JAM Industrial, Inc.

Servicing the Utah and Athabasca Oil Sands Industries

MENU

HOME
ASPHALT RIDGE - STATUS
ASPHALT RIDGE - HISTORY
SERVICES
KEY PERSONNEL
CONTACT US
LINKS

ASPHALT RIDGE - OUR HISTORY & a TECHNOLOGY REVIEW

Society of Petroleum Engineers - Paper - 2004

"Study and Demonstration of a Process to Extract Bitumen from Utah Tar Sands"

spe86945.pdf

INTRODUCTION

The Asphalt Ridge oil sand deposit is located approximately 4 miles Southwest of Vernal, Utah. The deposit stretches approximately 11 miles along Asphalt Ridge and contains an estimated 1.1 billion barrels of bitumen. The deposit has been identified as a potential hydrocarbon resource since the 1800's. Since that time, numerous development concepts have been promoted to exploit the resource.

BRIEF HISTORY OF ASPHALT RIDGE DEVELOPMENT

Significant historical activities involving the Asphalt Ridge deposits:

- First known mining for local road paving as early as 1920's
- First known extraction plant built in 1930's (using hot water extraction)
- In the 1950's Knickerbocker Investment Company and W.M. Barnes Engineering Company acquired a large block of oil placer mining claims and began the first comprehensive evaluation program (drilling and mapping).
- Subsequent to this work, the claims were then leased to Sohio Petroleum Co., which completed its own extensive drilling and mapping program.
- In the 1970's, Major Oil Co. obtained a working agreement with Sohio to mine oil sands, extract the bitumen, and ship the bitumen to a refinery in Roosevelt, Utah. The extraction technology used was a hot-water solvent process.
- In the 1970's several other oil companies also performed exploratory drilling, including; Sun Oil Co., Texaco, Phillips, and Shell.
- Throughout the 1980's and 1990's Uinta County utilized the raw tar sands to make cold mix and hot mix asphalts for local road paving.
- Buena Ventura Resources (later Crown Energy) obtained several leases covering the Asphalt Ridge deposits in the early 1990's.
- Crown Energy and MCN Energy built an extraction plant based on solvent extraction technology at Asphalt Ridge in 1997.
- In 1998, Mr. Burk Adams (JAM Industrial) was retained by Crown and later by MCN to assist in commissioing the extraction plant. The solvent extraction technology was problematic in several areas, and the plant was not able to operate continuously.
- In 1999, MCN Energy retained the Canadian Western Research Centre (CANMET) to conduct tests at the facility to develop an alternative bitumen extraction process. Mr. Adams and Mr. Phil Coleman led the engineering and management effort for MCN and with the assistance of CANMET built and operated a hot water extraction pilot plant at the site in 1999 and 2000. The testing plant was operated successfully for 14 months, processing nearly 15,000 tons of oil sands.
- MCN Energy was acquired by Detroit Edison (DTE) in 2001.
- In 2003, DTE acquired full ownership of the Asphalt Ridge leases and plant assets. DTE decided not to pursue development of Asphalt Ridge since it did not fit their strategic goals as a Michigan utility company.
- WEMBCO owned the A tract and D tract deposits at Asphalt Ridge since the 1970's and leased these lands to Crown and later DTE. In 2004, DTE yielded control of the land and plant assets to WEMBCO.

- In 2008, Korea Technology Industry America (KTIA) purchased WEMBCO which included the lands and plant assets. In January, 2008 KTIA retained the services of JAM Industrial to assist in the development of the site.
- In January, 2009 KTIA with the assistance of JAM began design of a retrofit of the existing facilities to implement a 1,200 barrel/day hot water extraction facility based on the 1999 - 2000 pilot facility.
- In January, 2010 commissioning of the constructed facility successfully commensed.

A BRIEF HISTORY OF BITUMEN EXTRACTION TECHNOLOGY AT ASPHALT RIDGE

A review of historical development of bitumen extraction technology at Asphalt Ridge reveals that it was often intertwined with development of Canadian Athabasca oil sands extraction technology. For example, the basis of hot water extraction technology in Athabasca was developed by Dr. Karl Clark in the 1920's and is referred to (even at present) as the "Clark hot water process". It is interesting to note that the first attempts to extract bitumen at Asphalt Ridge occurred in the 1930's using hot water extraction.

Commercial production of bitumen from oil sand began in Canada in 1967 when Great Canadian Oil Sands (later Suncor) began operations near Fort McMurray, Alberta. Syncrude Canada Ltd. became the second operating mine nearby in 1972.

In 1973, the energy crisis in the United States spurred renewed interest in development of oil sand resources. In that same year the University of Utah was granted funds from the DOE and initiated a research program through its Fuels Engineering Department. Bitumen extraction technology research has focused in the following areas:

- Water based extraction and flotation (similar to the Clark process)
- Solvent assisted water extraction and flotation
- Solvent extraction
- Fluidized bed pyrolysis
- In-situ steam flooding – gravity drainage
- In-situ fire tube – gravity drainage

It is beyond the scope of this discussion to address each technology. However, of specific interest to current developments is a short discussion of water based extraction and solvent based extraction.

