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TREATING ATHABASKA SANDS UTILIZING A FLOTATION GAS

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TREATING ATHABASKA SANDS UTILIZING A FLOTATION GAS

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The present invention is generally concerned with the recovery of hydrocarbons and bitumen from tar sands. The invention is especially concerned with an improved technique of efficiently removing hydrocarbons, as by bitumen, tars, and the like, from tar sands containing the same, such as Athabaska tar sands. The invention is particularly concerned with a unique method of securing the separation of bitumen particles from sand particles which, in essence, comprises the utilization of a hydrocarbon gas as, for example, methane which will function to change the apparent density of the bitumen particles to that of the density of water. The invention is particularly adapted for use in conjunction with a water technique conducted at ambient temperatures wherein from about 40 to 400% by weight of water is added to the tar sands.

In various areas of the world, tar sands exist which contain various types of hydrocarbons as, for example, the heavy deposits of Athabaska tar sands existing in Canada. These sands contain tremendous reserves of hydrocarbon constituents. For example, the oil in the sands may vary from about 5% to 21% by volume, generally in the range of about 12% by volume. The gravimetric oil ranges from about 6° to 10° API, generally about 8° API. These sands may lie from about 200 to 300 feet below an overburden and the beds may range from about 100 to 400 feet thick. A typical oil recovered from the sands has an initial boiling point of about 300° F., 1.0% distilled to 430° F., 20.0% distilled to 650° F. and 50.0% distilled to 980° F. However, the recovery of hydrocarbons in the past has not been effective to any great extent due to the deficiencies in operating techniques for the recovery of these hydrocarbons. For example, a relatively small amount of oil (from about 0% to 30%), usually about 5%) in the sand greatly retards recovery of the oil utilizing conventional water techniques. Apparently the oil and the clay form skins which envelop small pockets of water often containing finely divided sand; then the enveloped pockets are distributed in water, thus forming a type of emulsion.

Numerous attempts have been made in the past to recover bitumen from the Athabaska tar sands in various manners. For example, it has been suggested that a solvent be added in order to reduce the viscosity of the bitumen, and in conjunction with water, to float the bitumen solubilize mixture away from the sand. Although this technique achieves a good separation of clean sand, the addition of water results in problems with the formation of stable emulsions and sludges which have been very difficult to separate. Thus, extensive supplementary processing has been required in order to avoid large oil losses. Generally, in extracting the bitumen from tar sands, two main methods have been proposed: (1) the hot water wash employs water at about 180° F. plus a small amount of air; (2) the cold water wash at about 80° F. employs a large amount of light hydrocarbon diluent. In each of these processes, the major problem results from the very tight emulsions or sludges which are formed by interaction of the small amount of very fine solids in the sands plus oil, plus water. These tight emulsions are very difficult to break and the mixture of oil, water and solids is too dilute in hydrocarbon to make it practical to feed the whole “melt” to, say, a coking operation.

It has also been suggested in the past that tar sands as they are mined be handled by a thermal process in order to recover the bitumen therefrom. However, this process has been uneconomical due to the large amount of heat which is lost due to the fact that the heat is imparted to the sand and cannot be effectively and efficiently recovered therefrom. It has been suggested for example that tar sands be handled in a direct fluid coking operation. However, as pointed out, this process is uneconomical for the reasons given above. Also, any process that will effectively handle tar sands must have the ability to handle a very wide range of tar sand and compositions which occur even in an immediate location.

Thus, for example, it has been found that when tar sand is intermittently mixed with sufficient cold water, such as about 200 wt. percent of water at 70° F., a mixture containing small particles of bitumen and sand is obtained. Under these conditions, the sand particles in such a dilute suspension are essentially bitumen-free. This is the case even when, under certain mixing operations, a relatively small amount of the water as, for example, from 30 to 50 wt. percent is added and mixed under a shearing action and then the remaining quantity of water added to the slurry in order to dilute the slurry. This latter technique helps to break down any large particles in the sand. However, in such a process as described, the dilute cold suspension in general tends to produce a settled layer containing both the particles of bitumen as well as the particles of sand. The reason there is no sharp separation of sand from the bitumen is that the bitumen has a density slightly higher than that of water and, thus, does not float. For example, specific gravities of Athabaska bitumen vary from about 1.007 to 1.022 at 77° F. Even higher apparent specific gravities may be obtained if some fine clay is contained within the bitumen particle.

