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[54] **METHOD FOR TAR SANDS BITUMEN FROTH TREATMENT**

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[56] **References Cited**

UNITED STATES PATENTS

2,013,668 9/1935 Peltzer et al. ..... 233/16 X

FOREIGN PATENTS OR APPLICATIONS

480,943 3/1938 Great Britain 233/17

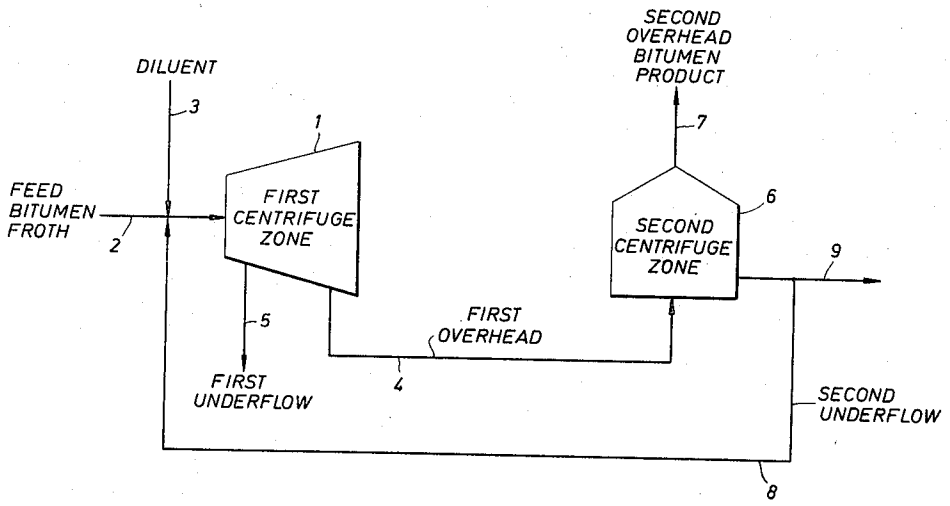
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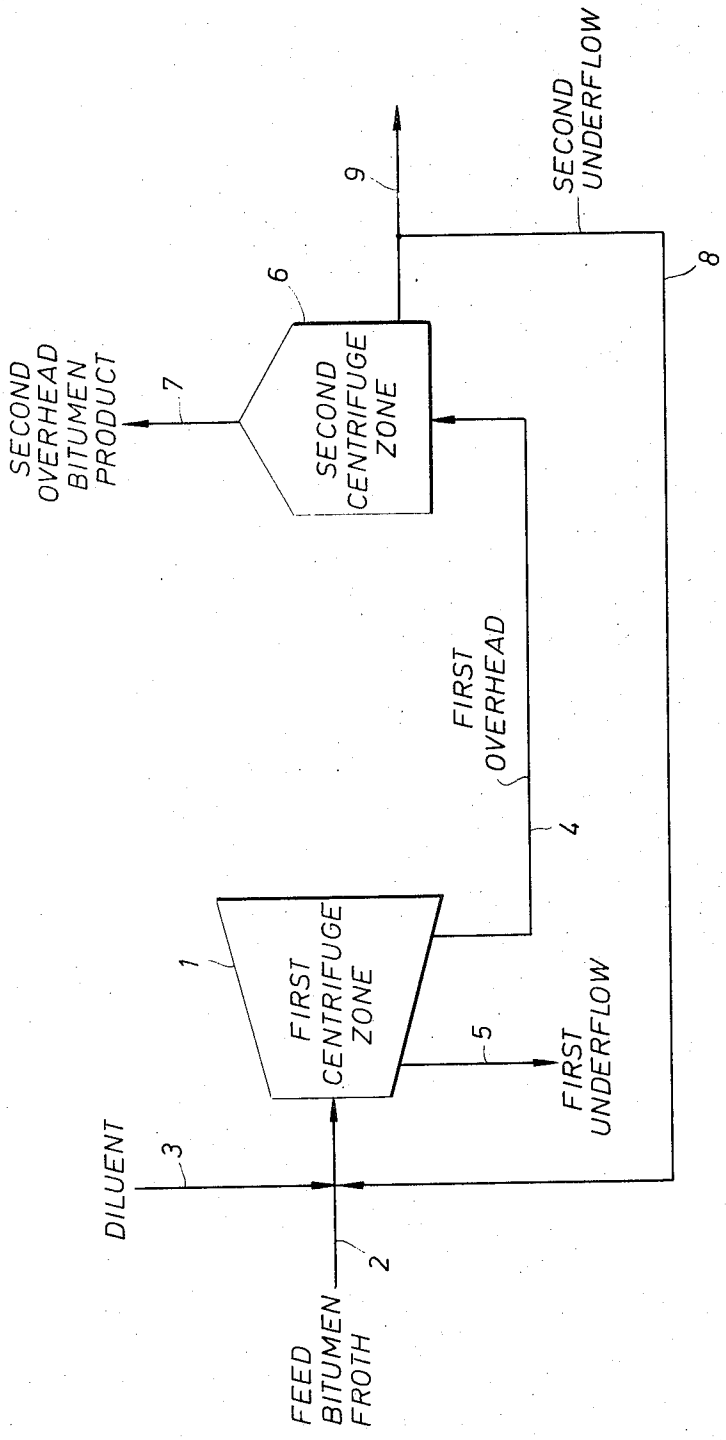
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[57] **ABSTRACT**

