METHOD OF DETERMINING PROCESSABILITY OF TAR SANDS

ABSTRACT: The specification discloses a method for selectively mining bituminous tar sands which comprises collecting samples of tar sands from an exploration zone, analyzing the samples for their content of aluminum, and correlating the sample locations with the analysis to determine the location having the lower content of aluminum and hence the more easily processable tar sand.
METHOD OF DETERMINING PROCESSABILITY OF TAR SANDS

This invention relates to a method for selectively mining bituminous tar sands. Deposits of these sands occur in numerous localities as relatively shallow deposits. The largest known bituminizing tar sand deposits occur in the Canadian province of Alberta and are commonly referred to as the Athabasca tar sands. The deposits are of Mesozoic Age and underlie truncated Paleozoic limestones and are usually overlain by Pleistocene sediments. They underlie more than 13,000 square miles at depths of 0 to 2,000 feet. Total recoverable reserves of oil from the deposits after extraction and processing are estimated at more than 300 billion barrels. Other deposits on the North American continent are found in California, Utah, Kentucky, Kansas, Oklahoma, Wyoming, and elsewhere.

The tar sands are composed of a siliceous material, generally having a size greater than that passing a 325 mesh screen, saturated with a relatively heavy, viscous bitumen in quantities of from 5 to 21 weight percent of the total composition. More typically, the bitumen content of the sands is about 8 to 15 percent. This bitumen is quite viscous and contains typically 4.5 percent sulfur and 38 percent aromatics. Its specific gravity at 60°F. ranges typically from about 1.00 to about 1.06. The tar sands also contain clay and silt in quantities of from 1 to 50 weight percent of the total composition. Silt is normally defined as mineral which will pass a 325 mesh screen but which is larger than 2 microns. Clay is mineral smaller than 2 microns including some siliceous material of that size.

It has been proposed heretofore to recover oil from the sands by mining the deposit, separating the bitumen from other constituents of the tar sands, and further upgrading the bitumen to a crude oil suitable for further processing. In the hot water process for effecting the separation of bitumen from tar sands, the sands are jetted with steam and muddled with a minor amount of hot water at temperatures in the range of 140°F. to 210°F. The resulting pulp is dropped into a stream of circulating hot water and carried to a separation cell maintained at a temperature of about 150°F. to 200°F. In the separation cell, sand settles to the bottom as tailings and bitumen rises to the top in the form of an oil froth. An aqueous middlings layer containing some mineral and bitumen is formed between these layers. A scavenger step may be conducted on the middlings layer from the primary separation step to recover additional amounts of bitumen therefrom. This step usually comprises aerating the middlings as taught by K. A. Clark, "THE HOT WATER WASHING METHOD," Canadian Oil and Gas Industries 3, 46 (1950). These froths can be thicken, directed with naphtha, and centrifuged to remove more water and residual mineral. The naphtha is then distilled off and the bitumen is coked to a high-quality crude suitable for further processing. The hot water process is described in detail in U.S. Pat. application Ser. No. 509,589.

The processability of tar sands in this hot water process, and for that matter in any known bitumen separation process, varies considerably among sands mined even within a fairly localized area. As discussed in U.S. Pat. No. 3,273,967, Wilson, issued Sept. 20, 1966, the ease with which bitumen is separated from tar sand varies greatly. Some sands process easily while others tenaciously hold onto the oil. Thus, when employing the hot water process, recoveries of bitumen can range from about 50 to 95 percent.

The Wilson patent, U.S. Pat. No. 3,273,967, teaches a method for determining the processability of tar sands which comprises analyzing samples for their content of a matrix element selected from the group consisting of iron and zinc, and correlating the analyses with the sample to determine the location of the more easily processable tar sands. The patent teaches that zinc and iron and particularly iron are the only elements which appear to vary to any extent so as to give an indication of the processability of the tar sands. The patent teaches that tar sands which have higher contents of iron or zinc process more easily than those sands with lower contents of iron or zinc.

Generally, it has been found in the present invention that the iron and zinc contents of tar sands do give some indication of processability. However, it has also been found, in contrast to the teaching of the Wilson patent, that certain sands do not process with the ease which would be expected from an analysis of their zinc or iron content. Hence, it has been found that some tar sands with higher zinc or iron contents give low primary froth yields in the hot water process while other sands with lower zinc or iron contents give high primary froth yields.

