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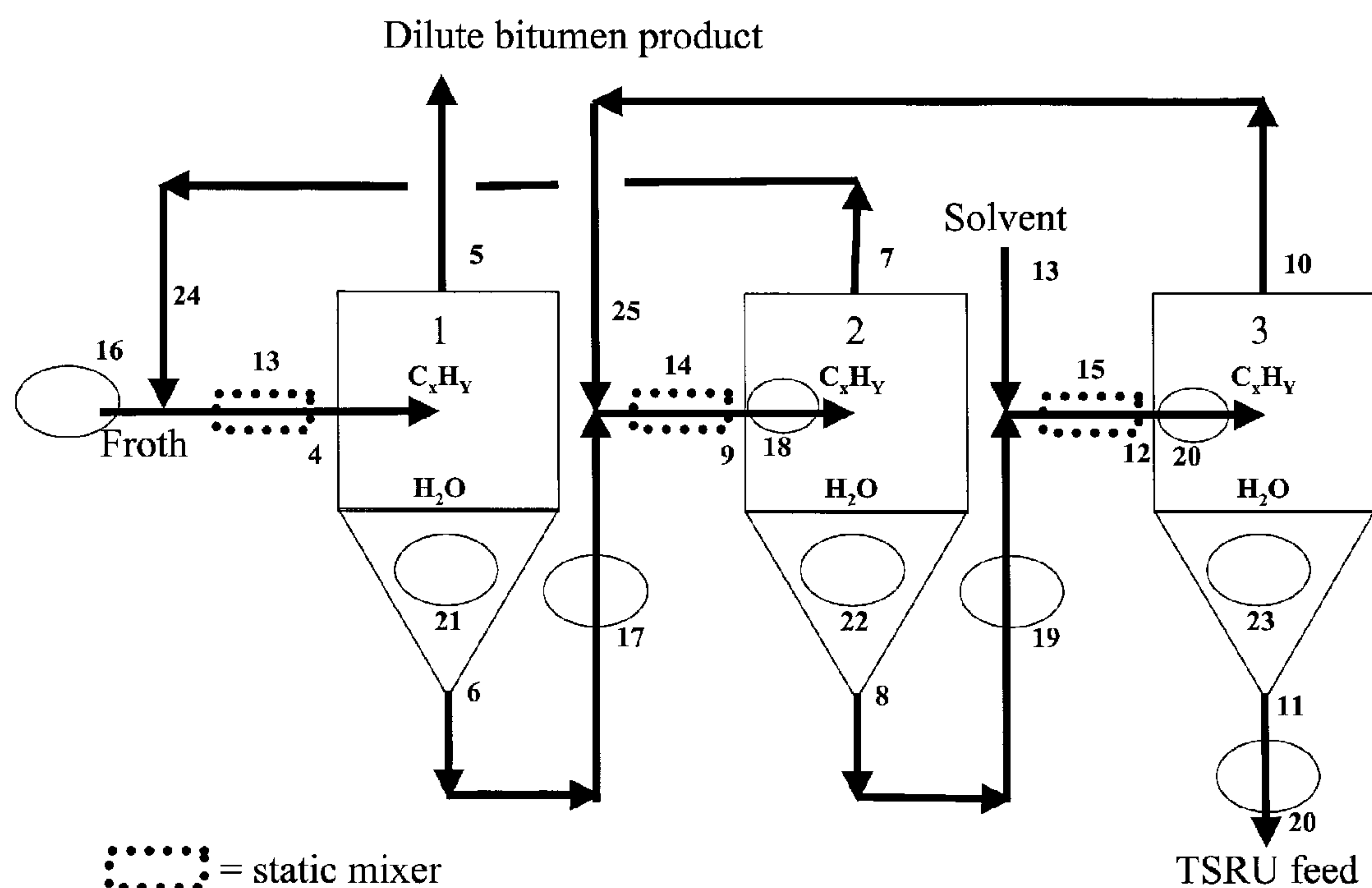
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(54) Titre : METHODE POUR SEPARER DU BITUME D'UNE MOUSSE DE SABLE BITUMINEUX

(54) Title: METHOD FOR SEPARATING BITUMEN FROM AN OIL SAND FROTH



(57) Abrégé/Abstract:

A method for separating an oil sand froth comprises: - mixing the oil sand froth with a paraffinic solvent; - inducing the fluid mixture to be separated by gravity separation in the separator into a bitumen enriched, water and solids depleted, upper fluid fraction (C_xH_y) and a bitumen depleted, water and solids enriched, lower fluid fraction (H_2O); - inducing the bitumen enriched, water depleted, upper fluid fraction to flow into an upper fluid outlet of the separator and inducing the water enriched, bitumen depleted, lower fluid fraction to flow into to a lower fluid outlet of the separator; and - agitating the fluid mixture with mixing means such that the bitumen depleted, water and solids enriched, lower fluid fraction within the separator comprises a substantially homogeneous mixture of solids and liquids and the formation of layers of highly viscous asphaltene containing material is inhibited.