A method for treating tar sands bitumen froth wherein the froth is centrifuged in a first zone to separate coarse mineral particles therefrom, the froth is then treated in a second centrifuge zone to separate fine mineral particles therefrom, and at least part of the fine mineral particle underflow from the second centrifuge zone is treated in the first centrifuge zone to remove additional bitumen associated with the fine mineral particles, and at least part of the thus treated fine mineral particles are removed from the first centrifuge zone along with the coarse mineral particles.

3 Claims, 1 Drawing Figure




FEED BITUMEN FROTH
DILUENT
FIRST CENTRIFUGE ZONE
FIRST OVERHEAD
FIRST UNDERFLOW
SECOND CENTRIFUGE ZONE
SECOND OVERHEAD BITUMEN PRODUCT
SECOND UNDERFLOW
1
2
3
4
5
6
7
8
9

METHOD FOR TAR SANDS BITUMEN FROTH TREATMENT

BACKGROUND OF THE INVENTION

This invention relates to an improvement in the plural stage centrifuging of bitumen from the froth produced in a hot water process for separating bitumen from bituminous tar sands. Tar sands are primarily composed of a fine quartz sand having a particle size greater than that passing 325 mesh screen. The quartz sand is impregnated with a viscous bitumen in quantities of from about 5 to about 21 weight percent of the total composition. 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 to about 1.06. In addition to the bitumen and quartz sand, the tar sands contain clay and silt in quantities of from about 1 to about 50 weight percent of the total composition. Silt is normally defined as material which will pass a 325 mesh screen but which is larger than 2 microns. Clay is material smaller than 2 microns including some siliceous materials of that size.

In the hot water process for separating bitumen from tar sands, the sands are jetted with steam and mulled with a minor amount of hot water at temperatures in the range of from about 140° to about 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 from about 150° to about 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 particles 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. These froths are then combined, diluted with naphtha or other diluent and centrifuged to remove more water and residual mineral particles. The naphtha is then distilled off and the bitumen is coked to a high quality crude suitable for further processing as desired.

The bitumen product from this hot water process has a relatively specific composition. The product contains from about 35 to about 45 weight percent water and from about 5 to about 10 weight percent mineral before dilution. The water content of this product is reduced to from about 4 to about 6 weight percent and the mineral particles to from about 1 to about 4 weight percent before the product is further processed. This reduction can be accomplished by plural stage centrifuging as described in Canadian Patent No. 596,561. Each stage of the centrifuging operation can consist of a single machine or a battery of machines connected in parallel. In these operations the first stages are conducted by the application of relatively low forces to remove coarse mineral particles, e.g., greater than about 5 microns in size, while relatively higher forces are applied in the later stages to remove fine mineral particles, e.g., about equal to or less than 5 microns in size, and most of the water. The mineral particles and water discharged from the centrifuges are removed from the centrifuging zone for disposal.

In this invention, reference to particle size means the diameter of the particle if it is essentially round or the largest cross-sectional dimension of the particle if it is not essentially round.

A substantial amount of the coarse mineral particles, particularly those greater than 100 microns in size, are water-wet whereas the fine mineral particles are hydrocarbon-wet so that a measurable amount of bitumen is carried out of the process with the fine mineral particles. Thus, the fine mineral particles removed from the last centrifuging zone have been removed from the bitumen recovery process and the bitumen associated with those fines has not been recovered.

Therefore, it is highly desirable to minimize the amount of bitumen associated with the fine mineral particles out of the bitumen froth treatment process.

