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An agency of Industry Canada

CA 2588043 C 2012/10/02

(11)(21) 2 588 043

(12) BREVET CANADIEN
CANADIAN PATENT

(13) C

(22) Date de dépôt/Filing Date: 2007/05/08

(41) Mise à la disp. pub./Open to Public Insp.: 2008/11/08

(45) Date de délivrance/Issue Date: 2012/10/02

(51) Cl.Int./Int.Cl. *C10G 1/04* (2006.01),
C10C 3/00 (2006.01)

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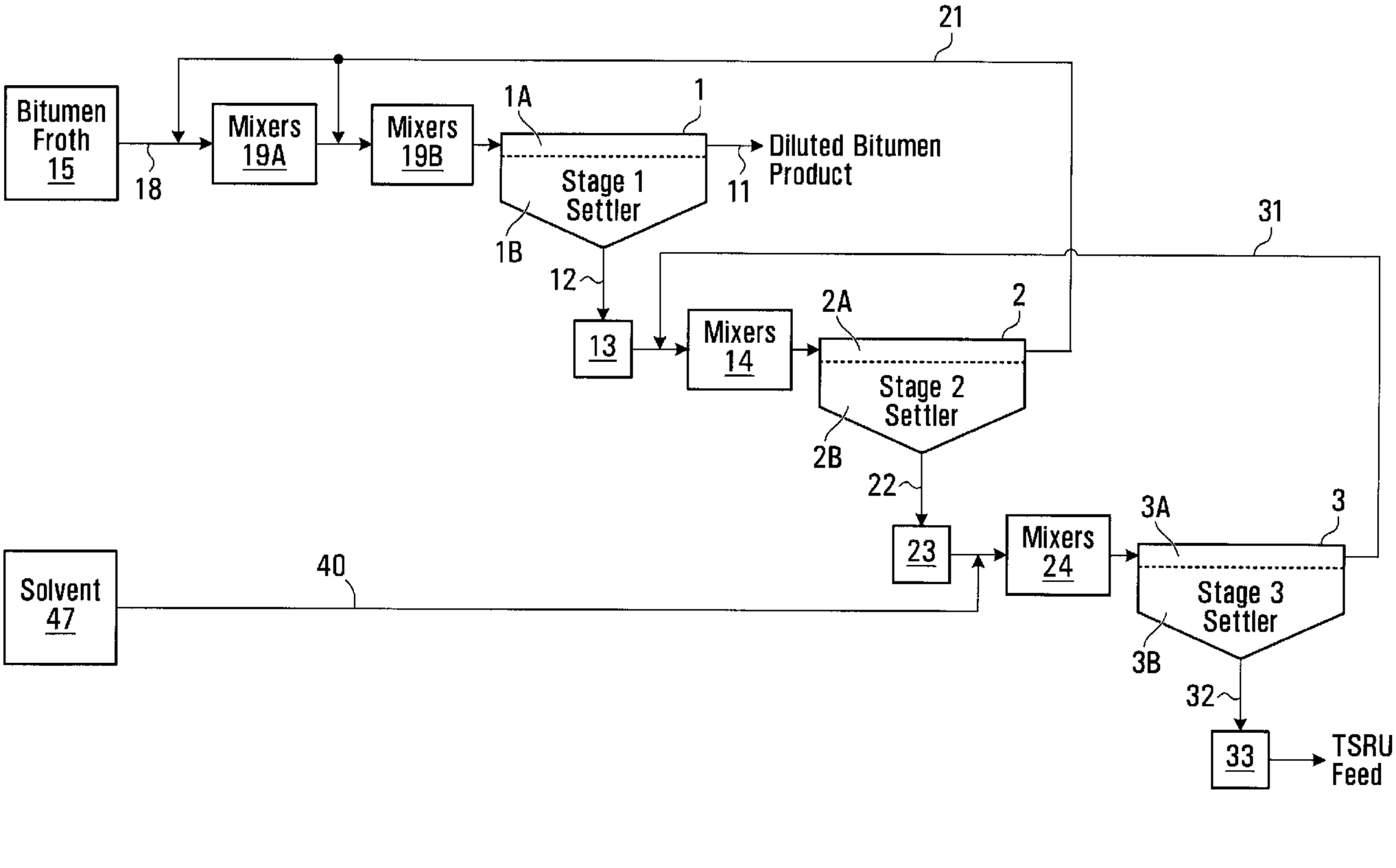
(54) Titre : PROCEDE DE SEPARATION D'ECUME DE BITUME EN FRACTIONS ENRICHIES DE MALTENES ET D'ASPHALTENES

