

Dec. 30, 1969

P. E. CHANEY ETAL

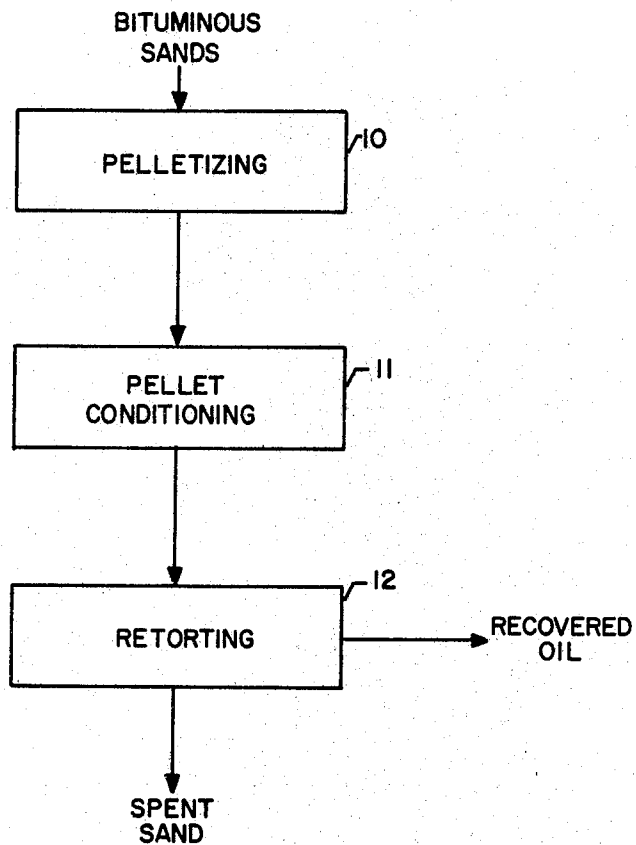
3,487,002

RETORTING OF BITUMINUS SANDS

Filed Sept. 8, 1967

2 Sheets-Sheet 1

FIG. 1



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2 Sheets-Sheet 2

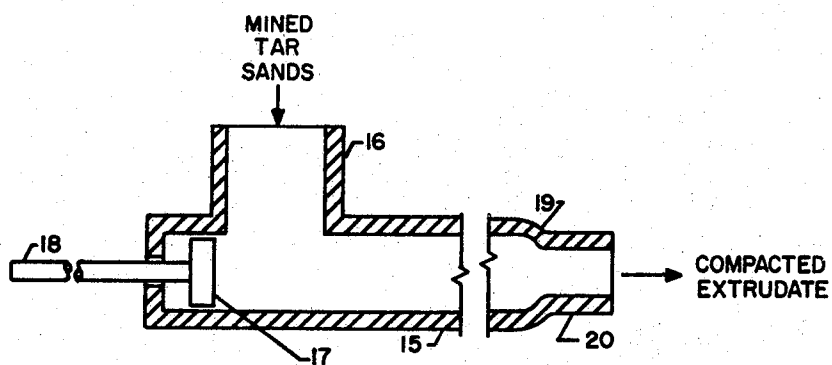
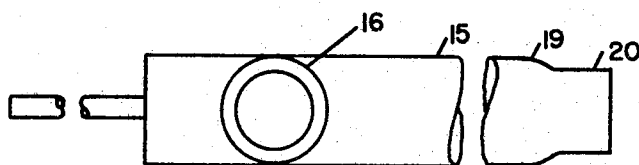


FIGURE 2

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3,487,002

RETORTING OF BITUMINOUS SANDS

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U.S. Cl. 208—11

9 Claims

ABSTRACT OF THE DISCLOSURE

Method of recovering oil from mined tar sands involving forming compacted tar sands pieces by special conditioning treatment that provides low internal permeability and then retorting in fixed bed form. The conditioning treatment can involve rolling of pre-formed pellets, compaction in a mold or pressure extrusion. Substantial collapsing of the bed during retorting is avoided.

Cross reference to related application

This application is a continuation-in-part of application Ser. No. 476,410, filed Aug. 2, 1965, now abandoned.

