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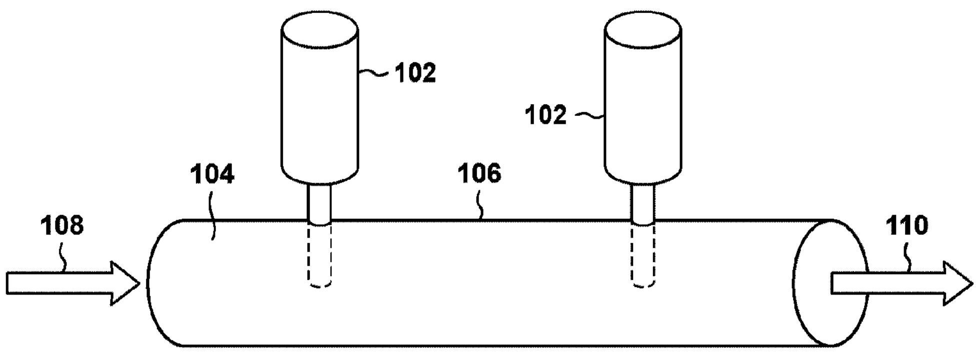
(54) **Titre : TRAITEMENT ULTRASONIQUE DE FLUX CONTENANT DES HYDROCARBURES**
(54) **Title: ULTRASONIC PROCESSING OF HYDROCARBON CONTAINING STREAMS**



(57) **Abrégé/Abstract:**
A disclosed method comprises providing an ultrasonic probe and delivering ultrasonic energy via the ultrasonic probe to bitumen froth for reducing an amount of air in the bitumen froth. Also disclosed are methods of delivering ultrasonic energy to a bitumen stream in a solvent recovery unit (SRU) flash drum for reducing an amount of solvent in the bitumen stream or to a tailings stream in a tailings solvent recovery unit (TSRU) for reducing an amount of solvent in the tailings stream.

ABSTRACT

A disclosed method comprises providing an ultrasonic probe and delivering ultrasonic energy via the ultrasonic probe to bitumen froth for reducing an amount of air in the bitumen froth. Also disclosed are methods of delivering ultrasonic energy to a bitumen stream in a solvent recovery unit (SRU) flash drum for reducing an amount of solvent in the bitumen stream or to a tailings stream in a tailings solvent recovery unit (TSRU) for reducing an amount of solvent in the tailings stream.

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ULTRASONIC PROCESSING OF HYDROCARBON CONTAINING STREAMS

BACKGROUND

Field of Disclosure

[0001] The disclosure relates generally to the field of oil sand processing, and more particularly to treatment of bitumen streams including bitumen froth.

Description of Related Art

[0002] This section is intended to introduce various aspects of the art, which may be associated with the present disclosure. This discussion is believed to assist in providing a framework to facilitate a better understanding of particular aspects of the present disclosure. Accordingly, it should be understood that this section should be read in this light, and not necessarily as admissions of prior art.

[0003] Oil sand extraction processes are used to liberate and separate bitumen from oil sand. Oil sand comprises bitumen, coarse sand, fines and clay materials and water which itself comprises electrolytes. The process of water-based oil sand extraction requires adding hot water to crushed mined oil sand to make a slurry. The slurry is typically conditioned through a hydro-transport pipeline where certain chemicals may be added to the slurry to facilitate the extraction process. As the slurry flows through the hydro-transport pipeline, air may be injected into the pipeline. Other oil sand extraction processes may not utilize direct air injection into the hydro-transport pipeline.

[0004] The presence of water facilitates bitumen liberation from the coarser materials. The slurry then enters a Primary Separation Cell (PSC), also known as Primary Separation Vessel (PSV), where liberated bitumen droplet attach to air bubbles present in the slurry (as a result of either air injection into the hydro-transport or natural air entrainment occurring in the slurry preparation/conditioning process). This step of the process is called bitumen flotation. During bitumen flotation, air bubbles attached to bitumen droplets, facilitate separation of

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bitumen from the rest of the slurry mainly comprising coarse sands and water. In the primary separation cell (PSC), separated bitumen droplets, which are attached to these air bubbles, float to the top of the vessel overflowing to a launder in the form of bitumen froth. The slurry is generally separated into three major streams in the PSC: bitumen froth, middlings, and a PSC underflow (also referred to as coarse sand tailings (CST)). The recovered bitumen froth stream from the top of PSC is primary bitumen froth which comprises bitumen (about 60 wt. %), water (about 30 wt. %), solids (about 10 wt. %). Primary bitumen froth also comprises some air, which is about 30-40 vol. %.