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ABSTRACT

A method for separating an oil sand froth comprises:

- mixing the oil sand froth with a paraffinic solvent;
- inducing the fluid mixture to be separated by gravity

5 separation in the separator into a bitumen enriched, water and solids depleted, upper fluid fraction (C_xH_y) and a bitumen depleted, water and solids enriched, lower fluid fraction (H_2O);

10 - inducing the bitumen enriched, water depleted, upper fluid fraction to flow into an upper fluid outlet of the separator and inducing the water enriched, bitumen depleted, lower fluid fraction to flow into to a lower fluid outlet of the separator; and

15 - agitating the fluid mixture with mixing means such that the bitumen depleted, water and solids enriched, lower fluid fraction within the separator comprises a substantially homogeneous mixture of solids and liquids and the formation of layers of highly viscous asphaltene containing material is inhibited.

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METHOD FOR SEPARATING BITUMEN FROM AN OIL SAND FROTH

BACKGROUND

The invention relates to a method for separating bitumen from an oil sand froth.

- 5 Various water extraction processes for the separation of bitumen from mined oil sand have been previously described. Typically, cool to hot water is used with or without process additives, such as caustic, to form an oil sand froth containing bitumen, water and solids.
- 10 Various techniques have been described to recover the bitumen from the oil sand froth, including Canadian patent No. 2,149,737 describing a process in which a paraffinic solvent is mixed with oil sand froth and fed to a first separator in which gravity separation is used to recover
- 15 dilute bitumen product.

In an application of the process, as described in Canadian patent application No. 2,350,907, a series of separators is employed in a counter-current mode of operation.

- In the separation assembly described in Canadian patent
- 20 application No. 2,350,907, each separator has an upper outlet, for removal of an overflow stream, located at or near the top of the separator, a lower outlet, for removal of an underflow stream, located at or near the bottom of the separator and an inlet, for the feed stream, located between
- 25 the bottom and top of the separator. The feed stream to the first separator comprises oil sand froth that has been contacted with a paraffinic solvent bearing stream. The feed stream to each separator after the first separator comprises the underflow stream from the previous separator that has

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been contacted with a paraffinic solvent bearing stream. The streams are contacted using contacting mixing means.

When an oil sand froth is mixed with a paraffinic solvent, a transformation is initiated, resulting in the formation of
5 at least four distinct phases of material.

The four phases can broadly be described as follows:

- 1) a dilute bitumen phase, mainly comprising solvent and high value components of the bitumen, known as maltenes;
- 2) an aqueous phase, mainly comprising water, water-soluble
10 materials and dispersed fine solids, such as clays;
- 3) an inorganic particulate phase, mainly comprising sand; and
- 4) an organic particulate phase, mainly comprising precipitated asphaltenes, with water and clays incorporated
15 in the aggregate structure of the asphaltenes.

The asphaltenes also have an affinity for solvent and maltenes, which are also incorporated in the aggregate structure of the asphaltenes.

In such an oil sand froth that has been contacted with a
20 paraffinic solvent:

- 1) the dilute bitumen phase typically has a density of less than 800 kg/m^3 ;
- 2) the aqueous phase typically has a density of more than 1000 kg/m^3 ;
- 25 3) the inorganic particulate phase typically has a density of around 2500 kg/m^3 ; and

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4) the organic particulate phase typically has a density of between 800 and 1000 kg/m³.

The four above described phases are present in each separator of the paraffinic froth treatment process.

- 5 The differences in density between each of the phases is such that gravity separation can take place in each of the separators. Because the density of the dilute bitumen phase is less than that of the other phases, it tends to float in each separator and can be withdrawn as an overflow stream.
- 10 Because the density of the other phases is greater than that of the dilute bitumen phase, they tend to sink in the dilute bitumen phase and can be withdrawn as an underflow stream from each separator. Each of the other phases exhibits a tendency to sink in the dilute bitumen phase that varies
- 15 according to its respective density and particle or droplet size. For example, the part of the inorganic particulate phase that has a particle size greater than 10µm tends to sink relatively quickly, because of its relatively high density compared to the dilute bitumen phase. It likewise
- 20 tends to sink in the aqueous phase. Conversely, the organic particulate phase tends to sink relatively more slowly in the dilute bitumen phase, especially when it is at the low end of its density range, and tends to float in the aqueous phase. Particles found in the particulate phases will have a
- 25 settling velocity that typically increases with increasing size when the particle is larger than 10µm.

Because the underflow stream from the first separator contains maltenes, which are incorporated in the aggregate structure of the asphaltenes, the underflow stream from the

30 first separator is mixed with paraffinic solvent and fed to

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a second separator in which further gravity separation occurs.