Background of the invention

This invention relates to the retorting of bituminous or tar sands for the purpose of recovering oil therefrom. More particularly the invention is directed to a process for retorting bituminous sands which process includes a conditioning treatment for putting the bituminous sands in a condition in which they are suitable for retorting in the form of a fixed bed.

Bituminous sands or tar sands comprising unconsolidated sands impregnated with heavy oil usually along with a small amount of water occur in numerous localities as relatively shallow deposits. The largest known bituminous sand deposit occurs in the Canadian province of Alberta and is commonly referred to as Athabasca tar sands. Other deposits on the North American continent are found in Utah, Kentucky, Kansas, Oklahoma, Wyoming, and elsewhere.

The prior art discloses numerous processes primarily intended for retorting oil-bearing shales but often described as being equally applicable to the retorting of tar sands. Examples are the following United States patents pertaining to retorting of carbonaceous materials, such as oil shales, coal and tar sands, in bed form: 2,406,810; 2,885,338; and 3,130,132. Disclosures which include tar sands among the carbonaceous feed materials described generally fail to take into account the marked difference in character of tar sands as compared to oil shales. The latter material is hard rock which is non-pliable and a bed composed of pieces of the oil shale rock has no tendency to collapse during retorting. On the other hand, tar sands are plastic material and pieces thereof normally are incapable of maintaining their shapes under retorting conditions.

In view of the distinctly different physical characteristics of oil shales on the one hand and tar sands on the other, prior procedures suitable for retorting oil shales have not proved to be applicable to tar sands. These processes are unsatisfactory for tar sands due to the fact that the chunks or particles will not retain their shape during heating, as a consequence of which the bed tends to collapse and the particles to fuse at the high temperature required for retorting. As this occurs the pressure drop necessary to maintain a reasonable flow

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of hot gas through the bed rises inordinately. In order to drive out most of the oil from the mined sands, a relatively large volume of hot gas is required, usually in excess of one pound of hot gas per pound of bituminous sands, in order to heat the entire bed to the desired retorting temperature. This temperature must be in excess of 700° F. and desirably is in the range of 900–1500° F. As the chunks or particles of bituminous sands are heated toward such temperature levels, the particles soften and the weight of the bed tends to cause it to collapse. With the bed in collapsed condition the cost of compressing a sufficient amount of gas to heat the entire mass to retorting temperature becomes excessive, making the retorting process uneconomical and impractical.

The present invention overcomes this problem resulting from collapsing of the tar sands bed during retorting and avoids the expense otherwise entailed in compressing the retorting gas. Practice of the invention permits the retorting operation to be carried out utilizing fans or blowers to effect the necessary circulation of hot gas through the bed of bituminous sands instead of compressors. The particles or pellets that form the bed retain their individual shapes throughout the entire retorting operation, with the result that collapsing of the bed does not occur and no substantial increase in pressure drop of the retorting gas is experienced. Furthermore, the individual pellets do not fuse together during the retorting operation in spite of the carbonaceous residues formed therein. Hence the retorted sands can readily be dumped or otherwise removed from the retorting zone.

Description of the invention

The improvement provided by the present invention in the retorting of bituminous sands is achieved by virtue of the manner by which the bituminous sands are prepared for retorting and the manner of handling the material during the retorting operation. The conditioning treatment can be carried out in several ways as hereinafter described, but in all embodiments the tar sands are compacted in a manner such that air or gas is squeezed out of the pores and the internal permeability of the tar sands material is reduced to within the range of 0–2000 millidarcies. The tar sands pieces so compacted can then be retorted in fixed bed form, and the pieces will substantially retain their shapes during retorting so that collapsing of the bed is avoided.

FIG. 1 is a schematic illustration of the invention in one embodiment in which tar sands pellets are first formed and then are conditioned by a rolling treatment prior to retorting.

FIG. 2 is an elevational view partly in section of apparatus for practicing another embodiment of the invention wherein conditioning of the tar sands prior to retorting is effected by pressure extrusion; and FIG. 3 is a plan view of the same apparatus.