[0005] In order to be able to transfer primary bitumen froth to bitumen storage tanks and eventually to froth treatment facilities through transfer pumps, it is necessary to reduce the air content of the bitumen froth. Otherwise, the froth transfer pumps will not be able to handle this amount of air and will not perform well, which in turn may decrease overall plant throughput.

[0006] From the PSC, the middlings, which may comprise about 1-7 wt. % bitumen and about 10-30 wt. % solids, or about 20-25 wt. % solids, and the rest water, is withdrawn and sent to flotation cells to further recover bitumen. The middlings are processed by injecting air into flotation cells which further facilitate bitumen extraction and help increase the overall bitumen recovery values. This process creates a secondary bitumen froth, which is recycled back to the PSC. Flotation tailings (FT) from the flotation cells, comprising mostly solids and water, are sent for further treatment or disposed in an external tailings area.

[0007] The secondary bitumen froth contains an amount of air due to the injected air into the floatation cells. Pumps that are used to transfer this secondary bitumen froth to the PSC may encounter air-locking difficulties and pose process challenges due to the air content of the froth.

[0008] Water based bitumen extraction process will typically result in the production of a bitumen froth that requires treatment with a solvent. Certain processes use naphtha to dilute bitumen froth before separating the product bitumen by centrifugation. These processes are

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called naphtha froth treatment (NFT) processes. Other processes use a paraffinic solvent, and are called paraffinic froth treatment (PFT) processes, to produce pipelineable bitumen with low levels of solids and water. In the PFT process, a paraffinic solvent (for example, pentanes, hexanes, and heptanes) is used to dilute the froth before separating the product, diluted bitumen, by gravity. A portion of the asphaltenes in the bitumen is also rejected by design in the PFT process and this rejection is used to achieve reduced solids and water levels. In both the NFT and the PFT processes, the diluted tailings (comprising water, solids and some hydrocarbon) are separated from the diluted product bitumen.

[0009] The PFT process may comprise at least three units: Froth Separation Unit (FSU), Solvent Recovery Unit (SRU) and Tailings Solvent Recovery Unit (TSRU). Mixing of the solvent with the feed bitumen froth may be carried out counter-currently in two stages in separate froth separation units. The bitumen froth comprises bitumen, water, and solids. The paraffinic solvent is used to dilute the froth before separating the product bitumen by gravity. The foregoing is only an example of a PFT process and the values are provided by way of example only. An example of a PFT process is described in Canadian Patent No. 2,587,166 to Sury.

[0010] Solvent is typically recovered from the diluted product bitumen component before the bitumen is delivered to a refining facility for further processing.

[0011] As discussed above, it is often desirable or necessary to reduce the air content of bitumen froth. One known method is through a deaerator tower, typically fed by a bitumen froth header downstream of the PSC launder, where steam in injected at the bottom of the tower and the froth enters from the top of the tower in a counter current flow. A challenge with such towers is that they frequently underperform, which may lead to excess air in the bitumen exiting the tower. The excess air may result in problems in the froth transfer pumps located downstream of the deaerator causing them to airlock frequently, and consequently not being able to draw the required bitumen flowrate, which leads to process upsets. The main mechanism of air reduction in the deaerator tower is viscosity reduction of the froth by increasing the froth temperature via heat transfer from the steam to the froth. Therefore, air bubbles can rise to the

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froth surface more easily and with a higher velocity and eventually get released out of the froth. It is additionally often desirable or necessary to reduce foamy characteristics in the PFT process, as these characteristics can lead to undesired consequences such as hydrocarbon carryover to the lighter streams in the SRU and TSRU columns and flash drums. The standard practice in the mining industry to prevent foaming is injecting anti-foam chemicals into the hydrocarbon streams. The disadvantage of this approach is the extra cost associated with the purchase of those chemicals. In addition, any added chemicals to process streams may have potential environmental implications when it comes to treating the tailings streams containing these chemicals.

