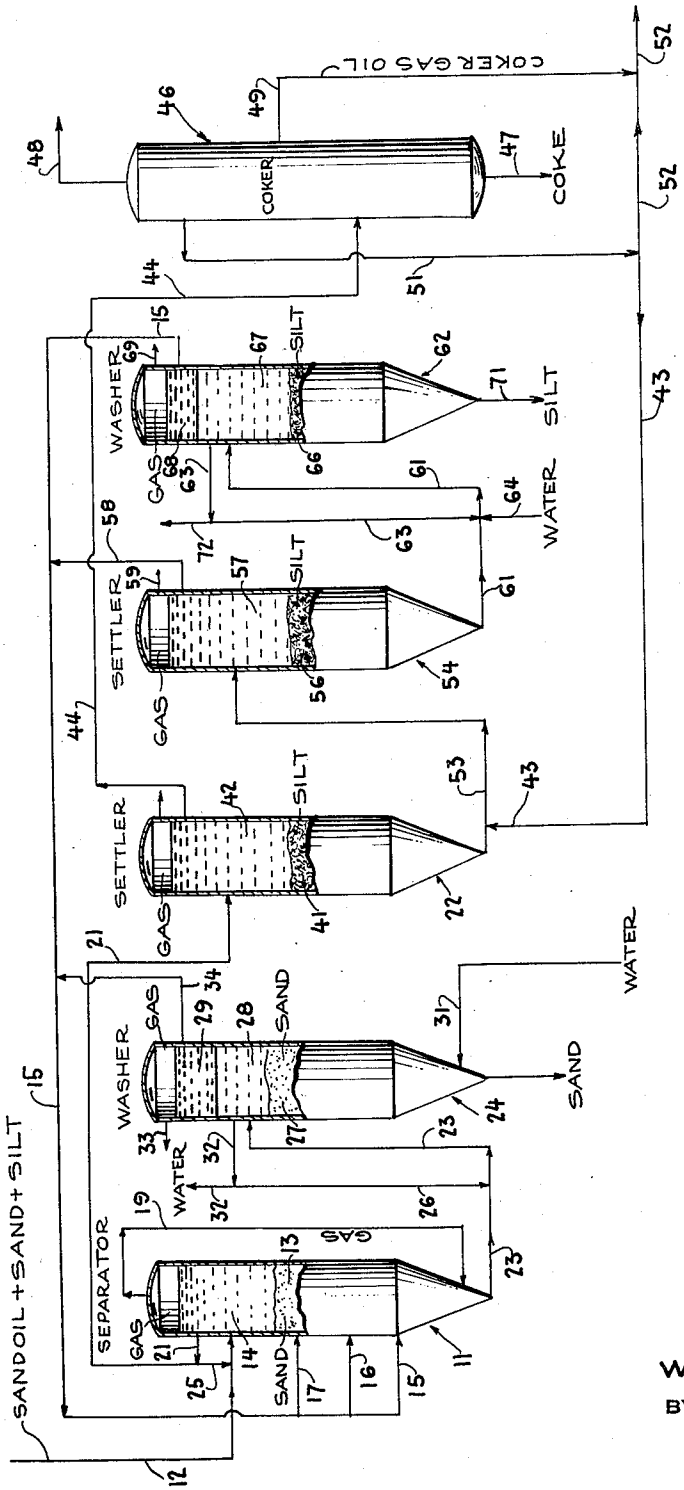
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RECOVERY OF OIL FROM BITUMINOUS SANDS

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RECOVERY OF OIL FROM BITUMINOUS SANDS

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This invention relates to an improved process for the removal of silt from mixtures containing the same and hydrocarbon oil and more especially to the recovery of crude oil from bituminous sand containing the same and silt.

Large deposits of bituminous sands are found in various localities throughout the world. The term "bituminous sand" is used herein to include those materials commonly referred to as oil sands, tar sands and the like. One of the most extensive deposits of bituminous sands occurs for instance in the Athabasca district of the Province of Alberta, Canada, and extends for many thousands of square miles in thicknesses ranging in up to more than two hundred feet.