In one embodiment of the invention illustrated by FIG. 1, the present process involves first forming the bituminous sands into pellets or chunks having sizes which are more or less uniform in all dimensions and which are mainly in the range of ¼ inch to six inches, more preferably one inch to four inches. The pellets then undergo treatment in a conditioning step that is essential for imparting to the pellets weight-supporting characteristics necessary for effecting the retorting step successfully. This conditioning step, in one embodiment of the invention, involves subjecting the pellets to a rolling action that effects a continuous gentle deformation thereof, whereby the sand grains within each pellet become more densely packed and the pellets assume a smoother and glossier appearance than they had before rolling. This rolling action causes a marked decrease in the permeability of the individual pellets. After the pellets have been rolled

sufficiently, they are then capable of forming a bed which can be subjected to retorting conditions without exhibiting any substantial tendency to collapse. During the retorting the pellets retain their shapes and do not tend to stick together appreciably. By passing sufficient gas heated to above 700° F., preferably to within the range of 900–1500° F., through the bed, typically 80% by weight of the bituminous material can be driven out and recovered as oil. The rest of the bitumen or heavy oil is converted to normally gaseous hydrocarbons and carbonaceous material which remains as a residue in the pellets.

With reference to FIG. 1, the embodiment therein illustrated involves three principal operations, namely, a pelletizing step indicated by numeral 10 wherein the bituminous sands are formed into pellets or pieces of suitable size, next a conditioning step indicated at 11 in which the pellets are subjected to a rolling action which increases their weight-supporting ability, and then a retorting step indicated at 12 wherein the oil is thermally educted from the rolled pellets.

In bituminous or tar sands as they occur in nature the packing arrangement of the sand grains probably approaches the most dense packing possible, namely, rhombohedral packing, since the sand grains have had the opportunity to settle for eons. In spite of the close packing the unmined sands contain some pore spaces not filled with bitumen or water, since they exhibit some degree of permeability and gas can be made to flow at substantial rate therethrough if sufficient pressure is applied. However, mining and other handling of the sands tends to disrupt the arrangement of the sand grains and cause the permeability to increase substantially. Chunks or pellets of the mined sands with sizes in the range of ¼ inch to six inches commonly will have internal permeabilities in the range of 5000–50,000 millidarcies, which represents a considerably greater permeability than that of the sands in their native state. The pieces in this disrupted state are friable and incapable of supporting substantial weight, and their surfaces appear dry and rough. Subsequent conditioning of the pieces by rolling as more fully discussed below causes the sand grains again to assume a more dense packing arrangement and generally reduces the permeability of individual pellets typically to 0.5–10% of the permeability prior to rolling. Also this treatment makes the pellets less friable and causes the surfaces to appear smooth and glossy.

Considering the process of FIG. 1 more specifically, the bituminous sands as obtained by mining a deposit generally will vary in size from small particles to relatively large hunks. These are first processed in any suitable manner to put them in the form of pellets or pieces mainly of the size range of ¼ inch to six inches, more preferably one inch to four inches. For example, the mined sands can be passed through choppers, and the sands can then be extruded and cut into pieces of the desired size. Alternatively wire grid cutters or a series of knife blades can be used to cut the mined material on three dimensions to form cubic or other hexahedral pieces of appropriate dimensions. In fact any procedure for forming pellets or pieces which do not readily fall apart when subjected to a rolling motion can be used in the pelletizing step.

The pelletized bituminous sands next undergo the conditioning treatment which reduces the permeability of the pellets and makes them considerably less friable. This conditioning treatment involves continuously rolling the pellets until the desired weight-supporting characteristics have been attained. This rolling operation can be carried out in an inclined drum which rotates on its axis and causes the pellets to tumble continuously. The drum suitably can be rotated, for example, at a speed in the range of 10 to 100 r.p.m., and the time of rotation generally should be in the range of 0.1–1.0 hour. The rate of rotation should not reach the value at which the pellets will be held at the side of the drum due to centrifugal

force, as this will eliminate the desired rolling of the pellets which is necessary for properly conditioning them. The degree of reduction of permeability of individual pellets can be used as an indication of whether the pellets have undergone sufficient rolling action. As a general rule the rolling action should be carried out for enough time to reduce the average permeability of the pellets to within the range of 0.5–10% of the pellet permeability prior to rolling. Typically the pellet permeability of the formed pellets prior to rolling will be in the range of 5000–50,000 millidarcies whereas that for the rolled pellets will be in the range of 50–2000 millidarcies. Usually rolling for 10–40 minutes is satisfactory for conditioning the pellets for the retorting step. In the rolling step the pellets tend to retain generally the shape and size which they had when fed to this step but become rounded at the edges. Also small particles become consolidated into the larger particles and thus disappear, but the larger particles themselves do not meld or merge with each other. The rolled pellets thus have a more uniform size than the material charged to the rolling step.