The overflow stream from the second separator, comprising very dilute bitumen, is mixed with, and becomes the source of paraffinic solvent for, the oil sand froth fed to the first separator. If the underflow stream from the second separator does not contain sufficiently high recoverable amounts of maltenes, then it is fed to tailings solvent recovery means and to tailings management. If the underflow stream from the second separator contains sufficiently high recoverable amounts of maltenes, then the underflow stream from the second separator is mixed with paraffinic solvent and fed to a third separator in which further gravity separation occurs. Additional separators and further gravity separation can be employed until the underflow stream from the last separator no longer contains sufficiently high recoverable amounts of maltenes. The overflow stream from each separator, other than the first separator, is mixed with, and becomes the source of paraffinic solvent for, the underflow stream fed to the previous separator.

An attractive feature of the paraffinic froth treatment process is that, by mixing paraffinic solvent with the feed streams to each separator, the ratio of solvent to bitumen becomes progressively higher in each separator. The ratio of solvent to bitumen in the first separator is sufficient to precipitate some of the asphaltenes present in the oil sand froth. By precipitating some of the asphaltenes out of the bitumen in the oil sand froth, the bitumen recovered from the overflow stream from the first separator is essentially free of water and particles and is of high quality. It has a low density, can be upgraded easily, and it has a low viscosity, low metals content and low sulphur content. Also, the precipitated asphaltenes act as an

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internal flocculent, which captures residual water and inorganic solids dispersed in the oil sand froth. In the second and subsequent separators, the progressively higher ratio of solvent to bitumen permits maltenes to be liberated
5 from each successive underflow stream and to separate as dilute bitumen product in the overflow stream of the next separator.

The above-described process can be carried out over a range of temperatures and pressures. If the process is carried
10 out at a temperature of about thirty degrees Celsius and at atmospheric pressure, sometimes called the low temperature froth treatment process, then typically three or more separators may be needed to recover essentially all of the maltenes from the oil sand froth.

15 If the process is carried out at higher temperatures and pressures, sometimes called the high temperature paraffinic froth treatment process, the separation proceeds at a higher rate and therefore fewer separators may be required to recover essentially all of the maltenes from the oil sand
20 froth. In the high temperature paraffinic froth treatment process typically two separators are used.

To gain an understanding of the instant invention, it is instructive to consider how the various phases behave in each of the separators. The dilute bitumen is the
25 continuous phase in the upper region of the separators. The water content in the feed streams to the separators is usually sufficient for the aqueous phase to be continuous in the lower region of the separators. This makes it possible to operate the separators as liquid/liquid separators. The
30 level of the interface between the dilute bitumen phase and the aqueous phase needs to be controlled and positioned below the inlet of the separators and well above the lower

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outlet of the separators. This can be accomplished by using sensors to detect the location of the interface and process control means to control the location of the interface.

Because the density of the organic particulate phase is
5 higher than that of the dilute bitumen phase but lower than that of the aqueous phase it tends to accumulate at the interface between the other two phases. It has been discovered that this tendency is more pronounced in the second separator of the high temperature paraffinic froth
10 treatment process and in the third separator of the low temperature paraffinic froth treatment process. If the organic particulate phase is allowed to continue to accumulate, it can form layers of highly viscous asphaltene containing material capable of plugging the outlet of the
15 separators and disrupting the continuous operation of the process. This phenomenon has been observed in pilot plant experiments of the high temperature froth treatment process and in commercial operation of the low temperature froth treatment process.

20 It is an object of the invention to provide a method for separating bitumen from an oil sand froth in one or more separators in such a manner that within each separator the formation of layers of highly viscous asphaltene containing material is inhibited.

25 SUMMARY

In accordance with the invention there is provided a method for separating an oil sand froth, the method comprising:

- mixing the oil sand froth with a paraffinic solvent;
- feeding the fluid mixture into a separator having a lower
30 fluid outlet near a bottom thereof and an upper fluid outlet near a top thereof;

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- inducing the fluid mixture to be separated by gravity separation in the separator into a bitumen enriched, water and solids depleted, upper fluid fraction and a bitumen depleted, water and solids enriched, lower fluid fraction;
- 5 - inducing the bitumen enriched, water depleted, upper fluid fraction to flow into the upper fluid outlet and inducing the water enriched, bitumen depleted, lower fluid fraction to flow into to the lower fluid outlet; and
- agitating the fluid mixture with mixing means such that
- 10 the bitumen depleted, water and solids enriched, lower fluid fraction within the separator comprises a substantially homogeneous mixture of solids and liquids.

In a preferred embodiment, the oil sand froth fed to the separator is mixed with a dispersant chemical, and/or a
15 wetting chemical which enhances hydrophilic properties of any asphaltenes within the oil sand froth.

Preferably, the dispersant chemical comprises glycol ether.