A reliable processability indicator has been found per the present invention which can be used to predict which tar sands deposits will result in high froth yields when mined and processed. This indicator predicts processability with a greater degree of accuracy than the zinc or iron content analyses indicia. It has been found that a reliable inverse relationship exists between the aluminum content of tar sands and bitumen content of the sands. Since bitumen content is generally indicative of primary froth yields from sands in a hot water process, the aluminum content can be used to indicate froth yield. In other words, tar sands which have higher contents of aluminum give lower primary froth yields than tar sands of lower aluminum contents.

The present invention is directed to two embodiments of an application of this observation and relates to the determination of the location of deposits of easily processable sands and to the selective mining of bituminous tar sands. In one embodiment, the invention is a method for determining the processability of bituminous tar sands deposits which comprises; collecting samples of tar sands from an exploration zone, determining the aluminum content with the sample locations in the exploration zone to determine the location having the lower content of aluminum and hence the more easily processable tar sands.

In another embodiment, the invention is a method for selectivity mining bituminous tar sands which comprises; collecting samples of the tar sands, determining the aluminum content of the samples, correlating the aluminum content with the sample locations to determine the areas having sands of lower content of said aluminum and hence the more easily processable tar sands and mining tar sands from those areas.
The following example illustrates the present invention: Four samples of tar sands are collected from various locations within a tar sands mining area and are analyzed for aluminum and iron content by neutron activation analysis. In this analysis, a neutron flux is directed on the samples to activate them. Counting yields from radiation from the samples are measured and recorded by scalers which correct for background radiation and Compton gamma rays from higher energy gamma radiation. The neutron flux, which is held at a constant level through servocomputers in the generator control circuit, is also recorded on a scaler. At the end of a preselected counting interval, the outputs of the five scalers, the 24-hour time, and the elapsed time are printed and the system reset for the next count by action of the data analysis control circuit. The counts obtained from each sample are correlated against the counts from known samples to obtain aluminum and iron contents. The table shows percent aluminum and iron of each sample and percent bitumen, the latter as determined by solvent extraction.

<table>
<thead>
<tr>
<th>Sample</th>
<th>Percent Aluminum</th>
<th>Percent Iron</th>
<th>Percent Bitumen Content</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>1.5</td>
<td>0.1</td>
<td>12.6</td>
</tr>
<tr>
<td>B</td>
<td>2.3</td>
<td>0.3</td>
<td>8.7</td>
</tr>
<tr>
<td>C</td>
<td>2.8</td>
<td>0.6</td>
<td>4.7</td>
</tr>
<tr>
<td>D</td>
<td>4.8</td>
<td>0.5</td>
<td>3.2</td>
</tr>
</tbody>
</table>

In a hot water process highest primary froth yields are obtained from the processing of the tar sands from the location represented by Sample A. Tar sands from locations represented by Samples B, C, and D give progressively lower yields with sands from the location represented by Sample D giving the lowest yield. These yields correlate inversely with percent aluminum for each sample as shown in the table. On the other hand, no correlation can be derived between iron content and froth yield. For example, Sample A is low in iron content and it would therefore be expected that tar sands represented by this sample would give low froth yields, while Sample C is high in iron and it would be expected that tar sands represented by this sample would give high bitumen yields. However, as indicated, processing of the tar sands from location A results in the highest froth yields of the tar sands from any of the sampled locations while processing of the tar sands from location C results in very low froth yields.

What is claimed is:

1. A method for determining the processability of bituminous tar sands deposits which comprises: collecting samples of tar sands from an exploration zone; determining the aluminum content of said samples thereby indicating clay content of said deposit; and correlating the aluminum content with the sample locations in said exploration zone to determine the locations having the lower content of said aluminum and hence the more easily processable tar sands.

2. The method of claim 1 in which said determining step comprises: rendering a sample of said tar sands radioactive by neutron irradiation; recording emissions from said radioactive sample; and analyzing said emissions to determine the aluminum content of said sample.

3. A method for selectively mining bituminous tar sands which comprises: collecting samples of said tar sands; determining the aluminum content of said samples; correlating the aluminum content of the samples with the sample locations to determine the areas having the lower content of said aluminum and lower content of clay and hence the more easily processable tar sands; and mining tar sands from those areas having the said lower content.

4. The method of claim 3 in which said determining step comprises: rendering a sample of said tar sands radioactive by neutron irradiation; recording emissions from said radioactive sample, and analyzing said emissions to determine the aluminum content of said sample.