Prior to rolling, the pelleted particles of bituminous sands can be crumbled rather easily and their surfaces appear dry and rough. Upon rolling, the pellets take on a smooth, glossy, non-porous appearance and become much less easy to crumble. In this latter condition the pellets are capable of forming a bed which surprisingly will retain its high permeability and not collapse even when the pellets are subjected to retorting temperatures. This desirable and necessary change in pellet characteristics resulting from the rolling action comes about due to the continuous gentle deformation or kneading which the pellets undergo during rolling. Such kneading forces air out of the pores of the pellets and reduces their porosity, allowing the sand grains to assume a more perfect packing arrangement more like they originally had before mining. Hence, as pointed out above, the pellets after the rolling step have internal permeabilities which are only of the order of 0.5–10% of the permeability of the pelleted material charged to this conditioning step.

Another manner of rolling the pelleted bituminous sands to condition them for retorting involves the use of a traveling conveyor belt instead of a rotating drum. One suitable manner of transporting mined materials from the mine site to a processing plant is to employ a conveyor belt system. In practicing the present invention an appropriately designed conveyor belt system can be used to transport the mined sands from the mine to the retorting plant while simultaneously conditioning the sands for retorting. For this purpose the pelletizing apparatus is located at the mine site, and the mined sands are first pelleted and then placed on the conveyor belt. The belt is arranged to move along a trough and alternately to slant toward one side and then toward the other. Hence as the pelleted material travels along with the moving belt, the pellets are caused to roll back and forth across the belt. This effects the continuous gentle deformation of the pellets which puts them in suitable condition for retorting.

The final step of the process is the retorting in which the conditioned pellets in the form of a bed are subjected to retorting temperatures above 700° F. to drive out the oil. This is done by passing hot gas, preferably at a temperature in the range of 900–1500° F. through the bed until the entire mass has been heated sufficiently to drive out substantially all of the recoverable oil. We have found that a bed of pellets conditioned as described above can be successfully retorted without requiring a high inlet pressure for the retorting gas at any time during the retorting. For pellets of ¼ inch to six inch size and more preferably one inch to four inches, the individual pellets can be heated throughout within a reasonable time period by passage of the hot gas through the bed, even though the conditioned pellets have internal permeabilities which are relatively low. Adequate heat transfer from the outside

surface to the interior of the individual pellets will occur so that excessive heating periods and unreasonably large heating gas flows are not required. Generally 70-88% by weight of the organic matter can be recovered as liquid oil product in addition to a substantial amount of gaseous hydrocarbon products. The remainder is coke or carbonaceous residue which remains on the sand in the pellets. The pellets do not themselves tend to fuse and stick together in spite of the high retorting temperatures and the carbonaceous residue formed. The latter does act as a binder for the sand grains, so that each pellets remains intact throughout the retorting periods. The depleted pellets can readily be dumped or flowed from the retort.

Numerous specific procedures have been proposed for retorting beds of carbonaceous materials and those procedures utilizing a "fixed bed," as defined below, are generally applicable to retorting of the conditioned bituminous sands of the present invention. Any procedure wherein hot retorting gas is passed through a "fixed bed" of particulate charge material can be used for the present purpose. By "fixed bed" is meant a bed in which the pellets during the retorting operation do not move substantially with respect to the wall of the retort vessel or to each other although the entire bed together with containing vessel may move as a unit such as, for example, through a tunnel-type retorting arrangement for cyclic operation. Procedures using either one or more stationary beds or one or more transported beds of the pelleted bituminous sands can be used. However, any procedures in which substantial jarring or other rough handling of the pellets might occur during the retorting operation should be avoided. It is generally preferred that the fixed bed of conditioned pellets have a bed depth in the range of 0.5-5 feet.