It is also preferred that the mixing means agitate the fluid mixture such that the lower fluid fraction comprises a
20 substantially homogeneous mixture of solids and liquids in which solids are substantially fully dispersed and in which any asphaltenes become part of a substantially homogeneous distribution of an organic particulate fraction in the aqueous phase and in which formation of layers of
25 asphaltenes is inhibited.

The mixing means may comprise a rotating mixing blade assembly and/or a jet assembly via which a fraction of the fluid mixture is extracted from and then reinjected into the fluid mixture.

30 The mixing means may be arranged at least partly within a fluid inlet conduit of the separator.

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Alternatively, the mixing means may be arranged at least partly within the interior of the separator.

Optionally the method according to the invention further comprises

- 5 - feeding the bitumen depleted, water and solids enriched lower fluid fraction via the fluid outlet into a second separator having a lower fluid outlet near a bottom thereof and an upper fluid outlet near a top thereof;
- inducing the fluid mixture to be separated by gravity
- 10 separation in the second separator into a bitumen enriched, water and solids depleted, upper fluid fraction and a bitumen depleted, water and solids enriched, lower fluid fraction;
- inducing the bitumen enriched, water depleted, upper fluid
- 15 fraction to flow into the upper fluid outlet of the second separator and inducing the water enriched, bitumen depleted, lower fluid fraction to flow into to the lower fluid outlet of the second separator.

In such case the lower fluid outlet of the first separator

20 may be connected to a fluid inlet conduit of the second separator, in which conduit the fluid mixture is agitated by second mixing means which comprise a rotating mixing blade assembly and/or a jet assembly via which a fraction of the fluid mixture is extracted from and then reinjected into the

25 fluid inlet conduit of the second separator.

Optionally the method according to the invention still further comprises:

- feeding the bitumen depleted, water and solids enriched lower fluid fraction via the fluid outlet of the second
- 30 separator into a third separator having a lower fluid outlet near a bottom thereof and an upper fluid outlet near a top thereof;

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- inducing the fluid mixture to be separated by gravity separation in the third separator into a bitumen enriched, water and solids depleted, upper fluid fraction and a bitumen depleted, water and solids enriched, lower fluid
5 fraction;
- inducing the bitumen enriched, water depleted, upper fluid fraction to flow into the upper fluid outlet of the third separator and inducing the water enriched, bitumen depleted, lower fluid fraction to flow into to the lower fluid outlet
10 of the third separator.

In such case, the lower fluid outlet of the second separator may be connected to a fluid inlet conduit of the third separator, in which conduit the fluid mixture is agitated by third mixing means which comprise a rotating mixing blade
15 assembly and/or a jet assembly via which a fraction of the fluid mixture is extracted from and then reinjected into the fluid inlet conduit of the third separator.

It is preferred that the water content in the feed stream to each separator is controlled so that the bitumen depleted,
20 water and solids enriched fluid fraction in a lower region of each separator is substantially water-continuous.

Optionally, the temperature of the fluid mixture in each separator is maintained above 50 degrees Celsius.

These and other features, objects and advantages of the
25 method according to the invention are described in the accompanying claims, abstract and the following detailed description of preferred embodiments in which reference is made to the accompanying drawings.

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BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 is a flow scheme of three separators in a low temperature paraffinic froth treatment process for separating bitumen from an oil sand froth according to one
5 embodiment of the invention; and

FIG.2 is a flow scheme of two separators in a high temperature paraffinic froth treatment process for separating bitumen from an oil sand froth according to another embodiment of the invention.

10 DETAILED DESCRIPTION

Thus, in the paraffinic froth treatment process according to the invention gravity separation may take place in two or more separators to separate an overflow stream comprising a dilute bitumen phase from an underflow stream comprising an
15 aqueous phase, an inorganic particulate phase and an organic particulate phase. By using equipment and operation control means to keep the inorganic particulate phase homogeneously dispersed in the aqueous phase in the separators, plugging of the separator outlets can be substantially minimized.

20 Equipment and operation control means for use in the method according to the invention preferably perform one or more of the following functions:

-controlling the water content in the feed stream to each separator so that the lower region of each separator, below
25 the inlet to the separator, is water-continuous,

-using mixing means to treat underflow streams to ensure that the mixture of solids in liquids is homogeneous,

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-using mixing means in the separators to treat the material in the lower regions of the separators to ensure that the mixture of solids in liquids is homogeneous, and

-adding dispersant or water wetting chemicals to the feed streams to each separator in amounts sufficient to ensure that the material in the feed stream and in the lower regions of the separators remains homogeneous.

FIG.1 shows an assembly of three separators 1,2 and 3 in a low temperature froth flotation process, wherein the temperature in the vessels is about 30 degrees Celsius.