Various methods have been proposed previously for separating crude oil from bituminous sands such as the Alberta tar sands but none of these methods has met with any substantial success. Since the crude oil obtainable from this type of bituminous sand is relatively viscous material having high tar content and relatively low commercial value in comparison with other crude oils, a successful commercial process must involve relatively little expense in the separation of crude oil from the bituminous sands. Operating costs of previously conceived methods for separating the oil from bituminous sands have been sufficiently high so as to discourage commercial exploitation.

The most successful of the previously known methods for separating oil from tar sands such as the Alberta tar sands have involved the mixing of the bituminous sand with water followed by separation of sand from the mixture. In these processes it has been found that complete separation of the crude oil from the water has presented considerable difficulty due to the formation of oil-water emulsions resulting in the discarding of significant quantities of crude oil, which could not be successfully separate from the water.

In attempting to separate crude oil from bituminous sands considerable difficulty has also been experienced due to the fact that the solids content of bituminous sands such as the Alberta tar sands consists of particles of varying size and includes substantial amounts of silt in the form of clay and other very fine solids particles. In attempting to effect a complete separation of the crude oil from the bituminous sands previous processes have attempted to retain the silt with the remainder of the solids content of the sands and as a result have usually discarded considerable quantities of crude oil along with such silt and sand. My co-pending application Serial No. 820,000, filed June 12, 1959 (now Patent No. 2,965,557), of which this application is a continuation in part discloses an improved process for the separation of a mixture of crude oil and silt from bituminous sand containing the same. As disclosed in that application such a mixture of crude oil and silt may be treated by conventional settling methods for removal of some or all of the silt or may be processed directly as for instance by feeding the mixture containing crude oil and silt directly to a conventional coking process.

While it is quite possible, as mentioned above, to pass such a mixture of silt and crude oil directly to a processing unit such as a coker, it is frequently desired to remove some or all of the silt prior to passing such mixture to the processing unit. Thus, for instance, if the

mixture is to be passed to a coking unit removal of a majority of the silt before passing the mixture to the coker will substantially lessen the load on the coking unit and will also make a larger proportion of the coke produced available for supplying heat or for other purposes. It is, therefore, an object of the present invention to provide an improved process for removing silt from a mixture containing the same and hydrocarbon oil.

It is another object of the invention to provide an improved process for the separation of silt from a mixture containing the same and crude oil with substantially no loss of crude oil with the silt.

It is a further object of the invention to provide an improved process for the recovery of crude oil from bituminous sand containing the same and silt.

According to a preferred embodiment of the present invention a mixture containing crude oil and silt separated from bituminous sand in a sand separation zone and preferably containing liquid hydrocarbon diluent is passed to a first silt settling zone wherein it is allowed to settle to form a lower layer of silt, crude oil and hydrocarbon diluent and an upper layer of hydrocarbon diluent and crude oil. The upper layer is withdrawn from the first silt settling zone and preferably passed to a fluid coking unit for conversion of crude oil into liquid hydrocarbon products and coke while the lower layer containing silt is withdrawn from the first silt settling zone and passed to a second silt settling zone. Additional hydrocarbon diluent is introduced into the second silt settling zone, preferably together with the silt, and the resulting mixture is allowed to settle to form a lower layer of silt substantially free of crude oil and an upper layer of hydrocarbon diluent substantially free of silt. Hydrocarbon diluent is preferably withdrawn from this upper layer and recycled as the original hydrocarbon diluent contained in the mixture of silt and crude oil passed to the first silt settling zone. Silt is withdrawn from the second silt settling zone and passed to a silt washing zone to remove the remainder of the hydrocarbon diluent therefrom. In the silt washing zone the silt is contacted with water to form a lower layer containing silt and substantially free of hydrocarbon diluent, an intermediate layer of water and an upper layer of hydrocarbon diluent. Silt is withdrawn from the lower layer of the silt washing zone and discarded while water is withdrawn from the intermediate layer and hydrocarbon diluent is withdrawn from the upper layer of the silt washing zone and recycled with the hydrocarbon diluent from the second silt settling zone. A portion of the liquid hydrocarbon product from the fluid coking zone is passed to the second silt settling zone as fresh hydrocarbon diluent, while the remainder of the liquid product from the fluid coking zone may be used in any suitable manner. Likewise the coke formed in the coking zone may be disposed of in any suitable manner.