One known type of retorting procedure suitable for the present purposes involves the use of a grate which moves on a circular track within a compartmented tunnel. Means are provided at one point along the track for placing on the grate a bed of material to be retorted and for dumping out the spent material at another point after retorting. In one zone constituting a portion of the circular system the fresh material is heated to retorting temperature by passing preheated gas upwardly or downwardly through the bed until all recoverable oil has been educted. The gaseous effluent from this zone contains the educted hydrocarbons, and the oil product can be recovered therefrom by passing the effluent through a cooler and separating the oil as a condensate. The hot spent pellets from this stage are at the final retorting temperature and it is desirable to recover and utilize heat therefrom before discarding the pellets. Hence the hot bed passes to another portion of the circular system which constitutes a heat recovery zone. In this zone the cooled retort gas from which the liquid hydrocarbons were condensed is passed through the bed of spent pellets and is thereby heated. The resulting effluent gas from this zone still requires additional heat in order again to reach the desired temperature for retorting. Since this gas contains the light hydrocarbons produced in the retorting, such additional heating can be effected by adding air to the circulating stream and burning a portion or all of the hydrocarbon gases contained therein. The heated gas can then be circulated back to the retorting zone. After passing from the heat recovery zone the spent material is dumped from the grate and then pellets of fresh tar sands are placed on the grate to start a new cycle.

The optimum size for the rolled pellets fed to the retorting operation depends upon such factors as depth of the bed employed, temperature of the inlet retorting gas and compressive strength of the pellets resulting from the rolling action. The pellet size generally should not exceed six inches, since the time required to transfer sufficient heat to the interior of the pellet to drive out all recoverable

oil becomes excessive. On the other hand, since the weight-supporting ability of a pellet increases with its diameter or thickness, the pellet size should not be less than 1/4 inch. As the pellet size increases the hydrocarbon product from the retorting reaction tends to be more highly cracked. Optimum sizes for commercial practice are in the range of one inch to four inches.

As previously indicated the retorting can be carried out with the retorting gas flowing either upwardly or downwardly. When the flow is downwardly through the bed, the gas flow has a compressing effect on the bed which effect tends to require larger pellet size to prevent the particles from collapsing. On the other hand, when the gas flow is upwardly, liquid products which tend to condense in the bed as it is being heated up to retorting temperature can produce a hydrostatic head that requires a higher pressure drop for flow of the retorting gas. As a compromise between these two effects, the retorting operation alternatively can be carried out using a horizontal flow of retorting gas through the bed so that compression of the bed toward its bottom does not take place and any liquid condensate can more readily be pushed out of the bed due to the lateral flow of the gas.

A modification that can be practiced in connection with the retorting step 12 involves segregating the conditioned pellets from step 11 into at least two size ranges and charging the retort with the larger pellets at the bottom of the bed and the smaller at the top. With this arrangement an updraft is used for the retorting gas. Advantages of this procedure are that the larger pellets in the lower part of the bed have a better capacity for supporting its weight and also that they have a longer period to undergo retorting since the hot inlet gas contacts them first. Such longer retorting time is needed to effect heat transfer from the surface to the center of the larger material than is required for the smaller pellets.

The following example is a specific illustration of the process of FIG. 1 as applied to a batch of Athabasca tar sands having a bitumen content of about 12% by weight. The tar sands were first extruded by means of an ordinary meat grinder and cut into pieces having dimensions mainly in the range of 1/4 inch to 1/2 inch. A minor amount of smaller particles was present in the pelleted material. The surfaces of the pellets at this stage appeared dry and rough. This material was placed in a drum which was inclined with its axis at an angle of about 45° from horizontal. The drum was rotated on its axis at a speed of about 60 r.p.m. for 20 minutes. This subjected the pellets to a continuous rolling action, whereby they became more compacted internally and took on a smooth and glossy or oily appearance. During the rolling the smaller particles disappeared due to melding with the larger particles. Tests on two random samples prior to rolling and two other random samples after the rolling showed the following permeabilities:

	Permeability, millidarcies
Before rolling	20,400; 19,000
After rolling	272; 907

These results show that the rolling action markedly decreased the permeabilities of the pellets.