In each separator 1,2 and 3 an oil sand froth is separated into a bitumen enriched, water and solids depleted, upper fluid fraction, represented in the drawing as C_xH_y , and a bitumen depleted, water and solids enriched lower fluid fraction, represented in the drawing as H_2O .

The first separator 1 comprises a fluid inlet 4, an upper fluid outlet 5 and a lower fluid outlet 6.

The second separator 2 comprises an upper fluid outlet 7, a lower fluid outlet 8 and a fluid inlet 9, which is connected to the lower fluid outlet 6 of the first separator 1.

The third separator 3 comprises an upper fluid outlet 10, a lower fluid outlet 11 and a fluid inlet 12, which is connected to the lower fluid outlet 8 of the second separator 2 and to a paraffinic solvent supply conduit 13. Each fluid inlet 4, 9 and 12 is equipped with a static mixer 13,14 and 15 in which the underflow streams are contacted with solvent bearing streams. Fluid homogenizers 16, 17, 18, 19 and 20 are arranged in the fluid inlets 4, 9 and 12 and the fluid outlets 6, 8 and 11 of the first, second and third separators 1, 2 and 3. Fluid homogenizers 21, 22 and 23 are

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furthermore arranged in the frusto-conical lower parts of the first, second and third separators 1, 2 and 3.

The bitumen enriched fractions flowing through the upper fluid outlets 7 and 10 of the second and third separators 2 and 3 are re-injected partly into the inlets 4 and 9 of the first and second separators 1 and 2, as illustrated by arrows 24 and 25.

FIG.2 shows an assembly of two separators 21 and 22 in a high temperature froth flotation process, wherein the temperature in the vessels 21 and 22 is above 50 degrees Celsius.

In each separation vessel 21 and 22 an oil sand froth is separated into a bitumen enriched, water and solids depleted, upper fluid fraction, represented in the drawing as C_xH_y , and a bitumen depleted, water and solids enriched lower fluid fraction, represented in the drawing as H_2O .

The first separator 21 comprises a fluid inlet 24, an upper fluid outlet 25 and a lower fluid outlet 26.

The second separator 22 comprises an upper fluid outlet 27, a lower fluid outlet 28 and a fluid inlet 29, which is connected to the lower fluid outlet 26 of the first separator 21. At least part of the bitumen enriched upper fluid fraction flowing through the upper fluid outlet 27 is re-injected in the oil sand froth slurry in the fluid inlet 24 of the first separator 21, as illustrated by arrow 30.

Static mixers 31 and 32 and fluid homogenizers 33, 34, 35 and 36 are arranged in the fluid inlets 24 and 29 and the fluid outlets 26 and 28 of the first and second separators 21 and 22. Fluid homogenizers 37 and 38 are furthermore

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arranged in the frusto-conical lower parts of the first and second separators 21 and 22.

The static mixers 31 and 32 serve to contact the underflow stream with the solvent bearing stream and the fluid
5 homogenizers 33-38 serve to homogenize the fluid mixture such that accumulation of an organic particulate phase within the separators 21 and 22 is inhibited.

In a high temperature paraffinic froth treatment process pilot plant as illustrated in FIG.2, layers of asphaltenes
10 were observed to be accumulating in the second separator 22. A stirred fluid homogenizing vessel 34 was installed in the flow line between the lower fluid outlet 26 of a first separator 21 and the inlet 34 of the second separator 22. In this stirred fluid homogenizing vessel 34, the underflow
15 stream from the first separator 21 was mixed until it was determined that the solids were fully dispersed in the stream so that the solids concentration was homogeneous.

This resulted in changes to the appearance of the material in the lower region of the second separator 22 in that the
20 layers of asphaltenes disappeared and the asphaltenes became part of a homogeneous distribution of the organic particulate phase in the aqueous phase. Performance was enhanced when the homogenizer was located upstream from where the underflow stream is contacted with the solvent
25 bearing stream.

The desired mixing can be accomplished by using any one of various types of equipment such as agitators or jets driven by pump-arounds. The static mixing and fluid homogenizing equipment 31-38 can be located in or around the separators
30 21 and 22 themselves, or at least partly in the conduits between the separators 21 and 22, as shown in Figure 2.

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The amount of agitation required is that needed to substantially fully disperse the solids in the aqueous phase so that the solids concentration in the mixture is substantially homogeneous. The agitators that are located upstream of the separators should be designed and operated so that the break-up of asphaltene aggregates is minimized because too small particles will not be separated from the dilute bitumen overflow stream.

In further high temperature paraffinic froth treatment pilot plant tests, a glycol ether dispersant chemical was added to the underflow stream from the first separator 21, as illustrated by arrow 40.

This also resulted in the layers of asphaltenes, observed to be accumulating in the second separator, to change in appearance such that the asphaltenes became part of a homogeneous distribution of the organic particulate phase in the aqueous phase in the lower region of the second separator.