One solution to this problem is to wash the fine mineral particles after separation from the froth in a separate washing zone, and to then separate the washed fines from the bitumen and wash material. During separation these particles are agglomerated together to a significant extent by virtue of the bitumen which covers their surface. Upon washing, in which this bitumen is replaced with a less cohesive diluent, the particles are dispersed and become effectively even finer particles to separate. The difficulty of the recovery of fine particles increases greatly in this washing case. Thus, simply washing the fines is not practical. The fines become so small that it is extremely difficult to separate them from their carrier liquid. Further, separate and additional washing apparatus and fines separating apparatus adds considerable expense to the froth treatment apparatus and cost of processing.

Accordingly, it would be very advantageous to have a process whereby at least part of the bitumen associated with the fine mineral particles is recovered, the fine mineral particles removed from the process after at least part of the bitumen associated therewith has been removed therefrom, and all this accomplished with a minimum of additional apparatus and processing expense.

BRIEF DESCRIPTION OF THE INVENTION

It has now been discovered that in a situation where tar sands bitumen froth is treated in a first centrifuging zone to separate coarse mineral particles therefrom and thereafter treated in a separate, second centrifuging zone to separate fine mineral particles therefrom the underflow from the second centrifuging zone which contains the fines can be treated in the first centrifuging zone thereby removing at least part of the bitumen associated with the fine particles and removing substantial amounts of fine particles from the first centrifuging zone even though this zone is not designed to remove fines. Although not knowing to a certainty and therefore not desiring to be limited thereto, it presently appears that this removal of fines from the first centrifuging zone is caused at least in part by an agglomerate of some type forming between the coarse and fine particles due to an electronic interaction therebetween and because a relatively impervious sludge forms in the first centrifuging zone and physically entraps the fines, as in a filtering effect. Therefore, fines are laterally drug out of the treated liquid in the first centrifuging zone by materials normally separated in that first centrifuging zone. The net result then is that the fine particles are subjected to a retreatment and yet are still removed from the process, and at least part of the residual bitumen associated with the fines is removed there-

from and rendered recoverable by the process as a whole. All this is achieved in this invention without expensive or additional processing equipment.

These results are substantial and not to be expected since the first centrifuging zone is not designed to remove fines in the first place. This is a substantial improvement over the separate treatment of fines to remove residual bitumen therefrom since the fines cannot readily be separated from their carrier liquid by a separate treatment. However, with this invention at least part of the bitumen normally associated with the fines is kept in the froth treatment process and the fines are still removed from that process. Put another way, the total amount of bitumen recovered from the tar sands is increased without additional fines washing and separation equipment and without sacrificing the normal function of the first centrifuging zone. This latter point is so because the fines which are treated in that first zone will go to an equilibrium value much lower than would be expected from the low removal efficiency of the fines by the first centrifuging zone and since this zone will not plug up with fines even though a substantial amount of the fines underflow from the second centrifuging zone may be treated in the first centrifuging zone. Because of the solids and volume loading limit characteristics of centrifuges, even a large bulk of fines underflow being treated in the first centrifuging zone does not require a significantly increased amount of centrifuging apparatus. The net result then is that with less equipment than expected, high solids separation levels are reached and a substantially higher overall bitumen recovery is realized.

Another advantage of this invention is that it can result in a decreased carryover of fines into the bitumen product.

Another advantage of the process of this invention is that due to the effect dilution of the liquid in zone **1** together with the elimination of a substantial amount of bitumen coated fine particles, the effective viscosity of the liquid being centrifuged in zone **1** will be lowered and the ease of separation of solid mineral particles from that liquid will be proportionally promoted. This advantage is magnified more than would be normally expected when compared to conventional dilution because of the part played by the bitumen coating on the solids. Because of the interaction of these bitumen surface layers, the effective viscosity of even the diluted tar sands slurry is substantially greater than what would be observed in a slurry noninteracting spheres with an equivalent particle size distribution. This invention further reduces this interaction over conventional dilution.

Accordingly, it is an object of this invention to provide a new and improved method for treating tar sands bitumen froth. It is another object to provide a new and improved method for separating fine mineral particles from bitumen froth. It is another object to provide a new and improved method for treating fine particles from a bitumen froth for removal of at least part of the bitumen associated with the hydrocarbon-wet fine particles. It is another object to provide a new and improved method for treating fine mineral particles in a bitumen froth. It is another object to provide a new and improved method for removing fine particles from a bitumen froth treating process after the fine particles have been processed to remove additional amounts of bitumen from the fine particles. It is another object to provide a new and improved method for separating coarse and fine mineral particles from a bitumen froth while treating the fine particles to separate associated bitumen therefrom utilizing only two centrifuging zones.

Other aspects, objects and advantages of this invention will be apparent to those skilled in the art from this disclosure and the appended claims.