The rolled pellets in amount of 53 pounds were then placed in a retort which was a vertical section of pipe of 10 inch I.D. to form a bed 18 inches high. Means were provided for passing hot retorting gas upwardly through the pipe and then through a condenser. Nitrogen was used as the retorting gas and it was heated externally before entering the bottom of the retort. The rate of nitrogen flow, corrected to standard conditions, was 35 cu. ft./min. Means were also provided for measuring inlet and outlet temperatures of the bed and also the pressure drop through the bed during the run. The operation was started

with the entire bed at ambient temperature, and the following readings were taken as the run proceeded:

Time, min.	Temperature, ° F.		ΔP across bed, inches of water
	Upstream	Downstream	
Start-----	52	52	0.5
20-----	350	90	1.4
40-----	400	160	3.3
62-----	650	330	4.2
90-----	920	750	5.1
120-----	1,100	900	5.1

The run was stopped after two hours from start, as substantially complete retorting had then been effected. The yield of liquid hydrocarbon product obtained was about 85% by weight on the bitumen in the tar sands charged. This oil product had the properties shown below. For comparison the properties of raw tar obtained by solvent extraction from the original tar sands are included.

	Raw tar	Retort oil
Gravity, ° A.P.I.-----	7	14
Viscosity, cp. at 75° F-----	>50,000	140
Viscosity, cp. at 155° F-----	800	12
Pour point, ° F-----	90	-10
Conradson carbon, wt. percent-----	13	4
Sulfur, wt. percent-----	4.7	3.7

The pressure drop data given for the run above show that there is some increase in pressure drop through the bed during retorting but that this amounts to only a few inches of water. From this it is apparent that tar sands which have been conditioned by rolling according to the invention can be successfully retorted without the necessity of providing compressors to circulate the retorting gas. The low pressure drop that occurs permits fans or blowers to be used to effect the gas circulation, and hence the operation can be conducted with less expense than would be entailed if the step of rolling the pellets prior to retorting were omitted.

In another modification of the invention, the mined tar sands can be placed in a mold of any suitable shape and compacted by mechanical application of pressure of at least 25 p.s.i.g. For example, a cylinder having a piston for application of pressure, means for introducing batches of mined tar sands and means for removing the compacted cylindrical mass can be used to prepare pellets having a minimum width in the range of ¼ inch to 6 inches suitable for retorting. It has been found that application of pressure to a tar sand mass in this manner will readily reduce its permeability to essentially zero when the pressure is raised sufficiently, e.g., to 200 p.s.i.g. or higher. The resulting compacted pellets have excellent characteristics for retorting.

In still another embodiment of the invention, a pressure extrusion procedure is utilized for conditioning the tar sands prior to retorting. Apparatus for practicing this embodiment is illustrated in FIGS. 2 and 3. This procedure achieves compaction of the tar sand material while simultaneously forming it into a continuous cylindrical extrudate from which pieces of suitable length for retorting can be cut.

With reference to FIGS. 2 and 3, the compacting and extruding apparatus therein illustrated comprises a horizontal barrel 15 into which the mined tar sands are introduced through feed nozzle 16. Barrel 15 is provided with a piston 17 actuated through rod 18 for forcing the introduced tar sands therethrough under pressure and is swedged down at 19 to provide an outlet nozzle 20. This nozzle should have an internal diameter in the range of ¼ inch to 6 inches, more preferably 1-5 inches, so that the compacted extrudate issuing through nozzle 20 will have a corresponding diameter. The extruded tar sands can be transversely cut into suitable lengths, e.g., 0.5-10 feet, by means of a knife or wire cutter (not shown) to provide elongated cylinders or log-shaped pieces.