(54) Title: METHOD FOR SEPARATING A BITUMEN FROTH INTO MALTENES AND ASPHALTENES ENRICHED FRACTIONS



(57) Abrégé/Abstract:
In an oil sand processing plant, in which produced oil sand is mixed with a solvent, water and air to produce a bitumen froth, separation of the froth into maltenes and asphaltenes enriched fractions is enhanced by: adding a paraffinic solvent in an incremental manner to the froth; separating the froth/solvent mixture in a settler in an overflow fraction, which is enriched in maltenes and paraffinic solvent, and an underflow fraction which is enriched in asphaltenes, water and solids; discharging the overflow fraction from an upper region of the settler; and discharging the underflow fraction from a lower region of the settler.

ABSTRACT

In an oil sand processing plant, in which produced oil sand is mixed with a solvent, water and air to produce a bitumen froth, separation of the froth into maltenes and asphaltenes enriched fractions is enhanced by:

adding a paraffinic solvent in an incremental manner to the froth;

separating the froth/solvent mixture in a settler in an overflow fraction, which is enriched in maltenes and paraffinic solvent, and an underflow fraction which is enriched in asphaltenes, water and solids;

discharging the overflow fraction from an upper region of the settler; and

discharging the underflow fraction from a lower region of the settler.

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METHOD FOR SEPARATING A BITUMEN FROTH INTO MALTENES AND ASPHALTENES ENRICHED FRACTIONS

BACKGROUND

The invention relates to a method for separating a bitumen froth into maltenes and asphaltenes enriched fractions.

It is known from Canadian patent No's. 2,149,737 and 2,232,929 to add a paraffinic solvent to a bitumen froth in an oil sand processing plant. US patent 6,746,599 discloses the use of a naphtha diluent in a process for separating a bitumen froth in an oil sand processing plant.

In a typical oil sand processing plant, mined oil sand is mixed with water to produce a slurry. The slurry is an emulsion of bitumen and other components of the sand in water. The slurry is screened to remove oversize rocks and oil sand lumps and then conditioned in a hydro transportation pipeline or via other conditioning means. The thus conditioned slurry is introduced into a slurry separation tank from which a bitumen froth is recovered. The froth typically contains about 60% by weight of bitumen and the remainder is mainly made up of water and solids. The froth is typically treated by adding a solvent and/or other agents to promote the separation of bitumen from the other components of the froth, including water, solvent or other agents and residual solids.

Bitumen is a viscous liquid hydrocarbon which typically comprises maltenes and asphaltenes.

Maltenes are high value components of bitumen.

If a paraffinic solvent is used, some asphaltenes can be precipitated from the froth and can assist in agglomerating fine particulates, including clays, and water droplets, so that they can more easily be separated by gravity. The ultimate objective of the gravity separation step in the paraffinic froth treatment process, is to produce a dilute bitumen overflow product that is clean and dry and that contains proportionally more maltenes than did the bitumen in the froth.

The rate at which the precipitated asphaltenes with agglomerated fine particulates settle is an important factor as it affects the efficiency of the overall process. If the settling rate can be increased, the size of the separation vessels can be decreased, thereby reducing capital equipment cost for a given rate of throughput. Alternatively, for a given equipment size, if the settling rate can be increased, the rate of throughput can be increased if the separator vessels are a process bottleneck.

It is desirable to provide an improved method for separating a bitumen froth into maltenes and asphaltenes enriched fractions.

SUMMARY

In accordance with the invention there is provided a method of separating a bitumen froth into maltenes and asphaltenes enriched fractions in an oil sand processing plant in which produced oil sand is mixed with water and air to produce a bitumen froth, the method comprising:

adding a paraffinic solvent in an incremental manner to the froth to produce a froth/solvent mixture;

separating the froth/solvent mixture in a settler into an overflow fraction enriched in maltenes and paraffinic solvent, and an underflow fraction enriched in asphaltenes, water and solids;

discharging the overflow fraction from an upper region of the settler; and

discharging the underflow fraction from a lower region of the settler.

In an embodiment, the paraffinic solvent is added in a staged and incremental manner to the froth to produce a froth/solvent mixture.

