially zero parts per million (ppm) in sulfur.

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MR. COOK noted that the remaining slides are photographs, including one demonstrating Sasol Chevron's work with Daimler Chrysler on emissions tests. There is also a slide that depicts the alliance for synthetic fuels in Europe (ASFE). He then turned to the slide relating the Sasol Chevron GTL challenge, for which a number of standard diesel vehicles were driven 11,000 kilometers across Africa using GTL diesel. One slide shows the clarity of the diesel and the slide titled, "Journey's End" shows the oil of the GTL diesel after 11,000 kilometers versus the standard diesel after 5,000 kilometers. Those slides provide a base for deductions related to engine wear and tear and longevity [when using GTL diesel versus standard diesel].

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MICHAEL GRADASSI, Project Development Manager, BP Conversion Technology Centre, BP America, Inc., began by informing the committee that he has more than 33 years experience in the petroleum industry. He related that over the last 18 years he has been involved in the development and application of technologies addressing the conversion of natural gas to liquids. He noted that during that time he has published several papers on the economics of GTL technology and have provided research guidance to help steer its development toward more favorable commercialization options. Mr. Gradassi opined that he is a strong proponent of GTL technology, but an even stronger proponent of identifying and carrying out the best project option for any given gas resource asset. He further opined that GTL isn't the best option for Alaska's North Slope gas. The commercial viability of GTL depends upon plant site, capital costs, gas costs, and market opportunities. He said his remarks would focus on plant site and capital costs, which amount to staggering costs for a GTL plant on the North Slope. The aforementioned along with gas costs would likely render a GTL plant on the North Slope uneconomic compared to GTL plants in other parts of the world that could benefit from locations that aren't remote, lower construction costs, and significantly milder weather costs.

MR. GRADASSI then explained that GTL technology is the chemical conversion of natural gas to a pumpable synthetic crude oil that can be further converted to refined products. The process involves three steps, the first of which is when natural gas is chemically converted at pressure and very high temperature to an intermediate gas that is chemically converted to another intermediate or waxy hydrocarbons, which can be mildly treated to reduce its waxy properties and convert it into a pumpable synthetic crude oil. This synthetic crude oil and the products made from it are especially attractive because of their properties, purity, and cleanliness. Mr. Gradassi informed the committee that BP has been involved in developing just such technology since the early 1980s. In fact, it's currently being demonstrated at BP's Nikiski test facility. The test facility, he related, is designed to convert about 3 million standard cubic feet (mcf) a day into 300 BPD of synthetic crude oil.

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CO-CHAIR GATTO inquired as to how much of the resource is consumed for every 100 units of gas used to produce a unit of GTL.

MR. GRADASSI said that about 10,000 cubic feet of natural gas is used to produce 1 barrel of GTL liquid. If one counts all of the energy requirements for the process itself as well as the supporting utilities, about 50-60 percent of the resource would be used. In further response to Co-Chair Gatto, 50-60 percent of btus will be used. The barrel of GTL will represent 50-60 percent of the total btus. He noted that higher figures are related when only the process is taken into consideration without the supporting utilities.

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MR. GRADASSI continued his presentation, and informed the committee that the synthetic crude oil from BP's Nikiski plant is stored in a storage tank and is transported via truck for further processing. The facility cost $100 million to build. However, the capacity and cost for BP's demonstration facility is a far cry from that of a 400,000 BPD commercial scale ANS GTL plant where both site remoteness and Arctic weather conditions add substantially to a plant's capital costs. Mr. Gradassi pointed out that Dr. Chukwu doesn't address the North Slope GTL plant itself, although he implies capacity of upwards of 400,000 BPD. The scale of such a GTL facility is unprecedented and would resemble a conventional crude oil refinery in size. In fact, it would consume about 4 bcf a day of natural gas and would have an expected capital cost in the tens of billions of dollars. Although BP hasn't recently costed a plant of such scale, BP can draw from its recent evaluation of a GTL plant for its gas assets in Columbia. Although the site in Columbia isn't Arctic, it's remote as it sits 600 miles inland on the other side of the Andes Mountains. A capital cost estimate in excess of $40 billion isn't unreasonable. He highlighted that the $40 billion is the cost before recognizing the added costs to build a plant that can operate reliably in the severe Arctic conditions of the North Slope.

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CO-CHAIR GATTO inquired as to why BP, with its remote site in Columbia, doesn't build a pipeline to ship the crude elsewhere for conversion into LNG.

MR. GRADASSI pointed out that Columbia doesn't enjoy the infrastructure that the U.S. does in terms of gas pipeline transport.

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MR. GRADASSI returned to his presentation. He informed the committee that similar capital costs can be inferred from GTL construction costs published by one of BP's competitors who is in the early stages of constructing the largest ever GTL plant in Qatar. That plant, at 140,000 BPD, is one-third the capacity envisioned for the ANS GTL project. He opined that to consider building a plant three times the scale of the Qatar plant prior to the commercial approval of the Qatar plant and to do so under the severe conditions of the North Slope would expose developers to substantial capital and economic risks as it will compete daily with GTL plants elsewhere that experience lower capital, operating, and maintenance costs. Additionally, an ANS GTL project would face many other large economic hurdles. Furthermore, there are other cost challenges of modifying TAPS to accommodate batched GTL synthetic crude oil along with regular crude in order to maintain GTL's attractive qualities.