For a better understanding of the invention reference should be had to the accompanying drawing, which is a diagrammatic illustration in elevation of a suitable arrangement of apparatus for carrying out a preferred embodiment of the invention.

In the drawing bituminous sand is introduced into a sand separation zone shown here as a separator 11 through a conduit 12. The bituminous sands treated according to the invention are bituminous sands which include crude oil and silt in addition to the coarser sand particles. For purposes of this application silt may be defined as solids particles which pass through a 200 mesh screen and may include for instance extremely fine sand particles as well as clay or other solids present in the form of particles of this size. Bituminous sands of this type may contain widely varying amounts of silt but such silt frequently comprises between about one and about 20

weight percent of the total solids content of the bituminous sand. Similarly, the amount of oil in bituminous sands may vary widely. Typical tar sands from which crude oil is obtained in accordance with this invention frequently contain between 10 and about 20 weight percent crude oil. In addition, such tar sands frequently contain between about one and about 15 weight percent water. Compositions of suitable bituminous sands may, of course, vary over even wider ranges and minor amounts of other ingredients may also be present.

Prior to introducing bituminous sand to a sand separation zone such as the separator **11** it is generally preferred to first mix the sand with hydrocarbon diluent in order to obtain a slurry which is easily transferable to the separator. Such mixing may be done in any suitable manner such as in the manner taught by my above mentioned application S.N. 820,000 (now Patent No. 2,965,557). The hydrocarbon diluent used for this purpose may, if desired, be fresh diluent such as that described below but for convenience is preferably a recycle stream comprising a portion of the mixture of crude oil, hydrocarbon diluent, and silt withdrawn from the sand separation zone as described below.

In the separator **11**, the slurry of tar sand and diluent separates to form a lower fluidized layer or bed **13** of sand and an upper liquid layer **14** of crude oil, hydrocarbon diluent and silt. Liquid hydrocarbon diluent is introduced into the separator **11** through conduits **15**, **16** and **17** and injected into the sand bed **13** to aid in separating oil and silt from the sand and also to fluidize the sand bed. A mixture of this diluent together with the crude oil and silt separated from the sand forms the upper layer of oil and silt **14**, while sand which is preferably substantially free of crude oil forms the lower fluidized layer **13**. The sand bed **13** is a conventional bed of fluidized solids and has physical characteristics which are generally similar to those of beds of fluidized solids used in other processes such as catalytic cracking fluid coking, etc. The fluid characteristics of the bed **13** are not substantially altered by the use of a liquid fluidizing medium rather than the more conventional gaseous fluidizing medium. The liquid fluidizing medium may be passed upwardly through the bed **13** with any suitable velocity such as between about 2 and about 10 ft./sec.

The hydrocarbon diluent with which the bituminous sand is contacted in the separator **11** and which is introduced through conduits **15**, **16** and **17** should have specific gravity substantially less than 1.0 and preferably has a gravity between about 55° and about 65° API. Suitable diluents are for instance those having boiling point ranges between about 100° and 400° F. Hydrocarbon diluent is preferably employed in the sand separation zone in a quantity sufficient to dilute the crude oil contained in the bituminous sands with between about 1 and about 5 barrels of diluent liquid to each barrel of crude oil with a dilution of about 3 to 1 being preferred. While hydrocarbon diluent supplied through conduits **15**, **16** and **17** may be fresh hydrocarbon diluent, it is preferred to use recycle diluent as described below and shown in the drawing. While hydrocarbon diluent from conduit **15** may be added to the bituminous sand entering the sand separation zone it is preferred to utilize recycle oil and silt from the separation zone for this purpose and to introduce the fresh hydrocarbon diluent into the lower layer of sand as shown.

Gaseous hydrocarbons which may accumulate in the separator **11** may be removed therefrom through a conduit **19** and are preferably introduced into the lower portion of the sand bed **13** to aid in fluidizing the sand layer and to at least partially strip the sand of entrained hydrocarbons. Other suitable gaseous material such as nitrogen, hydrogen, helium, etc., from an appropriate source may, of course, be used for this purpose, if desired.

Oil and silt is removed from the separator **11** through a conduit **21**, and passed through the conduit **21** to a first silt settling zone such as a silt settler **22** to be described in greater detail below. A portion of the oil and silt withdrawn through conduit **21** is recycled through a conduit **25** to form a slurry with the sand introduced through conduit **12** as described above.

