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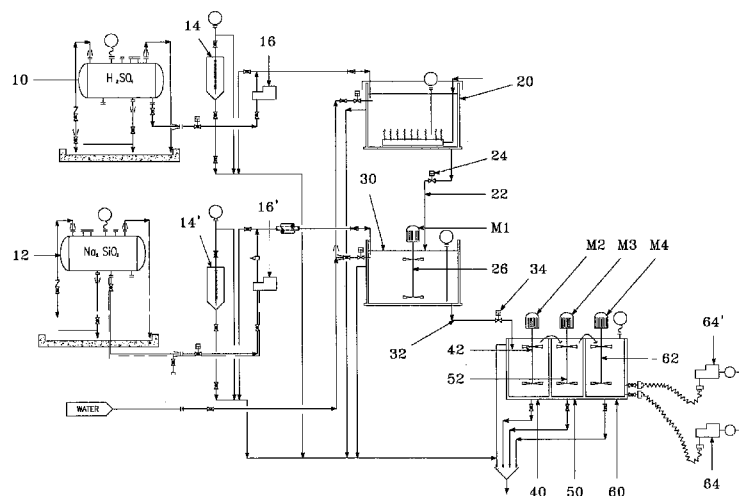


FIG. 1

(57) Abstract: The invention concerns a process and an apparatus for producing activated silica suitable for use in a treatment process of waste water produced in oil/gas fields. The process is based on the reaction of a solution of sulphuric acid and a solution of sodium silicate in water and allows to prepare a suspension with a silica content that can be tailored depending on the needs directly in the installations of extraction of crude oil and/or natural gas.

PROCESS AND APPARATUS FOR PREPARING ACTIVATED SILICA AND USE OF
THE THUS PRODUCED ACTIVATED SILICA IN THE TREATMENT OF WASTE
WATERS

DESCRIPTION

Field of the invention

The present invention relates generally to a process and an apparatus for preparing activated silica. More particularly the invention relates to a process and an apparatus for preparing activated silica for use in the treatment of waste waters containing high amounts of oils and other hydrocarbons, and to the use of the silica thus obtained in such treatment of waste waters.

Background of the invention

Oil and gas reservoirs are sub-soil cavities containing crude oil and/or natural gas. Oil and gas reservoirs have a natural water layer, called formation water, that, being denser, lies under the hydrocarbons. Oil reservoirs frequently contain large volumes of water, while gas reservoirs tend to produce only small quantities. To achieve maximum hydrocarbons recovery, additional water is usually injected into the reservoirs to help force the oil/gas to the surface. Both formation and injected water are eventually produced along with the hydrocarbons and, as an oil field becomes depleted, the amount of produced water increases as the reservoir fills with injected water. Such water is called “produced water”.

Produced water is typically removed from the oil, but still contains a number of undesirable components such as paraffins, oils, other hydrocarbons and organic substances, muds, salts, solids and the like. Oil may be present in different amounts, depending on the type of oilfield and other factors, from a few hundreds parts per million (ppm) to large amounts such as up to 5% by volume or more. Also, produced water has typically an acidic pH, for example between 5 and 6. The contaminated produced water must be disposed of in some manner. It can be treated and released as surface water or it can be injected back into the oil or gas reservoir. Recycling produced water by reinjecting it into the oil/gas reservoir is particularly interesting when the oil/gas field is onshore and in a desertic area. However, the processing required to render produced water fit for reinjection is costly.

After extraction from reservoirs hydrocarbons are also washed with water to remove or reduce the high content of salts. The amount of such water, called “washing water” may exceed the amount of produced water. Washing water contains hydrocarbons too, and must be disposed of in some manner or treated.

Description of the Prior Art

A number of technologies have been disclosed and/or tried to various extents to treat waste water in extraction installations of oil and gas reserves. Such technologies include membrane filtration technology, electrocoagulation with membrane technology, extraction with supercritical fluids (CN 101186350) and treatment with ozone (US 2007/0056913 A1; CN 201276464), to name a few.

Activated silica is a well-known material which may be described as a highly dispersed polymeric form of silica produced when dilute aqueous solutions of alkali metal silicates are reacted with mineral acids, or with multivalent metal ions such as calcium, iron or aluminum. Descriptions of the chemistry and method of preparation of activated silica are well covered in the literature. The chemistry is to be found in Iler (1979, p. 231), J. G. Vail ("Soluble Silicates," Vol II New York: Reinhold, 1960), K. R. Lange and R. W. Spenser (Envir. Sci. and Technology 2: 3 (1968) 212-6), and T. Hasekawa et al. (Water Science and Technology 23 (1991) 1713-1722). The manufacture of this material is described by C. Henry (J. Am. Water Works Ass. 30:1 (1958) 61-71), and is disclosed in U.S. Pat. No. 3,963,640 (Jun. 15, 1976 to Anglian Water Authority, U.K. and No. 4,147,657 (to the PQ Corporation).

Activated silica may be manufactured and stored using specialized equipment, or can be prepared in situ. The material has been used for many years in the commercial purification of drinking water and has found application in the flocculation of alumina and silver bromide sols and also as a retention/drainage aid in papermaking. However, no description was found of any special ability of activated silica to remove oils and/or hydrocarbons from water.