Preferably the paraffinic solvent is injected in an incremental manner into a conduit through which the froth is fed into the settler.

The number of incremental additions is not particularly limited. In an exemplary embodiment, the incremental addition comprises a first and second addition, such that in a first addition, sufficient solvent is added to reduce viscosity and density of the froth/solvent mixture and in the second addition, sufficient solvent is added to precipitate the desired amount of asphaltenes. The desired amount of asphaltenes depends on the desired product quality specification for a given context. While a certain minimum amount of asphaltenes should be precipitated to remove a desired degree of water and solids from the froth, additional asphaltene removal may be necessary for other purposes, including, without limitation, providing asphaltene levels appropriate for an upgrader facility, and such other purposes would require diverse asphaltene levels, as would be clear to one skilled in the art.

It is also preferred that the first addition of paraffinic solvent is injected into the conduit such that

the froth flowing from the conduit into the settler comprises, for example, between 5 and 50 vol%, between 5 and 40 vol%, between 5 and 30 vol%, between 5 and 20 vol%, between 5 and 10 vol%, between 10 and 50 vol%, between 20 and 50 vol%, between 30 and 50 vol%, between 40 and 50 vol%, between 10 and 40 vol% or between 20 and 30 vol% of paraffinic solvent and during the second addition paraffinic solvent is injected into the conduit such that the froth flowing from the conduit into the settler comprises the rest of the paraffinic solvent. The actual final volume will depend on desired product quality.

In another embodiment of the method described herein, the froth/solvent mixture is separated in a series of settlers. In an exemplary embodiment, the froth solvent/mixture is separated in a series of three settlers by:

discharging a first underflow fraction from a first settler via a first underflow conduit into a second settler;

discharging a second underflow fraction from the second settler via a second underflow conduit into a third settler;

discharging a third overflow fraction from an upper region of the third settler into the second settler via a third overflow conduit, which discharges into the first underflow conduit;

discharging a second overflow fraction from an upper region of the second settler into the first settler via a second overflow conduit, which discharges into a froth

feed conduit through which the froth/solvent mixture is fed into the first settler;

discharging a third underflow fraction from a lower region of the third settler via a third underflow conduit; and

discharging a first overflow fraction from an upper region of the first settler via a first overflow conduit.

These and other features and embodiments of the method according to the invention are described in the accompanying claims, abstract and the following detailed description of an embodiment of the method according to the invention, which is shown in the accompanying drawings.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG.1 depicts a process flow scheme of a paraffinic froth treatment process according to one embodiment of the invention; and

FIG.2 is a diagram that shows the effect of incremental addition of paraffinic solvent to the separation of a bitumen froth into a maltenes enriched overflow fraction and an asphaltenes enriched underflow fraction.

DETAILED DESCRIPTION OF THE SHOWN EMBODIMENT OF THE INVENTION

FIG.1 depicts a process flow scheme showing the paraffinic froth treatment process according to one embodiment of the invention.

A bitumen froth 15 is transported from an oil sand mining site (not shown) and then pumped by a pump (not

shown) via a feed conduit 18, which comprises mixers 19a and 19b (which can be static mixers or impeller tank mixers), into the Stage 1 settler 1.

In the Stage 1 settler 1 the froth/solvent mixture is separated into a primary maltenes/asphaltenes and solvent enriched overflow fraction 1A, which is discharged via a first overflow conduit 11, and a primary precipitated asphaltenes, water and solids enriched underflow fraction 1B, which is discharged via a first underflow conduit 12 which discharges into a second separation tank 2 and which is equipped with a pump 13 and a mixer 14.

In the Stage 2 settler 2 the primary underflow fraction 1B discharged by the Stage 1 settler 1 is further separated into a secondary maltenes and solvent enriched overflow fraction 2A and a secondary asphaltenes, water and solids enriched underflow fraction 2B.

The secondary maltenes and solvent enriched overflow fraction 2A is recycled from the Stage 2 settler 2 back into the Stage 1 settler 1 via a second overflow conduit 21 which discharges into the feed conduit 18.

The secondary asphaltenes, water and solids enriched underflow fraction 2B is discharged from the bottom of Stage 2 settler 2 via a second underflow conduit 22 which discharges into a Stage 3 settler 3 and which is equipped with a pump 23 and a static mixer 24. Each of the overflow conduits 11, 21, 31 may also be provided with a pump (not shown).