Sand which is relatively free of crude oil, but which contains some entrained hydrocarbon diluent is removed from the separator **11** through a conduit **23**. Although the sand withdrawn from the lower layer of the sand separation zone through conduit **23** is preferably substantially free of crude oil, such sand, even though it has been stripped as described above, contains small amounts of hydrocarbon diluent which it is usually desirable to recover. Also, in the event stripping gas is not employed in the sand separation zone, such sand will, of course, contain somewhat greater amounts of hydrocarbon diluent. Such hydrocarbon diluent is preferably recovered by passing the withdrawn sand to a stand washing zone in which it is contacted with water. Sand withdrawn from the sand separation zone is preferably passed to the sand washing zone in the form of a slurry. Such a slurry may be obtained by mixing the sand in conduit **23** with water supplied through a conduit **26**. The resulting slurry is then passed through the conduit **23** to a sand washer **24**. In the sand washer **24**, the slurry of sand and water separates to form a lower fluidized bed of sand **27**, an intermediate layer **28** of water and an upper layer **29** of hydrocarbon diluent. Water introduced into the lower portion of the sand bed **27** through a conduit **31** serves to fluidize the bed **27** and also to aid in separating hydrocarbons from the sand and to provide make-up water. The sand bed **27**, like the sand bed **13**, is a conventional fluidized solids bed. Water is withdrawn from the layer **28** through a conduit **32** and a portion of this water is recycled through the conduit **26** to form a slurry with the sand in conduit **32** as described above, while the remainder is removed from the system through conduit **32** and may be discarded or used in any suitable manner. Any hydrocarbon vapors which accumulate in the washer **24** may be withdrawn from the upper portion of the washer **24** through a conduit **33**. Hydrocarbon diluent is removed from the upper layer **29** through a conduit **34** and recycled through the conduit **15** as a portion of the hydrocarbon diluent supplied to the separator **11** through the conduits **15**, **16** and **17**.

When sand withdrawn from the sand separation zone is washed as described above, it is especially important to avoid the use of excessively high boiling hydrocarbon diluent in the separation zone and to avoid retaining any substantial amount of the crude oil in the sand since such higher boiling hydrocarbons have a strong tendency to form emulsions with water and such emulsions are extremely difficult to control. If the preferred hydrocarbon diluent described above is used there is substantially no tendency for emulsions to form and the entire process may be carried out without the necessity for chemical or mechanical treatment to break or remove emulsions. This results not only in a process which requires no emulsion breaking or removing equipment but also results in greater recovery of usable hydrocarbons since the formation of emulsions almost inevitably results in loss of valuable hydrocarbons to waste water. It should be understood that, in general, the operation and construction of the separator **11** and sand washer **24** may be similar to that described in the above mentioned co-pending application S.N. 820,000 (now Patent No. 2,965,557) with respect to the separator **24** and sand washer **53**.

The mixture of crude oil, silt and hydrocarbon diluent which is introduced into the first silt settler **22** through the conduit **21** as described above separates in the settler **22** into a lower layer **41** of silt and hydrocarbon diluent and an upper layer **42** containing crude oil and hydrocarbon diluent and preferably containing at most only relatively minor quantities of silt. While the upper layer **42** of crude oil and hydrocarbon diluent in the first

silt settling zone is preferably free of large quantities of silt it should be understood that varying quantities of silt may be present in this layer and that, if desired, material withdrawn from this layer may be further treated as by setting for reduction of silt content.

A mixture of crude oil and hydrocarbon diluent is withdrawn from the upper layer **42** of the settler **22** through a conduit **44** and passed to a conventional fluid coking zone such as a fluid coker **46** for conversion into coke and liquid hydrocarbon products. Coke produced in the coker **46** is withdrawn through a conduit **47**, while gaseous products are withdrawn through a conduit **48** and a gas oil fraction is withdrawn through a conduit **49**. A gasoline fraction suitable for use as the above described hydrocarbon diluent is withdrawn from the coker through a conduit **51**. A portion of the gasoline withdrawn through conduit **51** is recycled through a conduit **43** as hydrocarbon diluent as described below, while the remainder passes from the system through a conduit **52** together with the gas oil withdrawn through conduit **49** as a product of the process.