He reminded the committee of Mr. Cook's remarks regarding the importance of maintaining those clean qualities. Mr. Gradassi then expressed the need to keep in mind the cost of separating and loading separate cargos of synthetic crude oil and regular crude oil for transportation to the market place. Moreover, there is continued competition with very low-cost gas that can feed GTL plants in other parts of the world. Mr. Gradassi reiterated that in order to be commercially viable, GTL projects require low capital cost, low cost gas, and ongoing low operating and maintenance costs for plant and transportation infrastructure.

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MR. GRADASSI turned to gas costs and expressed the need to recognize that every barrel of GTL liquid requires about 10,000 standard cubic feet of natural gas. Therefore, every $1 per 1,000 cubic feet of gas adds $10 to every barrel of GTL liquid. With a GTL plant located on the North Slope, he opined that it would be reasonable to expect that ongoing operating and maintenance costs wouldn't be low. Since an ANS GTL project meets none of the requirements for commercial viability relative to those offered by other GTL locations, it's certain to make an ANS GTL project uncompetitive.

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CO-CHAIR GATTO surmised then that Mr. Gradassi opposed the concept.

MR. GRADASSI reiterated his earlier statement that he is a proponent of GTL and GTL technology, although he said he recognizes that there are right and wrong places for [GTL] projects. He further said that he doesn't believe that [the North Slope] is the right place for a GTL project.

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CO-CHAIR GATTO asked if Mr. Gradassi's thinking would be changed if his company had 50 tcf of gas stranded on the North Slope.

MR. GRADASSI said that he couldn't comment on such. However, he said that he firmly believes that his remarks for the current situation are the right conclusion.

CO-CHAIR GATTO reminded Mr. Gradassi that the intention is to build a pipeline and sell the vaporized gas at the highest price for the least amount of money.

MR. GRADASSI pointed out that there is a value to that gas on the North Slope and every dollar going into that barrel of GTL liquid will be reflected as another $10 per barrel. The aforementioned has to be compared to what one believes are long-term forecasts for crude oil and products and whether or not it's worth the risk. "Would you ... actually be getting the returns for the gas that ... you'd be happy with versus the returns that you could get for the pipeline," he asked.

CO-CHAIR GATTO acknowledged that, but questioned what the return would be if a pipeline isn't built.

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MR. GRADASSI posed a scenario in which the gas on the North Slope is worth $2 per 1,000 standard cubic feet. When the aforementioned is converted into a barrel of GTL, it amounts to $20 a barrel, just for the gas alone. On top of that one must add the capital costs and the return on it, the ongoing maintenance costs, and the transportation to the marketplace. The aforementioned must be compared to what the marketplace is going to bear and determine whether it's a better return on the capital than if it was invested elsewhere.

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CO-CHAIR GATTO remarked that if the gas stays in the ground on the North Slope, it's probably worthless. Therefore, he asked if it would be the fair thing to take the gas and convert it to GTL, adding $20 per barrel in the scenario above.

MR. GRADASSI explained:

> It doesn't make a barrel of GTL for $20. ... you're going to be getting up there, you'd have to divide all your capital of all the barrels you're manufacturing, the return you want to get on that capital, and then add on top of that ... the $10 or $20 just for the gas cost itself.

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CO-CHAIR GATTO asked if the high quality diesel meets the specifications for kerosene.

MR. GRADASSI related that BP hasn't done those specific tests and published [the findings]. He recalled that the tests may have been sponsored by the U.S. DOE and the U.S. Department of Defense (DOD). He further recalled seeing a photograph of a military jet in flight fueled by GTL liquids.

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CO-CHAIR GATTO commented that the military would probably [be willing [to pay a lot] for a barrel of cleaner oil that provides greater range and lower maintenance.

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REPRESENTATIVE SEATON remarked that the discussion is based on whether a plant would be sized to do all of the gas on the North Slope or a plant with expansion capability for a gas line.

MR. GRADASSI clarified that his comments were based on the 400,000 figure that Dr. Chukwu used.

REPRESENTATIVE SEATON pointed out that part of what the [legislature] is reviewing is what has to be done for a gas line and whether there are alternative ways to monetize the gas. He then pointed out the "Prospects for Development of Alaska Natural Gas: A Review" by the U.S. Department of Interior dated January 2001. That document discusses TAPS throughput with no gas sales possibly [falling] to 200,000 BPD in 2015, and becoming uneconomic at that point. He asked if there would be a large capital incentive if "we could put 100,000 barrels a day and increase that so TAPS is still economic to run." Or, is the thought that the TAPS line would be replaced with a smaller pipeline, he asked. He opined that it would be a large capital cost if the rest of Prudhoe Bay is stranded.

MR. GRADASSI said that he's unable to answer that as he's not part of the BP Alaska project team.

CO-CHAIR GATTO pointed out that when TAPS quits working dismantlement, removal, and restoration (DR&R) must be done, which he estimated would cost a couple of billion dollars. He asked, "Would it enter into your equation if you knew that it's possible to extend the life of a pretty valuable resource before you start spending the money to remove it?"

MR. GRADASSI said that he would guess it probably would work into the equation, but how he didn't know.

2:51:52 PM

ADJOURNMENT

There being no further business before the committee, the House Resources Standing Committee meeting was adjourned at 2:52 p.m.