In this extrusion operation the application of pressure by the piston 17 to the tar sand mass in barrel 15 squeezes out the gas from the interstices and pores and compacts the mass. By operating so that the pressure applied to the mass at the swedge shoulder 19 is in excess of 25 p.s.i.g., and more preferably in the range of 50-500 p.s.i.g., the permeability of the extrudate can readily be reduced to below 2000 millidarcies and can even be caused to approach zero. Compaction of the tar sands in this manner so that the average permeability of the log-shaped pieces is in the range of 0-2000 millidarcies has now been found to condition the tar sands suitably for retorting in a fixed bed. For this purpose the cylindrical tar sand pieces cut to suitable length are transferred to the retorting zone wherein they are stacked horizontally in rows transverse to each other to form a fixed bed which can then be retorted essentially as described in connection with FIG. 1. Substantially collapsing of the resulting bed during retorting does not occur.

In any of the procedures described above for conditioning the tar sands prior to retorting, the internal permeability of the compacted pieces is reduced to below 2000 millidarcies and preferably to as low a value as is practicable. It should be clear that the reduction in internal permeability of the material is not inherently necessary to the subsequent retorting process but rather is a measure of the degree of consolidation and the mechanical strength of the compacted material. Because of this relationship between mechanical strength and internal permeability it can be predicted that chunks having high internal permeability will collapse during retorting while those having internal permeabilities within the prescribed range will have sufficient strength for retorting if carefully handled in a fixed bed retort.

It should be understood that the tar sands, even when compacted to the maximum possible degree, are plastic and relatively easy to deform. Furthermore, the strength of the pellets decreases substantially as the tar is melted during the retorting process. Hence we have found it impossible to achieve sufficient compaction of the tar sand to permit retorting in moving bed retorts. Only by gentle handling in fixed bed retorts as described above can retorting be achieved with these fragile materials. The ability of the pieces to retain their shapes under retorting conditions increases as the degree of compaction is increased. On the other hand, the ability of the pieces to allow maximum oil recovery during retorting is not adversely affected in spite of the low permeability resulting from the described conditioning treatments.

What is claimed is:

1. Method of retorting tar sands which comprises:

- (a) forming the tar sands into pellets having sizes mainly in the range of ¼ inch to 6 inches having an internal permeability in the range of 5000-50,000 millidarcies;
- (b) subjecting the pellets to a rolling action effecting a continuous gentle deformation thereof until the sand grains within each pellet have become more densely packed having an internal density in the range of 50-2000 millidarcies and the pellets have assumed a smoother and glossier appearance;
- (c) forming a fixed bed of the rolled pellets in a retorting zone;
- (d) and passing hot gas through the bed at a temperature and for a time sufficient to raise the temperature throughout the bed to above 700° F. and drive out a major portion of the oil therefrom, whereby said pellets substantially retain their shapes during retorting and collapsing of the bed is avoided.

2. Method according to claim 1 wherein said temperature is in the range of 900-1500° F.

3. Method according to claim 1 wherein said sizes mainly are in the range of one inch to four inches.

4. Method according to claim 1 wherein said rolling action reduces the internal permeability of individual

pellets to within the range of 0.5–10% of the permeability prior to rolling.

5. Method of retorting tar sands which comprises:

(a) subjecting tar sands having relatively high permeability to compression at a pressure above 25 p.s.i.g. and recovering the compressed sands as pieces of minimum width in the range of ¼ inch to 6 inches having internal permeability less than 2,000 millidarcies;

(b) forming a fixed bed of said pieces in a retorting zone;

(c) and passing hot gas through the bed at a temperature and for a time sufficient to raise the temperature throughout the bed to above 700° F. and drive out a major portion of the oil therefrom, whereby said pieces substantially retain their shapes during retorting and collapsing of the bed is avoided.

6. Method according to claim 5 wherein said temperature is in the range of 900–1500° F.

7. Method according to claim 5 wherein said compression is effected by compaction in a mold.

8. Method according to claim 5 wherein said compression is effected by pressure extrusion through a nozzle.

9. Method according to claim 8 wherein the compressed tar sands are extruded as an elongated cylindrical mass, said pieces are formed by cutting the cylindrical mass transversely to obtain elongated cylinders, and said fixed bed is formed by stacking the cylinders horizontally in the retorting zone.

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HERBERT LEVINE, Primary Examiner

U.S. Cl. X.R.

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