Silt is withdrawn from the silt separator **22** through a conduit **53**, mixed with additional hydrocarbon diluent supplied through conduit **43** and the resulting mixture is passed to a second silt settling zone such as a silt settler **54** in which it is allowed to settle to form a lower layer **56** of silt substantially free of crude oil and an upper layer **57** of hydrocarbon diluent which is preferable substantially free of silt.

The silt from the first silt settling zone contains at least some crude oil and hydrocarbon diluent. By diluting this mixture with additional hydrocarbon diluent the concentration of crude oil is drastically reduced. Following such dilution, the mixture is settled in the second silt settling zone. The silt layer which froms in the bottom of the second silt settling zone also, of course, contains at least some liquid but the concentration of crude oil in this lower layer is usually so minute that the silt can be washed as described below without the formation of an oil-water emulsion. If desired, an additional stage of dilution and settling could, of course, be used.

Hydrocarbon diluent is withdrawn from the upper layer **57** of the second silt settling zone through a conduit **58** and recycled to the separation zone through the conduit **15** as described above. Gas which accumulates in the upper portion of the settler **54** may be removed through a conduit **59**. Silt from the lower layer **56** of the silt settler **54** is withdrawn through a conduit **61**. Since this silt contains hydrocarbon diluent which it is desirable to recover, such mixture of silt containing hydrocarbon diluent is preferably passed through the conduit **61** to a silt washing zone shown in the drawing as a silt washer **62**. The silt passing to the silt washer **62** through the conduit **61** is preferably mixed with the water introduced, for instance, through conduits **63** and **64**. The water introduced through conduit **64** may be make-up water, while the water in conduit **63** is preferably recycled from the silt washing zone as described below. In the silt washer **62** the mixture of silt and water is allowed to settle into a lower layer **66** of silt, which is preferably susbtantially free of hydrocarbon diluent, an intermediate layer **67** of water and an upper layer **68** of hydrocarbon diluent. Hydrocarbon diluent from the upper layer **68** of the silt washing zone is withdrawn through the conduit **15** and recycled to the separator **11** as described above, while any gas which accumulates in the silt washer **62** may be withdrawn through a conduit **69**. A mixture of silt and water which is substantially free of hydrocarbon diluent is withdrawn from the silt washer through a conduit **71** to be disposed of in any suitable manner, while water is withdrawn from the intermediate layer **67** through the conduit **63** for mixing with the mixture of silt and hydrocarbon diluent in conduit **61** as described below. A portion of the water is preferably discarded through a conduit **72**.

While the lower silt containing layers **41**, **56** and **66** of the silt settler **22**, silt settler **54** and silt washer **62** respectively are shown as having well defined boundaries, it should be understood that the boundaries between these layers and the layers **42**, **57** and **67** immediately above them may be less well defined than shown. The transition between the lower, silt-containing layers **41**, **56** and **66** and the layers **42**, **57** and **67** immediately above these layers may, in fact, be sufficiently gradual so that no well defined boundaries are formed between the respective layers and the marked contrast in the composition of adjacent layers may be apparent only in portions of the layers relatively remote from the transition zone.

While there is no special temperature requirement for successful separation of silt from mixtures containing the same and crude oil in accordance with the present invention, the processes described herein are preferably carried out at temperatures approximating normal room temperatures such as between about 40° and about 100° F., more usually between about 60° and about 80° F. The following specific example illustrates a practical application of the present invention using the process described and shown in the drawing.

EXAMPLE

An Alberta tar sand having the properties shown in Table I below is fed to the feed hopper **14** at the rate of 10,000 barrels per day.

Table I

COMPOSITION AND PROPERTIES OF BITUMINOUS SAND FEED

Water	wt. percent	2.1
Mineral matter	do	82.8
Crude oil	do	15.1
Density	lb./ft.	125
Composition of crude oil:		
Carbon	wt. percent	83.3
Hydrogen	do	10.4
Sulfur	do	4.7
Nitrogen	do	0.4
Oxygen	do	1.2
Carbon/hydrogen ratio		8.0
Specific gravity at 77° F.		1.007
Sieve analysis of mineral matter after ignition:		
Retained on—		
50 mesh	wt. percent	18.3
80 mesh	do	49.9
100 mesh	do	13.3
200 mesh	do	11.0
Passing 200 mesh	do	7.5

