the ENERGY lab

PROGRAM FACTS

Strategic Center for Natural Gas & Oil

Arctic Energy Office

Alaska's fossil energy resources continue to play a greater role in meeting the nation's energy needs. Alaska holds several billion barrels of oil, about one-fifth of America's remaining proved oil reserves, and more than 30 trillion cubic feet of natural gas awaiting a means to reach a market.[1, 2] Undeveloped oil and natural gas resources abound as well. Alaska contains 25 to 30 billion barrels[3] of viscous or heavy oil that is largely untapped due to lack of technology, and the fact that it is largely within the existing North Slope infrastructure means it could be developed without growing the environmental footprint. NETL is continuing to invest in developing technology to safely produce natural gas from the vast methane hydrate resource located on the North Slope. As well, Alaska holds about one-half of the nation's coal deposits. The untapped energy resources of the high north make the area a key national energy asset.

There are many technological and economic challenges associated with developing Alaska's abundant fossil energy resources. NETL's Arctic Energy Office is coordinating with industry, academia, and other Government agencies to identify new technologies and methods for safely developing Alaska's fossil energy wealth while maintaining the pristine environment in which it is contained. The arctic resource projects currently being sponsored by NETL, less the methane hydrate projects, are briefly summarized in this Fact Sheet.

Environment

The Arctic Energy Office's objectives include a strong focus on environmental issues pertaining to the development of Alaska's resources. These issues are important due to the cold climate, fragile tundra, permafrost, wildlife protection, and the focus of the nation on preserving the pristine nature of Alaska.

The Arctic Energy Office works with state agencies and the University of Alaska to identify research that will address environmental issues that limit oil, gas, and coal development. For example, on Alaska's North Slope, the oil industry must travel off-road across the tundra during winter for a variety of reasons: to carry out seismic exploration, to build ice roads for exploratory drilling, to carry out construction activity, or to resupply remote oilfields. NETL's Arctic Energy Office is working with industry, academia, and state government agencies to improve access and efficiency of Arctic Transportation Networks needed to access Alaska's fossil fuel resources while maintaining the pristine environments in which they are found.

---

[1] Alaska Oil and Gas Report, November 2009, Alaska Department of Natural Resources, Division of Oil and Gas, Table I.1 November 2009 and "Summary: U.S. Crude Oil, Natural Gas, and Natural Gas Liquids Proved Reserves 2009", Table 6, Nov 2010.

[2] The Alaska reserves include proven producing, proven unproducing, and some probable reserves. Using EIA values for proven reserves only, Alaska reserves are listed as 3.6 billion barrels compared to 22.3 billion barrels for total U.S. or 16%.

[3] Thomas et al, "Alaska North Slope Oil and Gas: A Promising Future or an Area in Decline? Addendum Report", U.S. DOE/NETL/Arctic Energy Office, April 2009.

CONTACTS

Joel Lindstrom
Arctic Energy Office
National Energy Technology Laboratory
420 L Street, Suite 305
Anchorage, Alaska 99501
907-271-3618
joel.lindstrom@contr.netl.doe.gov

Ray Boswell
Technology Manager
Methane Hydrates
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4541
ray.boswell@netl.doe.gov

Ogunsola, Olayinka I. (Yinka)
Office of Future Oil and Gas Resources
U.S. DOE Office of Fossil Energy
1000 Independence Ave., SW
Washington, DC 20585
202-586-6743
olayinka.ogunsola@hq.doe.gov

Maria Vargas
Deputy Director
Strategic Center for Natural Gas & Oil
National Energy Technology Laboratory
636 Cochrans Mill Road
P.O. Box 10940
Pittsburgh, PA 15236-0940
412-368-5470
maria.vargas@netl.doe.gov

John R. Duda
Director
Strategic Center for Natural Gas & Oil
National Energy Technology Laboratory
3610 Collins Ferry Road
P.O. Box 880
Morgantown, WV 26507-0880
304-285-4217
john.duda@netl.doe.gov