DETAILED DESCRIPTION OF THE INVENTION

The drawing shows one embodiment within this invention. More specifically, the drawing shows a first centrifuge zone **1** which can be a battery of one or more centrifuges, e.g., solid bowl or scroll-type centrifuges, which are designed to take out solids down to about 5 microns in size. Feed bitumen froth is fed to zone **1** by way of pipe **2**. Prior to entry into zone **1**, the feed froth is diluted with a hydrocarbon or water by way of pipe **3** in order to reduce the density of the hydrocarbonaceous part of the froth, for example, to less than one gram per milliliter.

The diluted froth is treated in zone **1** and an overhead fraction and underflow fraction formed. The overhead fraction, termed "first overhead fraction," is removed therefrom by way of pipe **4** and contains as its major part the combination of bitumen, water, and diluent if different from water, while the combination of fine and any residual coarse mineral particles comprise the minor part of this fraction. The underflow from zone **1**, termed "first underflow," contains in its major part mineral particles and as a minor part the combination of bitumen, water, and diluent. The major part of the coarse particles in this first underflow when there is no fines treatment in accordance with this invention, is coarse particles with a very small amount of fines accidently present. However, with the treatment of fines in zone **1** in accordance with this invention, a substantial portion of the coarse particles in this first underflow is fines so that when this invention is practiced this first underflow contains a major amount of mineral particles, there being present in this major amount as many coarse particles as ordinarily found in the underflow of this first zone and, in addition, a substantially greater amount of fine particles than is normally found in this zone **1** when no treatment in accordance with this invention is practiced. The first underflow is removed from zone **1** by way of pipe **5** as waste and for disposal as desired.

The first overhead in pipe **4** passes to second centrifuging zone **6** which can also be a battery of one or more centrifuges, e.g., disc (disc-nozzle) type centrifuges which are designed to remove particles having a size of about 5 microns or less. The overhead from this second zone which is termed "second overhead" and which is the bitumen product of this portion of the froth treating process is removed from zone **2** by way of pipe **7**. This second overhead contains most of the bitumen in the froth and the combination of bitumen, water, and diluent comprises the major part of this second overhead fraction while the combination of fine and coarse mineral particles comprises a very minor part of this fraction. The underflow from this second zone which is termed "second underflow" is passed at least in part, preferably at least 50 volume percent of the second underflow fraction based on the total volume of the second underflow fraction, by way of pipe **8** to pipe **2** and/or into zone **1** as desired so that the fine

particles are subjected to treatment by diluent and other liquids in pipe 2 and zone 1 thereby removing additional amounts of bitumen associated with the fines from the fines and into the first overhead fraction in pipe 4. This increases the overall bitumen recovered by way of pipe 7. The thus treated fines in zone 1 are dragged therefrom by way of the coarse particles and sludge concentrated in zone 1 and into pipe 5. The achievement of separation of substantial amounts of fine particles from zone 1 by way of pipe 5 makes the treatment of fines in zone 1 with consequent additional bitumen recovery feasible. Part of the second underflow can be removed from the process by way of pipe 9 as desired.

In accordance with this invention it appears that since there is an increase in bitumen in the product in pipe 7, when residual bitumen is removed from the fines in zone 1, the fines are removed from zone 1 by way of the coarse mineral particles, sludge, and the like, before the fines can pick up additional bitumen. Thus, there is a net increase in bitumen retained in the process and added to the bitumen product in pipe 7.

Second centrifuge zone 6 preferably utilizes continuous discharge machines which reject at least 50 volume percent of their feed in pipe 4 into the second underflow in pipe 8 at such underflow rejection rates the overhead centrate in pipe 7 can contain less than 5 weight percent solids based on the total weight of the centrate even when these solids have been washed essentially bitumen free.

Although it can vary widely, depending upon the particular compositions of materials involved, the centrifuges involved, and the like, from about 25 to about 75 weight percent of the fine particles passed to zone 1 by way of pipe 8 can be removed into pipe 5.

EXAMPLE

A bitumen froth feed composed of 63 weight percent bitumen, 9 weight percent solid mineral particles (coarse and fine) and 28 weight percent water, all weight percents being based on the total weight of the feed, is passed by way of pipe 2 and diluted with 39 weight percent naphtha based on the weight of the feed after which the diluted froth is passed into a scroll-type centrifuge which constitutes first centrifuge zone 1. First underflow 5 from zone 1 pripr to the addition of any material from pipe 8 is essentially all greater than 5 micron solid particles and contains about half of the solids that were originally present in the froth feed (about 65 weight percent of the first underflow stream based on the total weight of that underflow stream), about one weight percent of the bitumen that was in the froth feed (about 6 weight percent of the first underflow stream based on the total weight of that underflow stream), with the rest being essentially naphtha and water. The first overhead stream in pipe 4 contains the remainder of the diluted froth feed that is passed into zone 1 by pipe 2 and therefore contains the remaining half of the solid particles that were in the original froth feed.

