Full Steam Ahead

Getting the right mix of resource management, environmental protection, and economic development in Alberta.

BY JOHN NICHOLSON

IN A WORLD HUNGRY FOR OIL, all signs point to growing production from the second largest source in the world. Despite the wishes of ardent environmental activists, development of the Alberta oil sands is not going to end any time soon. In the meantime, many experts and companies are working to find solutions for treatment and management of water used in these processes.

Some background

Most water experts are already keenly aware that the vast sands in northern Alberta are bound with bitumen, a tar-like mixture of hydrocarbons that is solid at room temperature. Surface mining is used to extract the bitumen at the surface, while in-situ technologies are used to extract the bitumen from further beneath the ground. The process, however, requires steam.

One of the more popular methods to extract bitumen is steam-assisted gravity drainage (SAGD). SAGD is an enhanced oil recovery technology that involves pumping steam into horizontal wells. The steam causes the bitumen to lose viscosity, allowing it to drain into a lower wellbore from which it is pumped.

Depending on the extraction method and its efficiency, the production of one barrel of oil requires anywhere from one-half to four barrels of fresh water. The water is needed for in-situ extraction (that is, SAGD) and for processing the bitumen into oil.

The oil industry uses both groundwater and surface water to extract bitumen from the oil sands and process it. Oil sands operations use approximately 174 billion litres of water per year. This accounts for approximately five per cent of Alberta's total water use.

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Water supply

With the vast amount of water needed to produce oil from the oil sands, access to water has become the limiting factor to

expanding operations. Another barrier to accessing the billions of litres of water for the extraction and processing of oil is that groundwater in the oil sands region is naturally salty. To use it requires a certain level of desalination.

One major surface water source for oil sands mining production projects is the Athabasca River. With plans to expand oil production, the utilization of water from the river is predicted to grow from its current one per cent to over two per cent.

Once water has been found and used, the concern becomes the wastewater produced as a result of extracting and processing. The sources of wastewater include condensate from SAGD, tailings water from froth treatment plants, and the existing tailings ponds.

Wastewater from oil sands production contains free oil, particulate (sand), organics, silica, hydrogen sulphide, mercaptans, and dissolved solids.

Water management, treatment, and reuse have become pressing issues for the oil industry as the remaining sources of water since surface water supplies are growing scarce, groundwater sources have naturally high salt concentrations, and the use of tailings ponds is heavily criticized.

Solutions

With support funding from federal and provincial governments, many of the oil companies in the region are currently undertaking research to learn how to properly manage and treat water.

Wastewater from the oil sands is very abrasive, is low in temperature, and contains petroleum-related chemicals such as naptha. More than one pilot-scale system has failed in meeting the treatment criteria in testing.

A number of Canadian-based technology companies have demonstrated success in treating water and wastewater from the oil sands. Here are two: Edmonton-based Titanium Corporation Inc. and London, Ontario-based Purifics ES Inc.

Titanium Corp.

Titanium Corp. has developed a propriety technology that recovers heavy minerals and bitumen contained in the waste tailings streams. The process, which has been in development since 2004, has been described as a blend of existing Canadian oil sands processing technology with conventional mineral sands processing technology.

There are two major steps to Titanium Corp.'s process. In the first step, the hydrocarbon and water recovery plant recovers bitumen and water as well as concentrates the heavy minerals. The mineral separation plant extracts saleable mineral products; namely zircon, ilmenite, and leucoxene. The waste products remaining after processing still require further treatment.

Titanium Corp. estimates that over $500 million of valuable resources are lost to tailings ponds each year. The

Credit: Purifics

One of Purifics' packaged oil/water treatment systems in use at an oil sands project.

company estimates that up to 75 per cent of zircon, bitumen, and solvent could be recovered by its technology and subsequently sold. Zircon, an industrial mineral used in ceramics and foundries, is currently over $2,000 per tonne.

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The company completed the second phase of its tailings demonstration pilot project in the spring at the CanmetENERGY Devon Research Centre near Edmonton. Plans are underway to build a commercial-sized, stand-alone facility.

Purifics

Purifics is actively working with oil sands companies in water treatment and reuse utilizing three of its technologies: Oil in-line Separation (OILS), continuous flow ceramic membrane system (CF-CMS) and photocatalytic membrane system (PHOT-CAT®).

Purifics' experience in treating oil/tar water mixtures can be traced back to the early 1990s when the company supplied the technology solution for cleaning up water contaminated with heavy oil cut with bis (2-chloroethyl) ether from a refining operation in Texas. Purifics' photocatalytic membrane system was selected over UV-hydrogen peroxide solution because of the capital and O&M savings it could provide. The photocatalytic membrane solution was installed in 1994 and ran continuously until 2000 when the site was pronounced clean. The system successfully treated the oil/tar contaminated water to meet surface water discharges standards and was subsequently redeployed to another similar application.

OILS is a coalescer device developed by Purifics that is capable of removing free or mechanically emulsified light oil. The OILS technology has been applied industrially since 1998 and is ideally suited for the recovery of naptha and similar light ends in the oil sands. Operators have found OILS to be a cost competitive solution.

Purifics' CF-CMS utilizes ceramic membrane ultrafiltration technology to remove sand and free oil. An installation of CF-CMS at an oil production facility in the Pelican Lake region of the oil sands has demonstrated reliable performance for oily water at temperatures as low as four degrees Celsius. CF-CMS is highly resistant to extreme operating pressures, pH, and chemicals. The end result is superior performance and lower life-cycle cost compared to conventional treatment methods.

CF-CMS is ideally suited to the pre-treatment of groundwater for use in oil extraction and production. As discussed earlier, much of the groundwater in the oil sands is naturally salty and needs to be treated with reverse osmosis prior to use. CF-CMS has proven very effective at first removing the sand from the water and thus making reverse osmosis (RO) possible.

Purifics is currently in discussions with an oil sands developer on an optimized solution for wastewater treatment utilizing its technologies prior to the RO system.

The third technology developed by Purifics and being pilot tested by companies developing the oil sands is its patented photocatalytic UV-activated, titanium dioxide advanced oxidation process (AOP), or PHOTO-CAT®.

What makes PHOTO-CAT unique compared to other AOP technologies is that it is chemical free—it does not require or use peroxide or ozone. A PHOTO-CAT system has demonstrated complete toxicity removal of tailings water when combined with CF-CMS. This allows for water reuse or the recharge of groundwater.

The path forward

The perception of the Alberta oil industry may be skewered by images of large tailings ponds and oil-covered birds, but the fact is that the industry is maturing rapidly and innovative methods of managing, treating, and reusing water are fast becoming the norm.

Companies involved in the oil sands are quickening their adoption of innovative and advanced treatment systems, including technologies from Canadian companies. It is reasonable to expect significant progress to be made in water management in the oil sands over the next decade. WC

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