Project Summaries

- ***North Slope Decision Support for Water Resource Planning and Management***

  Ice roads and ice pads provide a cost effective means of oil and gas exploration on Alaska's North Slope with minimal impact to the sensitive underlying tundra. This project is developing tools that support stakeholders' needs while meeting regulatory requirements. Key components include information system technology, Arctic hydrology and climatology, water resources management, and decision support through modeling. The project team regularly collaborates with industry and regulators to obtain stakeholder feedback with the goal of producing a useful ice road planning tool. A case study of the Chevron White Hills Ice Road implemented during the 2007–2008 exploration season was recently presented at the American Water Resources Association's Spring Specialty Conference on GIS and Water Resources, where a peer review was obtained from conference attendees. A separate presentation was also given on lake water budget modeling under future climate scenarios. These efforts have culminated in the refining of a module which allows users to click on a lake to retrieve information such as bathymetry and lake level. The design team continues to incorporate stakeholder feedback to further refine the model's ice road planning, water management, and natural systems components.

  http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05683_WaterManagement.html

Trans Alaska Pipeline System (TAPS)

Oil production from known resources as well as new discoveries is essential for keeping the Trans Alaska Pipeline System (TAPS) operating both technically and economically. Current production rates are about 600,000 barrels per day, down from a maximum of over 2 million barrels per day in 1988. The mechanical lower operating limit of TAPS is about 300,000 barrels per day. The economic limit of TAPS will depend on world oil prices and operating costs, but as oil production rates continue to decline, the tariffs can be expected to increase, affecting the economic viability of all North Slope production. With currently producing and identified development, the TAPS minimum flow rate could be reached as early as 2045 and strand over a billion barrels of oil currently booked as reserves (economically producible). Maintaining the viability of the TAPS pipeline is essential for maintaining access to undiscovered North Slope resources but will require access in a timely manner to the most promising areas for exploration and development (e.g., unexplored areas of the National Petroleum Reserve Alaska, and the Alaskan Outer Continental Shelf).

- ***Using Artificial Barriers (Snow Fences) to Augment Fresh Water Supply***

  Current Arctic energy production is situated in a "Polar Desert." Total annual precipitation averages only 6–10 inches. Given the short summer season, difficulties with storing and distributing water in Arctic conditions, in conjunction with high operating costs, make water a precious resource. This project evaluates the use of snow management by implementing snow fences to augment lake water supplies by increasing the probability that captured snow will help recharge the lake during the summer. A snow fence was constructed for two consecutive winters in the vicinity of Prudhoe Bay. Two lakes with similar water balances were analyzed; one that received a snow fence, and another that was left in its natural regime. It was found that during the 2011 snow season, the snow fence retained an additional 1.8 million gallons of water at the cost of $.01 per gallon. Similarly, in 2010 the snow fence added 1.5 million gallons of water to the lake at a cost of $.02 per gallon. Despite low precipitation levels in both years, the snow fence extended the snow melt season resulting in an additional month of fresh water supply.

  http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05684ArcticLakes.html

- ***Alaska North Slope Oil and Gas Transportation Support System (Arctic Transportation Networks)***

  A majority of oil and gas exploration and development on the North Slope takes place in winter when the tundra surface is stable (i.e. frozen). This project implements scientific understanding to develop a set of tools useful to industry and management. A major goal of this work has been to provide the ability to efficiently forecast environmental conditions so that management agencies can respond to snow cover and soil temperature audits more effectively and industry can coordinate their significant mobilization efforts accordingly. This project has established eight data collection stations on the North Slope in order to assist the modeling efforts which lead to forecast. The project team has also collaborated with other environmental networks to extend the findings of this work to other North Slope regions such as the Brooks Range Foothills. Soil temperature forecast modeling methods are under development, soil strength studies are being completed, and a snow measurement methods manual is being written with the intent that regulators, industry, and researchers will adopt a common method for data collection. A "smart phone" application has also been developed, which has enabled regulators to immediately report snow and soil conditions while working in the field. This tool has been found to eliminate two days from the historical time lag between measurements and reporting, which is a significant time savings when the industry has only about 100 days to complete a season's worth of work.

http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/01240_NStransportation.html

- ***Producing Light Oil from a Frozen Reservoir: Reservoir and Fluid Characterization of Umiat Field, National Petroleum Reserve, Alaska***