In the Stage 3 settler 3 the secondary underflow fraction 2B discharged by the Stage 2 settler 2 is further separated into a tertiary maltenes and solvent enriched overflow fraction 3A and a tertiary asphaltenes, water and solids enriched underflow fraction 3B.

The tertiary maltenes and solvent enriched overflow fraction 3A is recycled from the Stage 3 settler 3 back into the Stage 2 settler 2 via a third overflow conduit 31 which discharges into the first underflow conduit 12.

The tertiary asphaltenes, water and solids enriched underflow fraction 3B is discharged from the bottom of Stage 3 settler 3 via a third underflow conduit 32, which is equipped with a pump 33, and which conduit is connected to a tailings solvent recovery unit (TSRU) processing unit (not shown).

A paraffinic solvent supply conduit 40 is connected to the second underflow conduit 22.

Solvent is supplied at least partially into the conduit 40 by a solvent recycling unit (not shown) in which paraffinic solvent is removed from the primary overflow fraction flowing through the first overflow conduit 11. Recycled solvent is fed back to pump (not shown) by a conduit (not shown). In addition fresh paraffinic solvent may be added to the recycled solvent stream from a paraffinic solvent storage unit 47.

Applicant has determined under test conditions that the two-step solvent addition to the froth will have a beneficial effect on the separation of the bitumen froth into maltene and asphaltene enriched fractions. If paraffinic solvent is added in a staged fashion to the

froth fed to the Stage 1 settler 1, then the settling rate increases in the Stage 1 settler 1.

The test apparatus used for the above determinations included a mixing vessel, a temperature controlled water bath and a 1000 mL graduated cylinder to measure the effective settling rate of a mixture of froth and paraffinic solvent in a ratio such that the resulting mixture contains a pre-determined ratio of solvent to bitumen.

The test apparatus was operated at a temperature of 25 degrees Celsius. The froth and solvent were introduced to the mixing tank and mixed for ten minutes at a prescribed mixing rate. The mixture was transferred to the cylinder; the cylinder was sealed, inverted three times, and placed in the water bath to maintain temperature. Typically, after the cylinder is placed in the water bath, an interface is observed near the top of the cylinder, which interface drops over time until a compaction zone is reached and the settling rate slows down. The interface is the boundary between the dilute bitumen that accumulates above the interface and the solids, fine particulates including clays, water and entrained asphaltenes that accumulate below the interface. The settling rate is calculated by measuring the drop in the interface height in mm. from when the interface first appears to when the compaction zone is reached and the time from when the cylinder is placed in the water to when the compaction zone is reached.

When all the solvent was added at the same time to the froth, a settling rate of about 12 mm/minute was obtained. When the addition of the solvent was staged so

that between 10 and 45 percent of the solvent was first introduced and mixed and then the rest added, the settling rates increased as is shown in FIG.2.

The tests demonstrate that staged incremental addition of paraffinic solvent to a bitumen froth in a settler is beneficial for the separation of the froth into a maltenes and paraffinic solvent enriched overflow fraction and an asphaltenes, water and solid enriched underflow fraction.

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 and the art to which this invention belongs.

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CLAIMS:

1. A method of separating a bitumen froth into maltenes and asphaltenes enriched fractions in an oil sand processing plant in which produced oil sand is mixed with water and air to produce a bitumen froth, the method comprising:

adding a first addition of paraffinic solvent to the bitumen froth to form a mixture of bitumen froth and first increment of solvent;

adding a second addition of paraffinic solvent to the mixture of bitumen froth and first increment of solvent to form a froth/solvent mixture;

separating the froth/solvent mixture in a settler into an overflow fraction enriched in maltenes and paraffinic solvent, and an underflow fraction enriched in asphaltenes, water and solids;

discharging the overflow fraction from an upper region of the settler; and

discharging the underflow fraction from a lower region of the settler.

2. The method of claim 1, wherein the paraffinic solvent added in the first addition is in an amount such that viscosity and density of the froth/solvent mixture is reduced and the paraffinic solvent added in the second addition is in an amount to produce a desired final solvent/bitumen ratio.

3. The method of claim 2, wherein the amount of the paraffinic solvent in the first addition is between 5 and 50 vol% of the total amount of paraffinic solvent and the amount of the paraffinic solvent in the second addition is the balance of the total amount of paraffinic solvent.