<u>Hot Water Extraction</u>

When the first commercial oil sand production facilities were constructed in the late 1960's and early 1970's in Athabasca, the technology basis was hot water extraction. In this process, oil sand was mined and brought to the processing plant. At the plant, the oil sand was mixed with hot water and steam and gently agitated. This gentle agitation allowed the bitumen to separate from the sand matrix. After agitation, the mixture was diluted with more water and allowed to separate in a vessel. In this vessel, bitumen would float to the surface and be recovered for further processing.

When testing was performed on Asphalt Ridge and other Utah oil sand samples in the 1970's using the Clark hot water process, poor results were obtained. This was attributed to low water content in the Utah oil sands, resulting in what researchers describe as "oil-wet" oil sands in comparison to the "water-wet" oil sands of Athabasca.

One of the results of the University of Utah research program was the development of a hot water process that worked for lower viscosity bitumen oil sands such as Asphalt Ridge and resulted in US patent 4,120,7767. In that work, the researchers found that if they subjected the Asphalt Ridge oil sand to elevated temperature, high shear (agitation), and elevated pH (using caustic soda), then successful separation of bitumen was achieved in a hot water extraction process.

In the late 1980's and early 1990's, Athabasca oil sand operations began to experience significant recovery problems utilizing the traditional Clark process. A major research program was initiated to understand this problem. The result was the identification of "oxidized", or "transition" ores that required more intensive processing means than the "fresh" ores that had been previously processed. This research identified three important parameters that drive oil sand hot water processing:

1. Oil sand/water mixture temperature
2. Degree of mechanical energy input (agitation)
3. Addition of chemical aids (such as caustic soda)

The Athabasca processing plants were modified to impart a higher degree of agitation and the varied injection of caustic soda.

In 1999, the Asphalt Ridge processing facility operated by MCN Energy and Crown Energy engaged CANMET (Devon, Alberta) to explore other processing options besides solvent extraction. CANMET has been intimately involved in the research work conducted over the past two decades for difficult processing ores in Athabasca. CANMET conducted a testing program on Asphalt Ridge samples using a protocol developed for "transition" ores from Athabasca. CANMET found that the Asphalt Ridge samples responded in nearly identical fashion to the Athabasca transition ores. This work led to a comprehensive bench testing program at CANMET to explore details surrounding a "modified" hot water extraction process at Asphalt Ridge. Bench testing proved completely successful, resulting in the recommendation by CANMET to study the process in a continuous field pilot. The results of this bench study are found in (Mikula, et al, 2000, A Water-Based Extraction Process for Asphalt Ridge Tar Sands)8.

It is also of interest to note that surface or "weathered" ores at Asphalt Ridge respond poorly to hot water extraction. Testing by CANMET showed that samples that had been stockpiled for significant time (> 1 year) required extreme processing measures, such as very high temperature, high levels of agitation, and high levels of caustic soda addition to achieve acceptable recovery of bitumen. This testing appears to confirm similar testing work done by the University of Utah in the 1970's. A majority of samples tested from the Asphalt Ridge deposit in 1999 came from the newly uncovered pit area. These samples did not show any similarity to the heavily weathered ores mentioned above.

Based on this information, MCN Energy built and operated a continuous field pilot operation, processing 20 tons/hour of oil sands at the Asphalt Ridge operating facility in 1999 and 2000. The technology basis for this pilot plant was the "modified" hot water process developed by CANMET. Details of that pilot plant operation are provided in a subsequent section of this document below.

Solvent Extraction

Numerous solvent extraction technologies have been proposed for recovery of bitumen from oil sands. A review of literature and patents reveals the vast attention that this technology has been given with respect bitumen recovery from oil sand reserves. WESCO is only aware of two large scale operating facilities to have been built based on solvent extraction: the Crown Asphalt Ridge facility and the SOLVEX facility in the Athabasca region of Canada.

CANMET and other research organizations in Canada (Alberta Research Council, etc.) have performed significant research on the subject of solvent extraction. Several common themes reoccur with all proposed solvent extraction processes and are worth discussing in more detail:

1. Solvent losses to tailings: In solvent extraction processes, a solvent is contacted directly with the bulk oil sand. The solvent dissolves the bitumen and the solvent/bitumen solution is separated from the solids (sand). One major issue with this type process is the ability to fully remove and recover the solvent from the solids prior to the solids being

returned as tailings. Several options have been proposed including, boiling the solvent, displacing solvent with water and separating the solvent from water, etc.

One particular problem that is not often addressed is the presence of clay in the oil sand ore. These clays can absorb solvents, making it very difficult to ultimately recover all of the solvent. Extensive testing with low boiling point solvents have shown that it is very difficult to recover all the solvent from the clays, even when process temperature are raised significantly above the boiling point of the solvent.