[0012] Accordingly, there remains a need for improved methods of reducing the air content or foaminess of hydrocarbon containing streams, such as bitumen froth.

SUMMARY

[0013] A disclosed method comprises providing an ultrasonic probe and delivering ultrasonic energy via the ultrasonic probe to bitumen froth for reducing an amount of air in the bitumen froth.

[0014] Another disclosed method comprises providing an ultrasonic plate and delivering ultrasonic energy to a bitumen stream in a solvent recovery unit (SRU) flash drum for reducing an amount of solvent in the bitumen stream.

[0015] Another disclosed method comprises providing an ultrasonic plate and delivering ultrasonic energy via the ultrasonic plate to a tailings stream in a tailings solvent recovery unit (TSRU) for reducing an amount of solvent in the tailings stream.

[0016] Another disclosed method comprises providing an ultrasonic plate and delivering ultrasonic energy via the ultrasonic plate to bitumen froth in a flotation cell, or a bitumen froth in a pump box for reducing an amount of air in the bitumen froth.

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[0017] Also disclosed are uses of ultrasonic energy for reducing an amount of air in bitumen froth, for reducing an amount of solvent in a solvent recovery unit (SRU) flash drum, or for reducing an amount of solvent in a tailings solvent recovery unit (TSRU).

[0018] The foregoing has broadly outlined the features of the present disclosure so that the detailed description that follows may be better understood. Additional features will also be described herein.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] These and other features, aspects and advantages of the disclosure will become apparent from the following description, appending claims and the accompanying drawings, which are briefly described below.

[0020] Figure 1 is a schematic of two ultrasonic probes submerged in a bitumen froth header.

[0021] Figure 2 is a schematic of two ultrasonic probes in a primary separation cell launder.

[0022] Figure 3 is a schematic of an ultrasonic plate disposed above a foam surface of a bitumen/solvent or a tailings/solvent mixture.

[0023] Figure 4 is a graph showing air content reduction versus amplitude of ultrasonic processing into a batch container of bitumen froth.

[0024] It should be noted that the figures are merely examples and no limitations on the scope of the present disclosure is intended thereby. Further, the figures are generally not drawn to scale, but are drafted for purposes of convenience and clarity in illustrating various aspects of the disclosure.

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DETAILED DESCRIPTION

[0025] For the purpose of promoting an understanding of the principles of the disclosure, reference will now be made to the features illustrated in the drawings and specific language will be used to describe the same. It will nevertheless be understood that no limitation of the scope of the disclosure is thereby intended. Any alterations and further modifications, and any further applications of the principles of the disclosure as described herein are contemplated as would normally occur to one skilled in the art to which the disclosure relates. It will be apparent to those skilled in the relevant art that some features that are not relevant to the present disclosure may not be shown in the drawings for the sake of clarity.

[0026] At the outset, for ease of reference, certain terms used in this application and their meaning as used in this context are set forth below. To the extent a term used herein is not defined below, it should be given the broadest definition persons in the pertinent art have given that term as reflected in at least one printed publication or issued patent. Further, the present processes are not limited by the usage of the terms shown below, as all equivalents, synonyms, new developments and terms or processes that serve the same or a similar purpose are considered to be within the scope of the present disclosure.

[0027] Throughout this disclosure, where a range is used, any number between or inclusive of the range is implied.

[0028] A "hydrocarbon" is an organic compound that primarily includes the elements of hydrogen and carbon, although nitrogen, sulfur, oxygen, metals, or any number of other elements may be present in small amounts. Hydrocarbons generally refer to components found in heavy oil or in oil sand. Hydrocarbon compounds may be aliphatic or aromatic, and may be straight chained, branched, or partially or fully cyclic.