Hydrocarbon diluent supplied to the separator **11** through the conduit **15** comprises 0.8 volume percent crude oil and 99.2 volume percent of gasoline diluent having a boiling range of 125° to 325° F. and a gravity of 59° API. Gasoline diluent is supplied to the separator **11** through the conduits **15**, **16** and **17** at the rate of 30,000 barrels per day. This gasoline is recycle gasoline obtained from the sand washer **24**, silt settler **54** and silt washer **62** through conduits **34**, **58** and **15** respectively. Fresh hydrocarbon diluent is obtained from the fluid coker **46** in the form of gasoline having a gravity of 59° API and a boiling point range of 125° to 325° F. and is passed to the silt settler **54** through conduits **51**, **43** and **53** at the rate of 30,000 b.p.d. The mixture of crude oil and gasoline diluent passed from the slit settler **22** to the fluid coker **46** through the conduit **44** comprises 25 volume percent crude oil and 75 volume percent gasoline diluent and has a gravity of 45° API.

While the invention has been described in detail with respect to a preferred embodiment, it will be understood by those skilled in the art that various changes and modifications may be made without departing from the spirit and scope of the invention and it is intended to cover all

such changes and modifications in the appended claims.

I claim:

1. The process for treating bituminous sand containing crude oil and silt which comprises introducing the bituminous sand into a sand separation zone, introducting hydrocarbon diluent into said separation zone, to form therein a lower layer of sand and an upper layer of crude oil, hydrocarbon diluent and silt, removing sand containing entrained hydrocarbon diluent from said lower layer of the separation zone and passing same to a sand washing zone in which it is contacted with water to form in said sand washing zone a lower layer of sand, an intermediate layer of water and an upper layer of hydrocarbons, separately removing each of said layers from said sand washing zone, passing at least a portion of the mixture of crude oil, hydrocarbon diluent and silt removed from the upper layer of the sand separation zone to a first silt settling zone to form therein a lower layer of silt and an upper layer of hydrocarbon diluent and crude oil, removing hydrocarbon diluent and crude oil from the upper layer of the first silt settling zone and passing same to a coking zone wherein the same is treated under coking conditions to produce coke and liquid hydrocarbon product, withdrawing silt containing entrained hydrocarbon diluent and crude oil from the lower portion of the first silt settling zone and passing same to a second silt settling zone, introducing additional hydrocarbon diluent into said second silt settling zone to form therein a lower layer of silt and an upper layer of hydrocarbon diluent, removing hydrocarbon diluent from the upper portion of said second silt settling zone, removing silt containing entrained hydrocarbon diluent from the lower portion of the second silt settling zone and passing same to a silt washing zone, introducing water into said silt washing zone to form therein a lower layer of silt, an intermediate layer of water and an upper layer of hydrocarbon diluent, separately removing each of said layers from the silt washing zone, removing coke and liquid hydrocarbon product from said coking zone and passing at least a portion of such liquid hydrocarbon product to said second slit settling zone as hydrocarbon diluent.

2. The process for treating bituminous sand containing crude oil and silt which comprises introducing the bituminous sand into a sand separation zone, introducing hydrocarbon diluent into said separation zone, to form therein a lower fluidized layer of sand and an upper liquid layer of crude oil, hydrocarbon diluent and silt, removing sand containing entrained hydrocarbon diluent from said lower layer of the separation zone and passing same to a sand washing zone in which it is contacted with water to form in said sand washing zone a lower fluidized layer of sand, an intermediate layer of water and an upper liquid layer of hydrocarbons, separately removing each of said layers from said sand washing zone, passing at least a portion of the mixture of crude oil, hydrocarbon diluent and silt removed from the upper layer of the sand separation zone to a first silt settling zone to form therein a lower layer of silt and an upper layer of hydrocarbon diluent and crude oil, removing hydrocarbon diluent and crude oil from the upper layer of the first silt settling zone and passing same to a fluid coking zone wherein the same is treated under fluid coking conditions to produce coke and liquid hydrocarbon product, withdrawing silt containing entrained hydrocarbon diluent and crude oil from the lower portion of the first silt settling zone and passing same to a second silt settling zone, introducing additional hydrocarbon diluent into said second silt settling zone to form therein a lower layer of silt and an upper layer of hydrocarbon diluent, removing hydrocarbon diluent from the upper portion of said second silt settling zone and passing same to said sand separation zone, removing silt containing entrained hydrocarbon diluent from the lower portion of the second silt settling zone and passing same to a silt washing zone, introducing water into said silt washing zone to form therein a lower layer of silt, an intermediate layer of water and an upper layer of hydrocarbon diluent, separately removing each of said layers from the silt washing zone, passing hydrocarbon diluent removed from the upper layer of said silt washing zone to said sand separation zone, removing coke and liquid hydrocarbon product from said fluid coking zone and passing at least a portion of such liquid hydrocarbon product to said second silt settling zone as hydrocarbon diluent.