Instead of a glycol ether, any other dispersant chemical or wetting chemical, that has the effect of making the asphaltenes more hydrophilic, can be used so long as the dispersant chemical or wetting chemical, in the amounts used, does not have over-riding undesirable impacts on other processing steps downstream from the separators.

An example of an undesirable impact of the use of dispersant chemicals is the occurrence of foaming in the tailings solvent recovery unit, downstream from the separators. This impact can be managed by adjusting the operation of the tailings solvent recovery unit and by using anti-foaming chemicals.

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Although the foregoing invention has been described in some detail by way of illustration and example for purposes of clarity of understanding, it is readily apparent to those of ordinary skill in the art in light of the teachings of this invention that certain changes and modifications may be made thereto without departing from the spirit or scope of the appended claims.

It must be noted that as used in the specification and the appended claims, the singular forms of "a", "an", and "the" include plural reference unless the context clearly indicates otherwise.

Unless defined otherwise, all technical and scientific terms used herein have the same meaning as commonly understood to one of ordinary skill in the art to which this invention belongs.

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CLAIMS:

1. A method for separating an oil sand froth, the method comprising:

- mixing the oil sand froth with a paraffinic solvent to
5 form a fluid mixture;
- feeding the fluid mixture into a separator having a lower fluid outlet near a bottom thereof and an upper fluid outlet near a top thereof;
- inducing the fluid mixture to be separated by gravity
10 separation in the separator into a bitumen enriched, water and solids depleted, upper fluid fraction and a bitumen depleted, water and solids enriched, lower fluid fraction;
- inducing the bitumen enriched, water depleted, upper fluid fraction to flow into the upper fluid outlet and inducing
15 the water enriched, bitumen depleted, lower fluid fraction to flow into the lower fluid outlet; and
- agitating the fluid mixture with mixing means such that the bitumen depleted, water and solids enriched, lower fluid fraction within the separator comprises a substantially
20 homogeneous mixture of solids and liquids.

2. The method of claim 1, further comprising mixing the oil sand froth fed to the separator with a chemical which enhances hydrophilic properties of any asphaltenes within the oil sand froth.

25 3. The method of claim 2, wherein the chemical is a dispersant chemical, a wetting chemical or a combination thereof.

4. The method of claim 3, wherein the chemical comprises glycol ether.

30 5. The method of claim 1, 2, 3 or 4, wherein the mixing means agitate the fluid mixture such that the lower

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fluid fraction comprises a substantially homogeneous mixture of solids and liquids in which solids are substantially fully dispersed and in which any asphaltenes become part of a substantially homogeneous distribution of an organic particulate fraction in the aqueous phase and in which formation of layers of asphaltenes is inhibited.

6. The method of claim 1, 2, 3, 4 or 5, wherein the mixing means comprises a static mixer, a rotating mixing blade assembly and/or a jet assembly via which a fraction of the fluid mixture is extracted from and then reinjected into the fluid mixture.

7. The method of claim 6, wherein the mixing means is arranged at least partly within a fluid inlet conduit of the separator.

8. The method of claim 6, wherein the mixing means is arranged at least partly within the interior of the separator.

9. The method of claim 1, 2, 3, 4, 5, 6, 7 or 8, wherein the method further comprises controlling the water content in the fluid mixture fed into the separator so that the bitumen depleted, water and solids enriched, lower fluid fraction in a lower region of the separator is substantially water-continuous.

10. The method of claim 1, 2, 3, 4, 5, 6, 7, 8 or 9, wherein the temperature of the fluid mixture in the separator is maintained above 50 degrees Celsius.

11. The method of claim 1, 2, 3, 4, 5, 6, 7, 8, 9 or 10, further comprising
- feeding a fluid mixture comprising the bitumen depleted, water and solids enriched, lower fluid fraction via the

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lower fluid outlet into a second separator having a lower fluid outlet near a bottom thereof and an upper fluid outlet near a top thereof;

- inducing the fluid mixture to be separated by gravity

5 separation in the second separator into a bitumen enriched, water and solids depleted, upper fluid fraction and a bitumen depleted, water and solids enriched, lower fluid fraction;

10 - inducing the bitumen enriched, water depleted, upper fluid fraction to flow into the upper fluid outlet of the second separator and inducing the water enriched, bitumen depleted, lower fluid fraction to flow into the lower fluid outlet of the second separator.

12. The method of claim 10, wherein the lower fluid
15 outlet of the first separator is connected to a fluid inlet conduit of the second separator, in which conduit the fluid mixture is agitated by second mixing means which comprises a static mixer, a rotating mixing blade assembly and/or a jet assembly via which a fraction of the fluid mixture is
20 extracted from and then reinjected into the fluid inlet conduit of the second separator.

13. The method of claim 11 or 12, wherein the method further comprises controlling the water content in the fluid mixture fed into the second separator so that the bitumen
25 depleted, water and solids enriched, lower fluid fraction in a lower region of the second separator is substantially water-continuous.