[0029] "Bitumen" is a naturally occurring heavy oil material. Generally, it is the hydrocarbon component found in oil sand. Bitumen can vary in composition depending upon the degree of loss of more volatile components. It can vary from a very viscous, tar-like,

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semi-solid material to solid forms. The hydrocarbon types found in bitumen can include aliphatics, aromatics, resins, and asphaltenes. A typical bitumen might be composed of:

19 weight (wt.) % aliphatics (which can range from 5 wt. % - 30 wt. %, or higher);

19 wt. % asphaltenes (which can range from 5 wt. % - 30 wt. %, or higher);

30 wt. % aromatics (which can range from 15 wt. % - 50 wt. %, or higher);

32 wt. % resins (which can range from 15 wt. % - 50 wt. %, or higher); and

some amount of sulfur (which can range in excess of 7 wt. %), the weight % based upon total weight of the bitumen.

In addition, bitumen can contain some water and nitrogen compounds ranging from less than 0.4 wt. % to in excess of 0.7 wt. %. The percentage of the hydrocarbon found in bitumen can vary.

[0030] The term “solvent” as used in the present disclosure should be understood to mean either a single solvent, or a combination of solvents.

[0031] The term “degassing” as used in the present disclosure means reducing an amount of gas in the subject stream, e.g., bitumen froth.

[0032] The terms “approximately,” “about,” “substantially,” and similar terms are intended to have a broad meaning in harmony with the common and accepted usage by those of ordinary skill in the art to which the subject matter of this disclosure pertains. It should be understood by those of skill in the art who review this disclosure that these terms are intended to allow a description of certain features described and claimed without restricting the scope of these features to the precise numeral ranges provided. Accordingly, these terms should be interpreted as indicating that insubstantial or inconsequential modifications or alterations of the subject matter described and are considered to be within the scope of the disclosure.

[0033] The articles “the”, “a” and “an” are not necessarily limited to mean only one, but rather are inclusive and open ended so as to include, optionally, multiple such elements.

[0034] Described herein is the use of ultrasonic processing for degassing/deaerating/defoaming processing streams containing hydrocarbon, in particular

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bituminous materials. This ultrasonic processing may be carried out by using ultrasonic probes placed directly inside the processing stream. The ultrasonic probes can vibrate longitudinally very rapidly, causing cavitation and formation of microscale bubbles. The air bubbles enter the cavitation zones making them coalesce and rise to the surface. This ultrasonic processing may be applied to reduce the air content of bitumen froth upstream of the deaerator either in the primary separation cell launder or in the bitumen froth header from the PSC launder to the deaerator, for instance generally perpendicular to bitumen froth flow. This ultrasonic processing may also be applied to secondary froth in the flotations cells and the bitumen froth generated from coarse sand tailings (CST)/middlings flotation column cells. Additionally, ultrasonic processing may be used in tailings solvent recovery unit (TSRU) and solvent recover unit (SRU) columns/flash drums to suppress foam.

[0035] Described is a degassing process comprising providing an ultrasonic probe and delivering ultrasonic energy via the ultrasonic probe to bitumen froth for reducing an amount of air in the bitumen froth.

[0036] The bitumen froth may be in a primary separation cell (PSC) launder, or in a bitumen froth header from a PSC launder to a deaerating tower. Where the ultrasonic probe is in the PSC launder, the ultrasonic probe may be within 30 degrees of vertical. Where the ultrasonic probe is in the bitumen froth header, the ultrasonic probe may be disposed within 30 degrees of perpendicular to a direction of bitumen froth flow.

[0037] The bitumen froth may be generated from coarse sand tailings (CST) or middlings, utilizing flotation column cells or flotation cells. Where the ultrasonic probe is in a froth pump box, the ultrasonic probe may be within 30 degrees of vertical.

[0038] The ultrasonic probe may have a diameter of ½ inch to 6 inches.

[0039] Also described is a degassing process comprising providing an ultrasonic plate and delivering ultrasonic energy via the ultrasonic plate to a bitumen stream in a solvent recovery unit (SRU) flash drum for reducing an amount of solvent in the bitumen stream.