3. The process for recovering crude oil from bituminous sand containing the same and silt which comprises introducing said bituminous sand and liquid hydrocarbon diluent in an amount between about 1 and about 5 times the amount of crude oil present in said sand into a sand separation zone to form therein a lower layer of sand and an upper layer of hydrocarbon diluent, crude oil and silt, removing sand from said lower layer, passing a mixture of crude oil, silt and hydrocarbon diluent from said upper layer of the sand separation zone to a first silt settling zone to form therein a lower layer of silt and an upper layer of crude oil and hydrocarbon diluent, removing a mixture of crude oil and hydrocarbon diluent from said upper layer of the first silt settling zone, withdrawing a mixture of silt, crude oil and hydrocarbon diluent from said lower layer of the first silt settling zone and passing same to a second silt settling zone, introducing additional hydrocarbon diluent into said second silt setting zone in an amount between about 1 and about 5 times the amount of crude oil in the original bituminous sand to form therein a lower layer of silt containing hydrocarbon diluent and substantially free of crude oil and an upper layer of hydrocarbon diluent containing crude oil, withdrawing hydrocarbon diluent from said upper layer of the second slit settling zone and passing same to said sand separation zone, withdrawing silt containing entrained hydrocarbon diluent and substantially free of crude oil from said lower layer of the second silt settling zone and passing same and water to a silt washing zone to form therein a lower layer of silt substantially free of hydrocarbon diluent, an intermediate layer of water and an upper layer of hydrocarbon diluent, separately withdrawing each of said layers from said silt washing zone and passing thus withdrawn hydrocarbon diluent from said upper layer of the silt washing zone to the sand separation zone.

4. The process for treating bituminous sand containing crude oil and silt which comprises passing said sand to a sand separation zone, in said sand separation zone contacting said bituminous sand with liquid hydrocarbon diluent to form therein a lower layer of sand and an upper liquid layer of hydrocarbon diluent, crude oil and silt, separately withdrawing each of said layers from the sand separation zone, passing a mixture of crude oil, silt and hydrocarbon diluent thus withdrawn from said upper layer of the sand separation zone to a first silt settling zone to form therein a lower layer of silt and an upper layer of crude oil and hydrocarbon diluent, withdrawing a mixture of crude oil and hydrocarbon diluent from said upper layer of the first silt separation zone and passing same to a coking zone for conversion of the crude oil to coke and liquid hydrocarbon product, withdrawing silt containing entrained hydrocarbon diluent and crude oil from the lower layer of the first silt settling zone and passing same together with additional hydrocarbon diluent to a second silt settling zone to form therein a lower layer of silt and an upper layer of hydrocarbon diluent, separately removing each of said layers from the second slit separation zone, withdrawing liquid hydrocarbon product from said coking zone and passing at least a portion of same to said second silt separation zone as said additional hydrocarbon diluent.

5. The process for treating a mixture consisting essentially of crude oil, silt and hydrocarbon diluent which comprises introducing said mixture into a first silt settling zone to form therein a lower layer of silt, crude oil and

hydrocarbon diluent and an upper layer of crude oil and hydrocarbon diluent, withdrawing a mixture of hydrocarbon diluent and crude oil from said upper layer of the first silt settling zone and passing same to a coking zone for conversion of crude oil into coke and liquid hydrocarbon product, withdrawing silt, crude oil and hydrocarbon diluent from said lower layer of the first silt settling zone and passing same to a second silt settling zone together with additional hydrocarbon diluent to form therein a lower layer of silt and hydrocarbon diluent and an upper layer of hydrocarbon diluent, withdrawing hydrocarbon diluent from said upper layer of the second silt settling zone, withdrawing silt and hydrocarbon diluent from said lower layer of the second silt settling zone and passing same to a silt washing zone together with water to form therein a lower layer of silt substantially free of hydrocarbon diluent, an intermediate layer of water and an upper layer of hydrocarbon diluent, separately removing each of said layers from said silt washing zone, and passing at least a portion of the liquid hydrocarbon product from said coking zone to said second silt settling zone as hydrocarbon diluent.