In all cases, solvent losses in the process pose an economic and environmental problem. The high costs of solvents typically render the process uneconomic with even small losses. Even if economic amounts of solvent can be recovered through flashing (boiling), the high cost of energy required to flash the solvent is typically economically prohibitive. Solvent losses to tailings also cause problems in the environmentally acceptable disposal of tailings.

2. Emulsion formation: Another significant problem that occurs in solvent extraction processes is the formation of stable oil-clay-water emulsions if water is used to wash the sands. These emulsions can prove uneconomical to process in order to recover solvent and keep recycle water clean. Standard emulsion handling technologies, such as chemical breaking and heater treating have not proven successful in bitumen environments.

3. Contamination of the solvent/bitumen stream: As previously mentioned, fine clay tends to disperse in the extraction process. Since the solvent and bitumen must be separated from the solids by gravity separation, clay is often taken into the oil stream. This clay must be removed from the oil stream prior to solvent recovery. This clay is typically soaked in solvent/bitumen and attempts to separate it can prove very costly.

The original Crown Asphalt Ridge facility experienced all of these problems. The engineering team concluded that pursuit of hot water extraction technology would be the most viable course of action.

REVIEW OF THE HOT WATER EXTRACTION FIELD PILOT PLANT AT ASPHALT RIDGE

Based on bench scale testing of a modified hot water extraction process at CANMET, MCN Energy undertook the development of a 20 ton/hr pilot facility at the Asphalt Ridge operating facility.

Much of the existing plant equipment was utilized as infrastructure for the pilot operation. Other equipment that was not available on-site was leased from CANMET or equipment vendors.

The pilot plant, was designed and constructed to process 20 ton/hr of oil sands based on the successful development and operation of two previous pilot operations in Athabasca. The Shell Muskeg River pilot plant was built and operated at 20 ton/hr, from which the $3 billion Muskeg River Mine Complex project was successfully developed. The Syncrude Aurora Mine Complex was also successfully scaled from a 20 ton/hr pilot operation.

The pilot plant was constructed and successful operated for more than 14 months at an estimated cost of over $5 million. The project employed 15 operators and maintenance personnel, 4 full time consultants, as well as consultants from CANMET, Suncor, Colt Engineering, Pocock Industrial, and others, and processed over 15,000 tons of ore.

The pilot plant process was based on the modified hot water process proposed by CANMET and used in several operations in Athabasca. One unique feature of the process was the production of dry, stackable sand and clay tailing for mine backfill. This is an important feature of the process flow scheme, since the incorporation of large tailings ponds as seen in Athabasca operations was not deemed to be a desirable environmental option.

The pilot project was successfully commissioned, resulting in several hundreds of samples, data and observations being collected at critical process locations. The following issues

were carefully considered during testing:

- Water chemistry in recycle was carefully studied to ensure that the process was proven to be at equilibrium and no building of contaminants was evident.
- Diluent losses in the bitumen froth treatment process were carefully tested to ensure that these losses were in the economic and environmentally acceptable range.
- Hundreds of tons of performance grade asphalt were produced from the pilot runs. The asphalt was extensively tested at PRI Asphalt Technologies laboratory in Tampa, Fl. The asphalt was sold into the open market.
- The tailings were extensively tested for geotechnical stability for backfill into the pit. Over 15,000 tons of oil sands were run through the plant during testing, resulting in significant backfill quantities which proved to be very stable as backfill material.
- Environmental testing of the tailings was conducted. BTEXN values were tracked and shown to be significantly under environmental limit requirements.
- A variety of ore grades were run through the plant to understand the robustness of the process.
- Studies were conducted on several process units to understand sizing and scaling requirement for a larger facility.
- Heat balance testing was performed to better understand the ability to conserve heat in the process.
- Many others.

The conclusion of this testing was that it proved successful in all regards. Sample analysis was provided by CANMET. An engineering review was completed by Colt Engineering (Calgary, Alberta) and a technical due diligence review was performed by independent consultants in Canada. Based on this information, MCN undertook a feasibility study review with Roberts & Schaefer Company in Salt Lake City to develop a +/-20% cost estimate to retrofit the plant to process 250 tons/hr of tar sands. The feasibility study was completed in the 1st quarter of 2001.

In 2001, DTE Energy acquired MCN Energy. In reviewing the new companies mutual assets, DTE decided that a asphalt project in the Western US was outside it's core business, and decided not to pursue the project. In 2003, DTE Energy returned the plant, and leases to the land owner WEMBCO.

In 2008, KTIA purchased WEMBCO and all of it's assets. In 2009, KTIA employed JAM industrial to design a 1,200 BPD demonstartion plant based on hot water extraction, and dry tailings technology as developed during the pilot phase in 1999 and 2000.