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[0040] Also described is a degassing process comprising providing an ultrasonic plate and delivering ultrasonic energy via the ultrasonic plate to a tailings stream in a tailings solvent recovery unit (TSRU) for reducing an amount of solvent in the tailings stream.

[0041] Also described is a degassing process comprising providing an ultrasonic plate and delivering ultrasonic energy via the ultrasonic plate to bitumen froth in a flotation cell, or a bitumen froth in a pump box for reducing an amount of air in the bitumen froth.

[0042] The ultrasonic plate may be located above a surface of a fluid being degassed.

[0043] The ultrasonic signal may have an acoustic frequency of 10-100 kHz.

[0044] Also described is a use of ultrasonic energy for reducing an amount of air in bitumen froth. The bitumen froth may be in a primary separation cell (PSC) launder, or in a bitumen froth header from a PSC launder to a deaerating tower. Where the ultrasonic probe is in the PSC launder, the ultrasonic probe may be within 30 degrees of vertical. Where the ultrasonic probe is in the bitumen froth header, the ultrasonic probe may be disposed within 30 degrees of perpendicular to a direction of bitumen froth flow. The bitumen froth may be generated from coarse sand tailings (CST) or middlings, utilizing flotation column cells or flotation cells. The ultrasonic plate may be in a froth pump box and wherein the ultrasonic plate is within 30 degrees of vertical.

[0045] Also described is a use of ultrasonic energy for reducing an amount of solvent in a solvent recovery unit (SRU) flash drum or in a tailings stream in a tailings solvent recovery unit (TSRU).

[0046] Figures 1 to 3 illustrate examples of ultrasonic processing configurations.

[0047] Figure 1 is a schematic of two ultrasonic probes (102) submerged in bitumen froth (104) flowing in a froth header (106). The input bitumen froth stream (108) and output bitumen froth stream (110) are also illustrated.

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[0048] Figure 2 is a schematic of two ultrasonic probes (202) in a primary separation cell (PSC) launder (206) at top of a PSC (212).

[0049] Figure 3 is a schematic of an ultrasonic plate (302) disposed above a froth or foam surface (314) of a bitumen or tailings+solvent mixture (316) in a SRU flash drum or froth pump box or TSRU column (318).

[0050] Experimental

[0051] To investigate the impact of applying ultrasonic vibrations in reducing the air content of bitumen froth, the following experiment was performed.

[0052] 1) Produced fresh bitumen froth from ore in the lab;

[0053] 2) Used an ultrasonic processing probe to apply intensified sonication energy in the bitumen froth sample;

[0054] 3) Measured the change in volume of the froth;

[0055] 4) Investigated the impact of amplitude (intensity of cavitation); and

[0056] 5) Investigated the impact of probe size.

[0057] As seen in Figure 4, the ultrasonic processing resulted in reduced air content in the froth. Larger probes and higher amplitudes seem to be more impactful.

[0058] It should be understood that numerous changes, modifications, and alternatives to the preceding disclosure can be made without departing from the scope of the disclosure. The preceding description, therefore, is not meant to limit the scope of the disclosure. Rather, the scope of the disclosure is to be determined only by the appended claims and their equivalents. It is also contemplated that structures and features in the present examples can be altered, rearranged, substituted, deleted, duplicated, combined, or added to each other. The scope of the claims should not be limited by particular embodiments set forth herein, but should be construed in a manner consistent with the specification as a whole.

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CLAIMS:

1. A degassing process comprising:

providing an ultrasonic probe; and

delivering ultrasonic energy via the ultrasonic probe to bitumen froth for reducing an amount of air in the bitumen froth, wherein the bitumen froth is in a primary separation cell (PSC) launder or in a froth pump box, and wherein the ultrasonic probe is within 30 degrees of vertical.

2. A degassing process comprising:

providing an ultrasonic probe; and

delivering ultrasonic energy via the ultrasonic probe to bitumen froth for reducing an amount of air in the bitumen froth, wherein the bitumen froth is in a bitumen froth header from a primary separation cell (PSC) launder to a deaerating tower, and wherein the ultrasonic probe is disposed within 30 degrees of perpendicular to a direction of bitumen froth flow.