6. The process for treating a mixture consisting essentially of crude oil, silt and hydrocarbon diluent which comprises introducing said mixture into a first silt settling zone to form therein a lower layer of silt and an upper layer of crude oil and hydrocarbon diluent, withdrawing a mixture of hydrocarbon diluent and crude oil from said upper layer of the first silt settling zone and passing same to a coking zone for conversion of crude oil into coke and liquid hydrocarbon products, withdrawing silt containing entrained crude oil and hydrocarbon diluent from said lower layer of the first silt settling zone and passing same to a second silt settling zone together with additional hydrocarbon diluent to form therein a lower layer of silt and an upper layer of hydrocarbon diluent, withdrawing hydrocarbon diluent from said upper layer of the second silt settling zone, withdrawing silt containing entrained hydrocarbon diluent from said lower layer of the second silt settling zone, and passing at least a portion of the liquid hydrocarbon product from said coking zone to said second silt settling zone as hydrocarbon diluent.

7. The process for removing silt from a mixture consisting essentially of crude oil, silt and hydrocarbon diluent in an amount between about 1 and about 5 times the amount of crude oil in said mixture which comprises introducing said mixture into a first silt settling zone to form therein a lower layer of silt, crude oil and hydrocarbon diluent and an upper layer of crude oil and hydrocarbon diluent, withdrawing a mixture of hydrocarbon diluent and crude oil from said upper layer of the first silt settling zone, withdrawing silt, crude oil and hydrocarbon diluent from said lower layer of the first silt settling zone and passing same to a second silt settling zone, introducing additional hydrocarbon diluent into said second silt settling zone in an amount between about 1 and about 5 times the amount of crude oil present in the original mixture to form therein a lower layer of silt and hydrocarbon diluent substantially free of crude oil and an upper layer of hydrocarbon diluent containing crude oil, withdrawing hydrocarbon diluent and crude oil from said upper layer of the second silt settling zone, withdrawing silt and hydrocarbon diluent substantially free of crude oil from said lower layer of the second silt settling zone and passing same to a silt washing zone, introducing water into said silt washing zone to form therein a lower layer of silt substantially free of hydrocarbon liquid, an intermediate layer of water and an upper layer of hydrocarbon diluent, and separately removing each of said layers from said silt washing zone.

8. The process for treating a mixture consisting essentially of crude oil, silt and hydrocarbon diluent in an amount between about 1 and about 5 times the amount of crude oil in said mixture which comprises introducing said mixture into a first silt settling zone to form therein a lower layer of silt containing crude oil and hydrocarbon diluent and an upper layer of crude oil and hydrocarbon diluent, withdrawing a mixture of hydrocarbon diluent and crude oil from said upper layer of the first silt settling zone, withdrawing silt containing crude oil and hydrocarbon diluent from said lower layer of the first silt settling zone and passing same to a second silt settling zone, introducing additional hydrocarbon diluent comprising gasoline having a gravity of between about 55 and 65° A.P.I. and a boiling point range between about 100 and about 400° F. in an amount between about 1 and about 5 times the amount of crude oil present in the original mixture into said second silt settling zone to form therein a lower layer of silt containing hydrocarbon diluent and substantially free of crude oil and an upper layer of hydrocarbon diluent containing crude oil, withdrawing hydrocarbon diluent and crude oil from said upper layer of the second silt settling zone, withdrawing silt containing hydrocarbon diluent and substantially free of crude oil from said lower layer of the second silt settling zone and passing same to a silt washing zone, introducing water into said silt washing zone to form therein a lower layer of silt substantially free of hydrocarbon liquid, an intermediate layer of water and an upper layer of hydrocarbon diluent, and separately removing each of said layers from said silt washing zone.

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