14. The method of claim 11, 12 or 13, wherein the temperature of the fluid mixture in the second separator is
30 maintained above 50 degrees Celsius.

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15. The method of claim 11, 12, 13 or 14 further comprising

- feeding a fluid mixture comprising the bitumen depleted, water and solids enriched, lower fluid fraction via the lower fluid outlet of the second separator into a third separator having a lower fluid outlet near a bottom thereof and an upper fluid outlet near a top thereof;
- inducing the fluid mixture to be separated by gravity separation in the third separator into a bitumen enriched, water and solids depleted, upper fluid fraction and a bitumen depleted, water and solids enriched, lower fluid fraction;
- inducing the bitumen enriched, water depleted, upper fluid fraction to flow into the upper fluid outlet of the third separator and inducing the water enriched, bitumen depleted, lower fluid fraction to flow into to the lower fluid outlet of the third separator.

16. The method of claim 15, wherein the lower fluid outlet of the second separator is connected to a fluid inlet conduit of the third separator, in which conduit the fluid mixture is agitated by third mixing means which comprise a static mixer, a rotating mixing blade assembly and/or a jet assembly via which a fraction of the fluid mixture is extracted from and then reinjected into the fluid inlet conduit of the third separator.

17. The method of claim 15 or 16, wherein the method further comprises controlling the water content in the fluid mixture fed into the third separator so that the bitumen depleted, water and solids enriched, lower fluid fraction in a lower region of the third separator is substantially water-continuous.

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18. The method of claim 15, 16 or 17, wherein the temperature of the fluid mixture in the third separator is maintained above 50 degrees Celsius.