3. The process of claim 1 or 2, wherein the bitumen froth is generated from coarse sand tailings (CST) or middlings, utilizing flotation column cells or flotation cells.

4. The process of any one of claims 1 to 3, wherein the ultrasonic probe has a diameter of ½ inch to 6 inches.

5. The process of any one of claims 1 to 4, using an ultrasonic signal with an acoustic frequency of 10-100 kHz.

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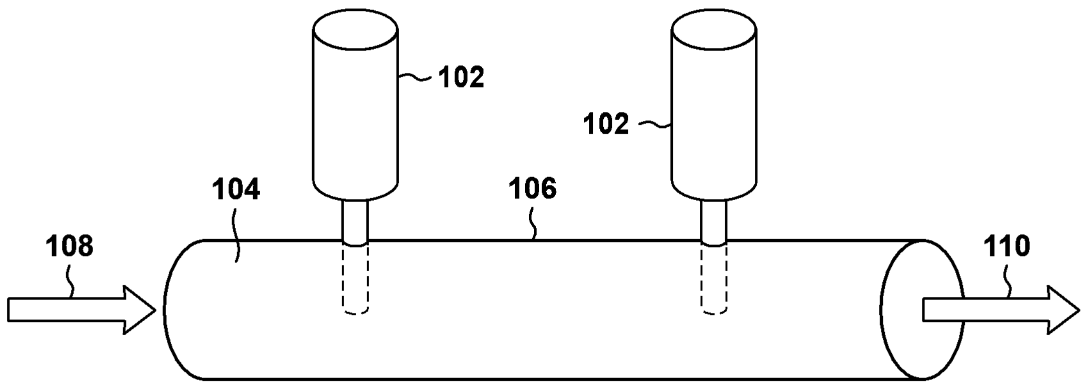