4. The method of claim 3, wherein the amount of the paraffinic solvent in the first addition is between 10 and 45 vol% of the total amount of paraffinic solvent and the amount of the paraffinic solvent in the second addition is the balance of the total amount of paraffinic solvent.

5. The method of claim 1, wherein at least one further addition of paraffinic solvent is added to form the froth/solvent mixture.

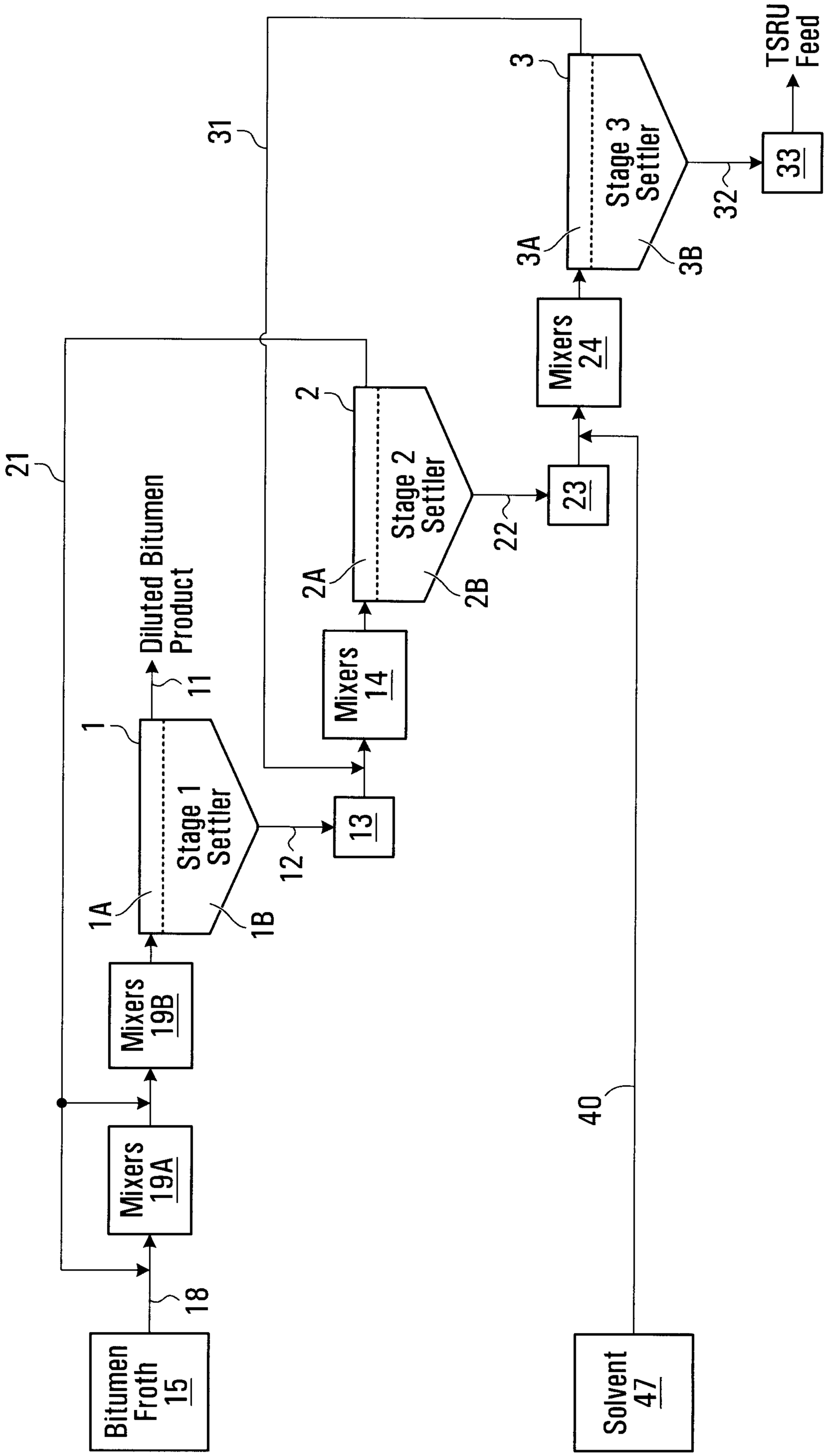

Bitumen Froth 15
18
Mixers 19A
Mixers 19B
Stage 1 Settler
1
1A
1B
Diluted Bitumen Product
11
12
13
Mixers 14
Stage 2 Settler
2
2A
2B
21
22
23
Mixers 24
Stage 3 Settler
3
3A
3B
31
32
33
TSRU Feed
40
Solvent 47

