DILUTED BITUMEN SLURRY AND FROTH, SOLVENT

**Introduction**

Oil sands, tar sands or heavy oils are a mixture of water, sand, clay and bitumen. The bitumen can be extracted from the mixture and be upgraded into a higher-value synthetic crude oil for producing the same petroleum products as from conventional oil. Bitumen content in the sands is usually between 1 and 20%.

Oil sands can be recovered by surface mining or from subsurface reservoirs by steam injection and they can be classified in two types. If the bitumen is separated from the sand by a film of water, the oil sands are called water-wet. The other type is oil-wet, where the bitumen is bonded directly to the sand, or with little water between them.

Because bitumen content is low in the oil sand, it is important to keep tight control during the extraction process to maximize bitumen recovery and quality.

**Application**

The bitumen extraction process starts by milling the mined ore and mixing it with a solvent in a large vessel to create a slurry. This slurry is agitated to incorporate air bubbles.

For the extraction of bitumen from water-wet sands, the *Clark Extraction Process* is commonly used, where the solvent is hot water. For extraction from oil-wet sands, the hot water is replaced by a water/solvent solution (usually alkali), or completely by an organic solvent, e.g. citrus based.

In hot water extraction, the excess of water separates the bitumen from the water and sand. Because the bitumen is hydrophobic, it attaches to the air bubbles created by agitation and floats on the surface. In the case of oil-wet sand, the solvent dissolves in the bitumen and immediately separates the bitumen from the insoluble ore materials.

Next, the slurry is pumped into a large vessel referred to as the *Primary Separation Cell* to allow physical separation.
The aerated bitumen instantly floats on the top when it enters the vessel and it can be easily skimmed off. This bitumen froth usually contains 60 % bitumen, 30 % water and 10 % fine solids. The sand (tailings) sink to the bottom of the vessel and are removed as an underflow to the tailings treatment plant. A middle phase (middlings) is also formed consisting in fines that are too light to sink, and too heavy to float. The middlings have a higher content of bitumen than the underflow normally between 1-4 %.

The separated fractions move on for further treatment. The bitumen froth is mixed with a light hydrocarbon solvent (naphtha-based or paraffinic) to reduce its viscosity and to allow further separation of the fine solids. After this, the bitumen may be further upgraded by distillation to meet the required specifications. The water or solvent in tailings is recovered for reuse and the solids are transported back to fill the mine.

Instrumentation and installation

The K-Patents Process Refractometer PR-43-GP is an ideal heavy-duty instrument for oil sands extraction and bitumen processing. The refractometer provides an accurate and continuous measurement of bitumen froth and solvent concentrations at any stage of the process. The measurement of the refractometer is selective to the liquid phase and is not influenced by bubbles, suspended solids or the color of the mixture.

The K-Patents refractometer is installed directly in the pipe or vessels, and provides Ethernet or 4-20 mA output signals for real-time process control. The signal from the refractometer can be used, for example, to monitor the effectiveness of the gravity separation by installing refractometers in the bitumen slurry, bitumen froth and underflow lines of the Primary Separation Cell.

Finally, the refractometer monitors the distillation operation to guarantee that the final product meets the strict requirements by the refineries. The precise measurement by the K-Patents refractometer improves productivity and quality of the bitumen product with less costs and reduced environmental impacts. Automatic prism wash may be required in this application.

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<th>Instrumentation</th>
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<td>K-Patents Process Refractometer PR-43-GP</td>
<td>is a heavy-duty instrument with non-weld body construction for diverse oil and gas industry applications. The refractometer is installed in the main processing line by welding stud and flange connection for 2 inch, 2.5 inch and larger pipe sizes and vessels, or via flange and FTC Flow through cell connection for 0.5 inch, 1 inch, 1.5 inch and 2 inch pipe sizes.</td>
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| User Interface | Selectable multichannel MI, compact CI or a web-based WI user interface options allow the user to select the most preferred way to access and use the refractometer measurement and diagnostics data. |

| Automatic prism wash | Prism wash system components are a refractometer with integral wash nozzle mounted at the refractometer probe or in a flow cell, wash supply line components and a Multi user interface MI with relay module for prism wash diagnostics and control. Alternative wash media can be used for wash, e.g. steam, high-pressure water and warm water (hot condensate). |

| Measurement range | Refractive Index (nD) 1.3200 – 1.5300, corresponding to 0-100 % by weight. |