FIG. 1

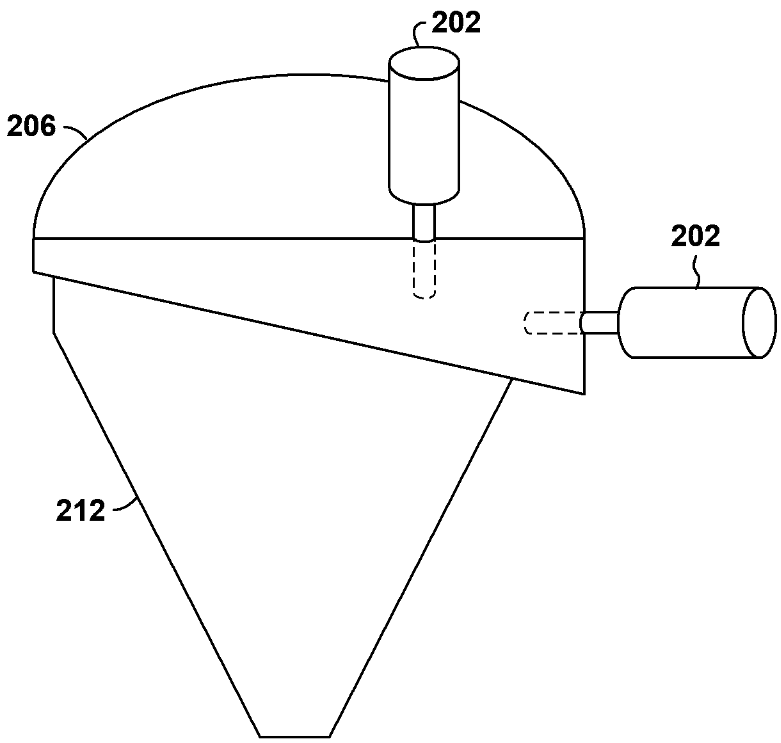

FIG. 2

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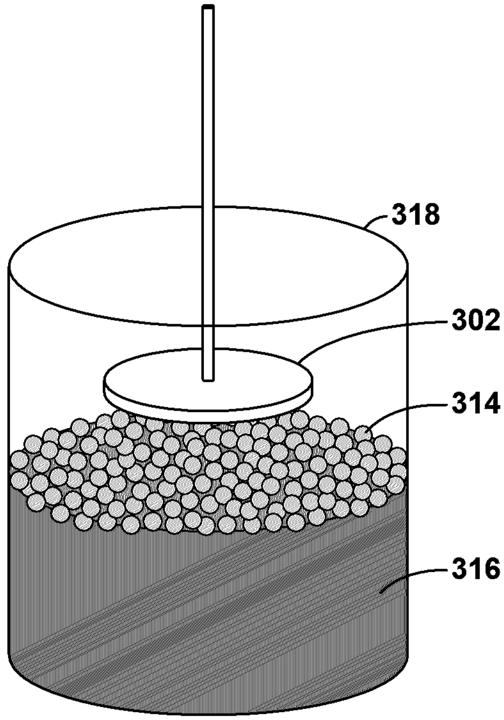

FIG. 3

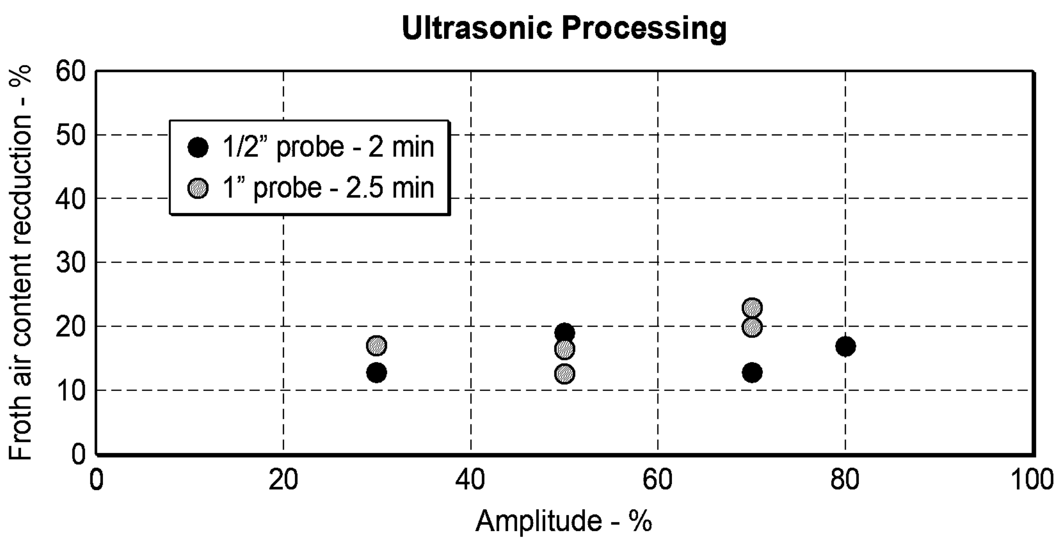

FIG. 4

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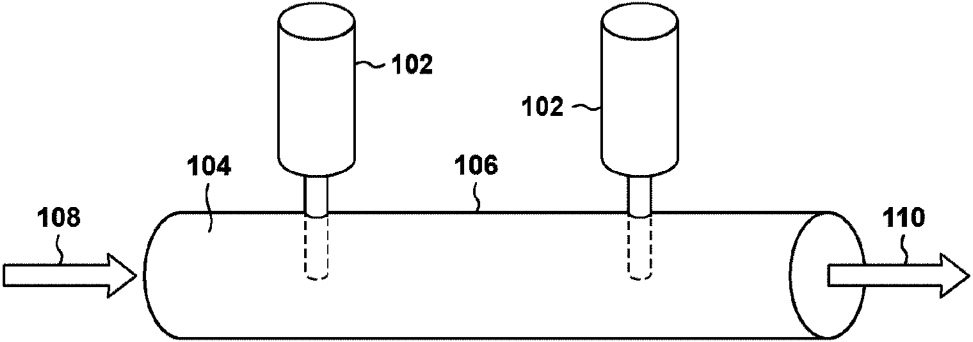

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