The Umiat field contains an estimated 1.2 billion barrels of oil in a shallow, frozen reservoir. This unconventional pool is thought typical of many light oil accumulations scattered across the Arctic. How to produce oil from such low pressure matrices of rock, ice and oil remains unresolved. This project is developing a reservoir model to evaluate the use of modern drilling and production methods for Umiat and similar permafrost reservoirs without the use of steam or other fluids that may disrupt the frozen matrix. Umiat core samples have indicated that natural fractures are not abundant. Thus, fieldwork to understand the reservoir geology has been performed, where results seem promising for exploiting the reservoir's anisotropic permeability. The reservoir was also found to contain upper and lower grandstands with distinct petrophysical properties which must be modeled separately. An oil sample existing from the initial Umiat exploration effort has been used to create a larger quantity of oil for in-depth fluid property testing. Experimental permeability studies have also been performed, where preliminary results show a 76% decline in the average relative permeability of oil in the presence of ice. The relative permeability was also found to have a strong dependence on freezing temperature, where a reduction in freezing temperature is accompanied by a significant reduction in permeability. The research team continues to refine the reservoir model to evaluate the effectiveness of the proposed drilling and production strategies, including pressure support through the injection of lean natural gas maintained at 26 °F.

http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/Arctic_Energy/5641_FrozenReservoirs.html

Alaska's Unconventional Oil Resource:

- The Alaska heavy oil resource is large, on the order of 45 billion barrels of original oil in place.
- The West Sak pool in the Kuparuk River Field is believed to contain between 15 and 20 billion barrels of oil (BBO) with variable oil gravity from 10 to 22°API.
- West Sak development is restricted to a core area of about 2 BBO of which only 1.2 BBO is considered to be economical to develop.
- The Schrader Bluff pool in the Milne Point Field is believed to contain between 15 and 20 BBO of 17°API oil.
- Schrader Bluff development is restricted to a core area of about 2 BBO of which only 1.3 BBO is considered to be economical to develop.
- Other heavy oil producing formations on Alaska's North Slope are the Ugnu, Tabasco, Orion, and Polaris.

Ice road north of the ConocoPhillips Alpine Facility (M. Lilly, 2008).

- ***Fluid and Rock Property Controls on Production and Seismic Monitoring Alaska Heavy Oils***

The Ugnu formation on Alaska's North Slope contains highly viscous, biodegraded oils. Because of the cold temperatures and low flow rates, standard production methods are ineffective. Additionally, Ugnu rocks have porosities, permeabilities, connectivities, and mineral contents that vary over short distances, and the resin and asphaltene content can also vary which further complicates recovery. This study characterized the reservoir fluid and rock properties by using seismic data to develop a geophysical monitoring program that could be used to enhance the recovery of the heavy oil. A large number of experiments have been conducted to help understand the heavy oil properties, including molecular beam mass spectroscopy, optical and scanning electron microscopy, x-ray CAT scan, and laboratory seismic measurements. A rock physics model was developed with the use of the Cold Heavy Oil Production Sands hypothesis. This effort sought to improve seismic resolution through permafrost and the ability to evaluate heavy oil reservoirs, where the capacity of imaging small changes in the reservoir in both the amplitude spectrum and the image space has been quantified. The capability to monitor, over time, the progress of a heavy oil recovery process by seismic measurements is expected to significantly enhance recovery effectiveness. This project was completed in June, 2012.

http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/05663_AlaskaHeavyOil.html

- ***Chemical Methods for Ugnu Viscous Oils***

The North Slope of Alaska has about 20 billion barrels of viscous oil in the Ugnu, West Sak and Shrader Bluff reservoirs. These pools overlie the already producing reservoirs of Kuparuk and Milne Point, but exist below the permafrost. The proximity of these pools to the permafrost requires the use of non-thermal oil recovery methods which do not risk melting the permafrost and the subsidence of unconsolidated sand. This work sought to develop efficient chemical recovery methods for extracting the viscous oil. The methodologies evaluated include the injection of brine at different salinities followed by an alkaline-surfactant (AS), alkaline-surfactant-polymer (ASP) or polymer formulation, in order to introduce and or generate surface active agents that reduce interfacial tension between the brine and oil. Single dimension (1-D) core flood experiments have been conducted with AS emulsions and 10,000 cp oil, and with ASP microemulsions and 330 cp oil. It was found that the oil recovery of the AS formulation was in the range of 50–75%, and that the ASP formulation recovered virtually 100% of the residual oil. A secondary polymer flood was conducted in the same core, where about 90% of the 330 cp oil was recovered. Experiments with AS formulations and 10,000 cp oil in a quarter 5-spot sand pack test bed have shown a brine flood recovery of 33–35%, with an additional 18–24% recovery obtained through the injection of the AS solution. This project was completed in March, 2012.

http://www.netl.doe.gov/technologies/oil-gas/Petroleum/projects/EP/ArcticResources/06556_UgnuViscousOil.html

Trans Alaska Pipeline Traversing the Brooks Range