By the technique of the present invention, the apparent densities of the bitumen particles are lowered to less than that of water, thereby producing a very effective separation between the sand particles and the bitumen particles. The process of the present invention may be fully understood by reference to the drawing illustrating one embodiment of the same. Referring specifically to the drawing, natural tar sands are introduced into zone 3 and mixed with water which is introduced by means of line 2. In zone 3, the mixture is subjected to a mixing-shearing action. It is to be understood that zone 3 may comprise a plurality of stages, which stages may be operated at the same temperature or may be operated at progressively decreasing temperatures. Furthermore, as pointed out herefore, a relatively small amount of water may be initially added to the tar sands to produce a slurry which is thoroughly mixed and the remaining quantity of water thereafter introduced.

In accordance with the present invention, the slurry is then passed by means of pump 4 through line 5 into a gas absorption zone 14. In this zone, the slurry is thoroughly mixed with the gas as, for example, methane, ethane, or the like, which is introduced by means of line 6. A preferred adaptation of the invention is to maintain the zone 14 at a pressure in the range from about 5 to 50 lbs./sq. in. gauge. Thorough mixing is secured in zone 14 by means of stirrer or equivalent means 15.

In accordance with the present invention, by contacting the tar sands with a normally gaseous hydrocarbon under a moderate elevated pressure, the tar sand tends to dissolve the hydrocarbon gas, thereby changing its apparent specific gravity. The mixture is then passed by means of line 7 through valve 8 into a settler 9 which is maintained at a pressure below that of the pressure in zone 14 as, for example, from 5 to 20 lbs./sq. in. less. In zone 9 the hydrocarbon gas as, for example, methane, comes out of solu-
tion and forms gas bubbles attached to the bitumen particles. The decreases the average specific gravity of the bitumen particles and causes the same to float. Thus, the bitumen particles may be removed as a bitumen phase by means of line 11 while the sand and water phase is removed as a bottoms stream by means of line 10. Gas particles are removed overhead by means of line 13 and repressured as a recycle stream. Make-up gas may be added by means of line 12.

A further advantage of the present invention is that, even if clay is present in the bitumen particles, these clay containing particles can also be made buoyant by the employment of adequate hydrocarbon pressure. In general, it is preferred that the pressure in zone 14 be in the range from 20 to 30 lbs./sq. in. gauge, preferably about 25 lbs./sq. in. gauge. It is preferred that the pressure in zone 9 be 10 to 15 lbs./sq. in. gauge below the pressure existing in zone 14.

The process of the present invention provides great flexibility and substantial advantages over the conventional hot water process in that tar sands containing substantial quantities of clay may be readily separated from the sand particles. For example, the bitumen particles may be separated from clean sand in a settling tank or in a hydraulic cyclone, both of which preferably operate at substantially atmospheric pressure. The drop in pressure from the methanization step provides the energy required for the hydraulic cyclones. Hydrocarbon gas as, for example, methane, will be recycled as it is freed from the bitumen in the settling zone.

What is claimed is:

1. In a process for the removal of bitumen from tar sands wherein a liquid is mixed with natural tar sands and the bitumen later recovered by a flotation technique, the improvement which comprises adding to the mixture of liquid and tar sands a hydrocarbon gas wherein said gas is added in an initial stage at an elevated pressure, the mixture agitated at said elevated pressure and then introduced into a second settling stage maintained at a lower pressure.

2. Process as defined by claim 1 wherein said hydrocarbon gas is selected from the class consisting of methane, ethane, and propane.

3. Process as defined by claim 1 wherein said elevated pressure is in the range from about 20 to 30 lbs./sq. in. gauge and said lower pressure is about atmospheric pressure.

4. Process as defined by claim 1 wherein said liquid comprises water.

5. Improved process for the recovery of bitumen from natural tar sands which comprises mixing a liquid with said tar sands to form a slurry, thereafter adding a flotation gas to said slurry at an elevated pressure, thereafter mixing said gas and slurry in a mixing zone at said elevated pressure thereafter passing said mixed slurry to a settling zone maintained at a lower pressure, removing a top layer of bitumen from said settling zone and removing sand and water from the bottom of said settling zone.

6. Process as defined by claim 5 wherein said liquid comprises water.

7. Process as defined by claim 6 wherein the gas added to said mixing zone is a hydrocarbon gas.

8. Process as defined by claim 7 wherein said gas comprises methane which is separated in said settling zone and recycled to said slurry.

9. Process as defined by claim 8 wherein the pressure in said mixing zone is in the range from about 20 to 30 lbs./sq. in. gauge and the pressure in said settling zone is about atmospheric.

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