FIG. 1

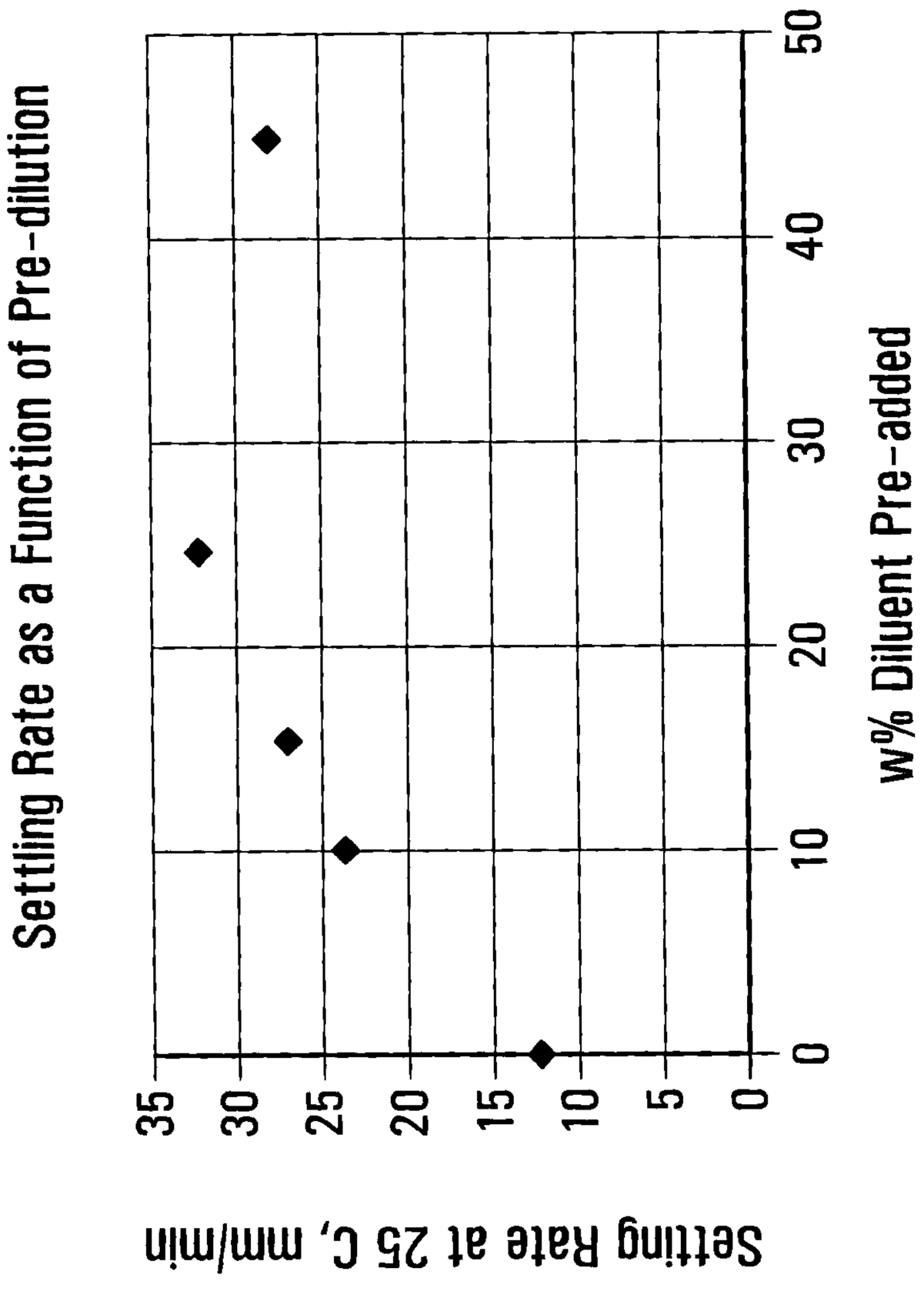
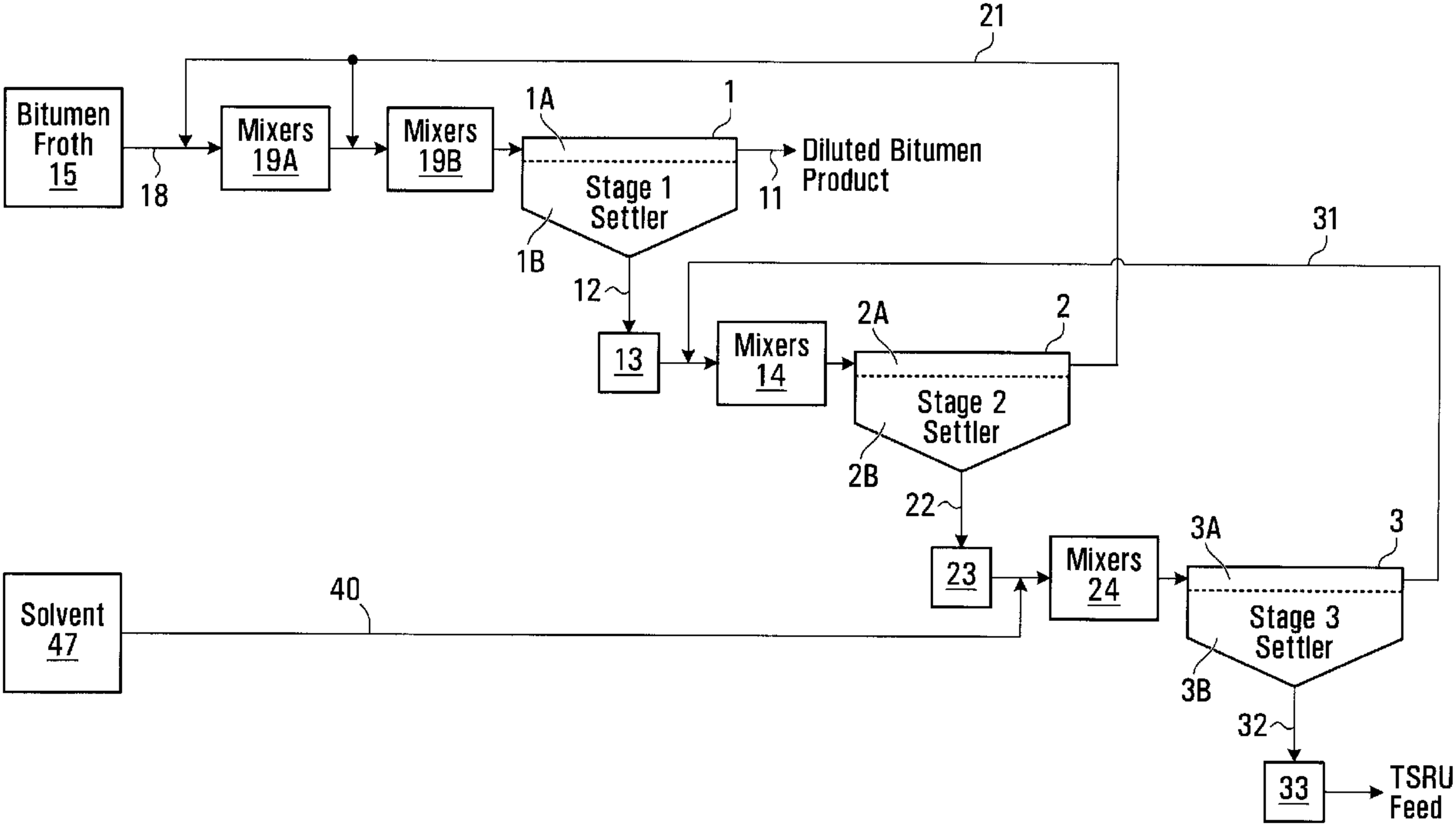

Settling Rate at 25 C, mm/min
35
30
25
20
15
10
5
0
0
10
20
30
40
50
w% Diluent Pre-added
Settling Rate as a Function of Pre-dilution

FIG. 2


Bitumen Froth 15
18
Mixers 19A
Mixers 19B
1A
1
Stage 1 Settler
1B
11
Diluted Bitumen Product
21
31
12
13
Mixers 14
2A
2
Stage 2 Settler
2B
22
23
Mixers 24
3A
3
Stage 3 Settler
3B
32
33
TSRU Feed
Solvent 47
40