The first overhead in pipe 5 is passed into a disc-nozzle centrifuge whose underflow stream in pipe 8 contains essentially less than 5 micron size solid particles which constitute about 45 percent of the solids that were in the original froth feed (about 14 weight percent of the second underflow based on the total weight of that underflow stream), and about 2.3 weight percent of the bitumen that was in the original froth feed (about 4 weight percent of the second underflow stream based on the total weight of that underflow stream), the rest being primarily water with a small amount of maphtha. The overflow of the second zone pipe 7 contains the rest of the bitumen, water, naphtha, and residual solids.

Half of this second underflow in pipe 8 is passed by way of pipe 8 to first zone 1 and the first underflow in pipe 5 after treatment of the second underflow from pipe 8 in zone 1 changes so that this first underflow now contains about seven-eighths of the solids that were originally in froth feed (this is opposed to one-half of the solids that were in the original froth feed before treatment of the material from pipe 8 in accordance with this invention) or about 65 weight percent of the first underflow stream based on the total weight of that underflow stream. This first underflow stream also contains about 1.7 weight percent of the original bitumen in the feed (about 6 weight percent of the first underflow stream based on the total weight of that stream), the rest being naphtha and water.

The amount of bitumen in the first underflow stream without treatment of material from pipe 8 plus the amount of bitumen in the second underflow from pipe 8, if these two underflow streams were separately disposed of as the prior art has heretofore done, would amount to about 3,3 weight percent of the bitumen in the initial froth feed being taken out of the process and not recovered in pipe 7.

By following the process of this invention, the amount of bitumen removed from the process by way of pipe 5 and not recovered by way of pipe 7 is 2.8 weight percent thereby yielding a 0.5 weight percent increase in bitumen in pipe 7 due to the treatment of the second underflow in pipe 8 in zone 1. Based on a 125,000 barrel per day plant, this 0.5 weight percent savings of bitumen amounts to an increase in bitumen in pipe 7 of about 625 barrels per day (228,000 barrels per calendar year) which is a substantial net savings in bitumen.

Reasonable variations and modifications are possible within the scope of this disclosure without departing from the spirit and scope of this invention.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A method for treating tar sands bitumen froth containing bitumen, water, diluent if different from water, water-wet coarse mineral particles, and hydrocarbon-wet fine mineral particles to separate substantial amounts of water and mineral particles from the bitumen comprising centrifuging said froth in a first centrifuging zone to separate said froth into a first overhead fraction containing essentially bitumen, diluent, water, and fine mineral particles and a first underflow fraction containing essentially water, diluent, and coarse mineral particles; said coarse mineral particles having a size of greater than about 5 microns, and said fine mineral particles having a size of about equal to or less than 5 microns; centrifuging said first overhead fraction in a second centrifuging zone to separate said first overhead fraction into a second overhead bitumen product fraction containing essentially bitumen and diluent and containing substantially less water and mineral particles than said froth feed and a second underflow fraction containing essentially water and fine mineral parti-

cles; and passing at least part of said second underflow fraction to said first centrifuging zone whereby residual bitumen is removed at least in part from said fine mineral particles and said fine mineral particles are removed at least in part in said first underflow fraction along with said coarse mineral particles.

2. A method according to claim **1** wherein at least 50 volume percent of said second underflow fraction based on the total volume of said fraction is treated in said first centrifuging zone.

3. A method according to claim **1** wherein in said first overhead fraction the combination of bitumen, water and diluent comprises the major part of said first overhead fraction while the combination of fine and coarse mineral particles comprise a minor part of said fraction, in said first underflow fraction after retreatment of at least part of said second underflow fraction in said first centrifuging zone the combination of fine and coarse mineral particles comprises a major part of said first underflow fraction while the combination of bitumen, water, and diluent comprises a minor part of said fraction, in said second overhead fraction the combination of bitumen, water, and diluent comprises the major part of said second overhead fraction while the combination of fine and coarse mineral particles comprises a minor part of said fraction, and in said second underflow fraction the combination of fine and coarse mineral particles comprises a major part of said second underflow fraction while the combination of bitumen, water, and diluent comprises a minor part of said fraction.

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