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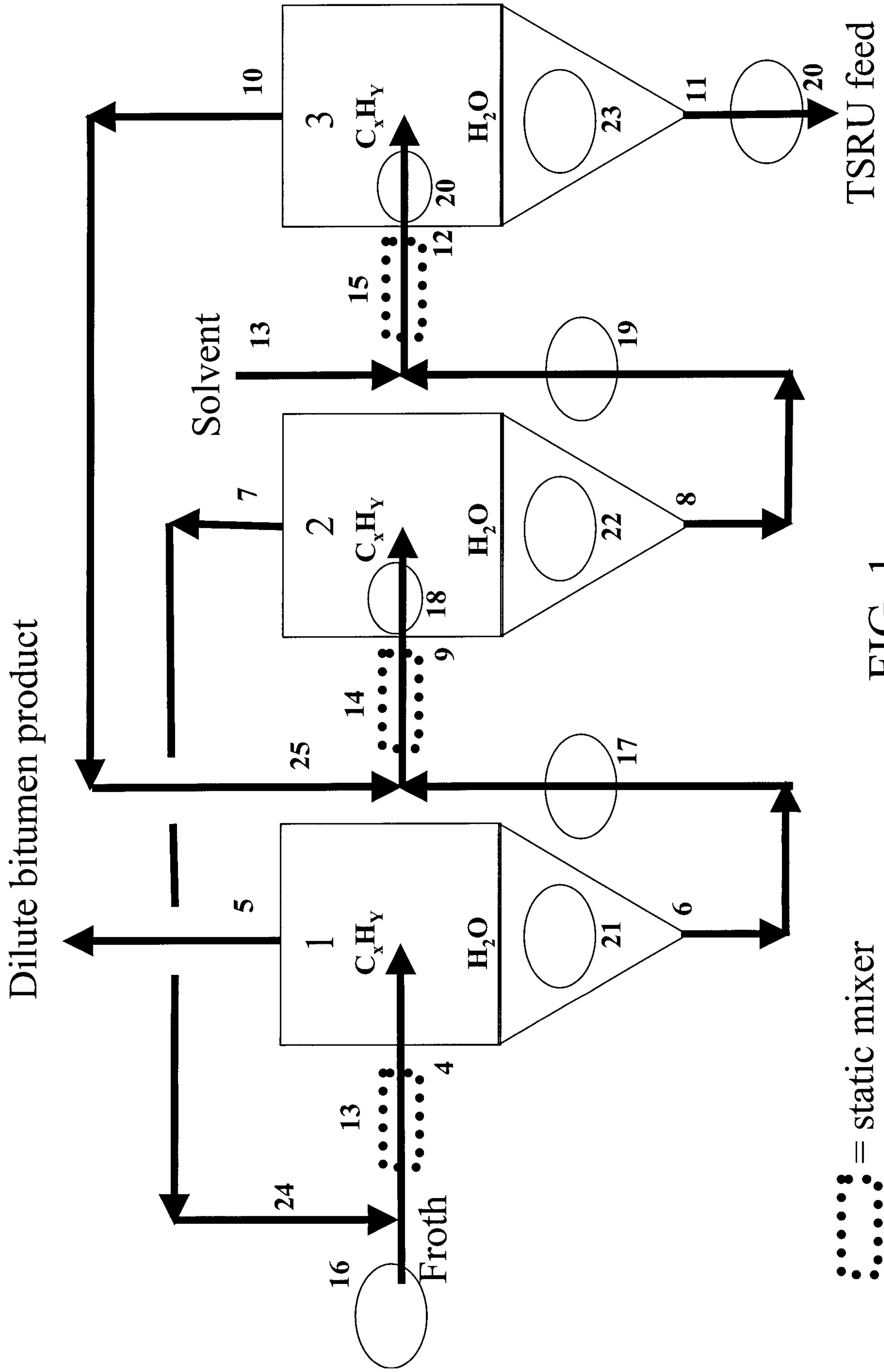
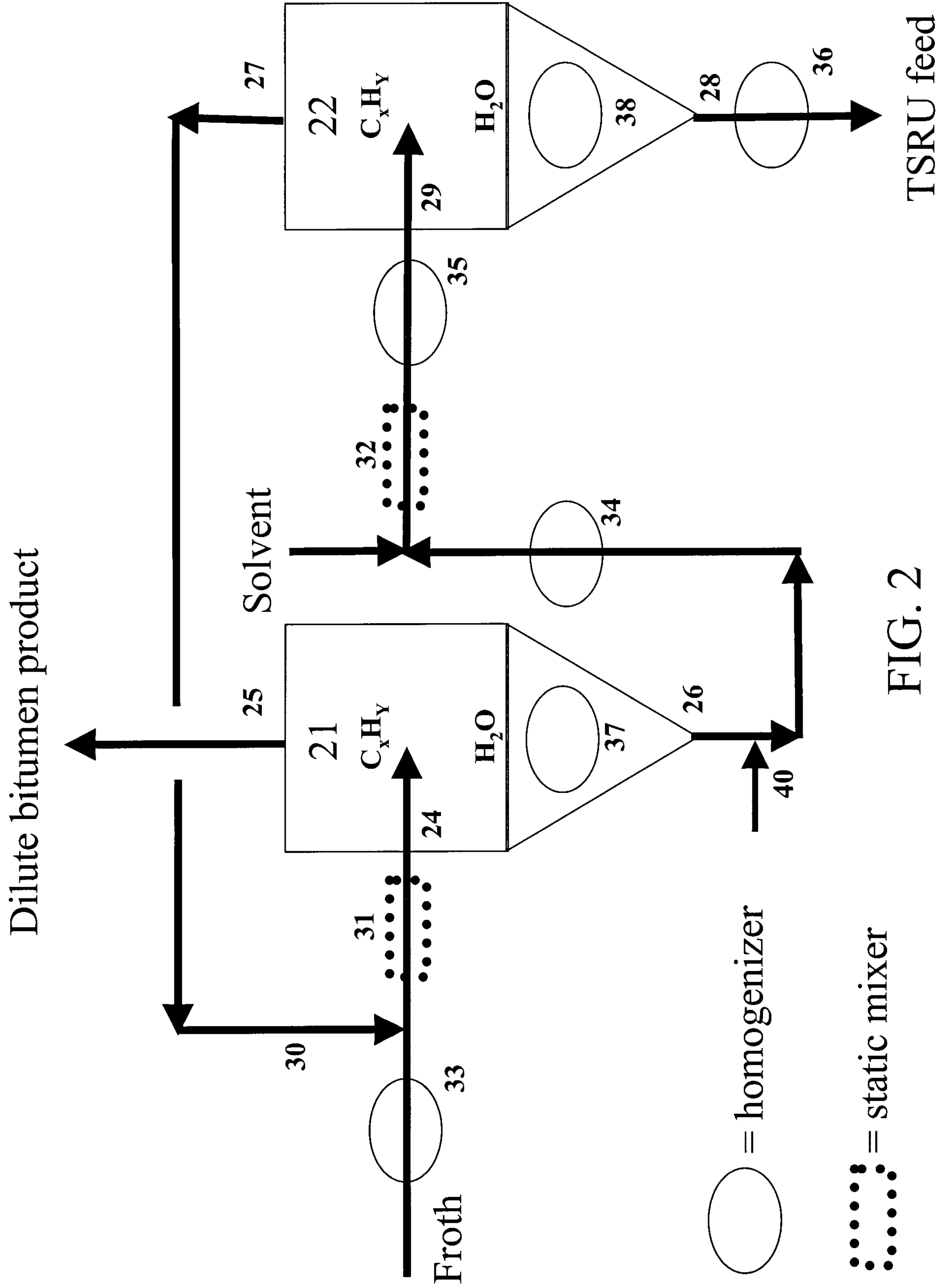


FIG. 1



Dilute bitumen product