US 2007/0095761 A1 discloses a method for preparing acidic solutions of activated silica and polyvalent metal salt for water treatment. Use of activated silica is disclosed in connection with sewage treatment plants located in urban areas, particularly to remove disinfection by-products (DBP) and DBP precursors. Reported amounts of DBP in such water is in the order of hundreds of ppb (parts per billion). The cited document disclosed to prepare activated silica in highly acidic conditions. Also, the cited document discloses that the highly acidic activated silica thus prepared ($1.5 \leq \text{pH} \leq 2.5$) must be stabilized by the presence of a polyvalent metal salt of aluminium or iron. Use of such metal salts, however, makes the product costly. Also, there are applications in which use of a highly acidic silica is not desirable. For example, use of a highly acidic silica suspension to treat a waste water that is rather acidic per se is undesirable.

There is thus a need in the art for a process and an apparatus for producing activated silica suitable for use in a treatment process of waste water in oil/gas fields. More particularly, there

is a need for a process and an apparatus that produce a non-acidic activated silica, that do not need costly metal salts as stabilizers and that are of simple operation, so that they can be operated by personnel in oil/gas fields.

A need also exists for such a process and apparatus that produce activated silica at a cost which is more economical than the existing technologies, and that can be operated in an automatic way.

Summary of the invention

An aspect of the present invention is an improved process for preparing activated silica by reacting a solution of sulphuric acid and a solution of sodium silicate in water, characterized by comprising the following steps:

- a) preparing a metered volume V_1 of a solution of sulphuric acid with a concentration of from 1 to 2 % by vol. in a dilution tank;
- b) introducing a metered volume V_2 of water in a reaction tank;
- c) discharging said metered volume V_1 of said solution of sulphuric acid from said dilution tank into said reaction tank to form a total volume $V_1 + V_2$ of solution, under stirring conditions;
- d) introducing into said reaction tank a metered volume V_3 of a solution of sodium silicate to form a solution of sodium silicate having a concentration of from 3 to 8 % by wt. with respect to the sum of volumes $V_2 + V_3$, whereby a suspension of activated silica is formed under stirring conditions, said activated silica having a concentration of from 0.5 to 2 expressed as percentage by weight of SiO_2 on the total volume $V_1 + V_2 + V_3$;
- e) transferring said suspension of activated silica from said reaction tank to at least one aging tank under stirring conditions;
- f) transferring said suspension of activated silica from said aging tank to a metering tank under stirring conditions;
- g) delivering a metered volume of said suspension of activated silica from said metering tank to a process for treating waste water;
- wherein the pH of said suspension of activated silica in said reaction tank is above 7 and is maintained above 7 in said aging and metering tanks, and;
- wherein the residence time of said suspension of activated silica in said aging and metering tanks is from 2 to 12 hours.

Another aspect of the present invention is an improved apparatus for preparing activated silica by reacting a solution of sulphuric acid and a solution of sodium silicate in water, characterized by comprising:

- storage tank for concentrated sulphuric acid and a storage tank for a water solution of sodium silicate, said storage tanks being provided with metering means;
- a dilution tank connected to said storage tank for concentrated sulphuric acid and pumping means connected to said storage tank and said dilution tank to transfer said concentrated sulphuric acid into said dilution tank;
- a reaction tank to produce activated silica, connected to said dilution tank and to said storage tank for a water solution of sodium silicate, pumping means being connected to said storage tank for a water solution of sodium silicate and said reaction tank to transfer said water solution of sodium silicate to said reaction tank, said reaction tank being equipped with stirring means;
- at least one aging tank connected to said reaction tank and equipped with stirring means;
- a metering tank equipped with stirring means and connected to pumping and metering means to deliver a metered volume of activated silica from said metering tank to a process for treating waste water.

A further aspect of the present invention is the use of a suspension of activated silica prepared according to the process of the invention in the treatment of waste waters and produced water in oil and gas fields.

Use of a suspension of activated silica prepared according to the process of the invention allows to remove any suspended matters from the produced water, including oils, other hydrocarbons and solids. Typically the final content of oils and hydrocarbons does not exceed 40 ppm, or even 10 ppm.

Additional objects, features and advantages of the process according to the invention will be apparent in the written description which follows.

Brief description of the drawings

FIG. 1 is a schematic flow diagram of the process of the invention showing also a schematic view of the apparatus according to the invention.

Detailed description of the invention

The invention comprises a process and an apparatus for preparing activated silica by reacting a solution of sulphuric acid and a solution of sodium silicate in water. Activated silica thus produced is to be used in a process to treat waste water and/or produced water from oil and/or gas fields.

In the present description the term “activated silica” or “suspension of activated silica” means a highly dispersed polymeric form of silica produced when dilute aqueous solutions of alkali metal silicates are reacted with mineral acids in an aqueous medium at a pH above 7.

A drawback associated with use of activated silica is stability. Activated silica is unstable due to gelling and other undesired phenomena. Therefore the present invention comprises a process and an apparatus for preparing activated silica in situ, namely in the oil and/or gas extraction installations. The process and the apparatus of the invention are suitable to supply activated silica to a waste water treatment plant in an oil and/or gas extraction installations. Also, the silica content of the suspension can be tailored depending on the type of waste water to be treated and the quality of the clean water available. Aging time can be suitably selected for optimal performance.

As used herein and in the appended claims, the term “produced water” means any waste water either from sub-soil or from other sources onshore or offshore associated with oil and/or gas fields that needs to be treated for further use or release in the environment, including washing water.

Produced water may contain different amounts of oil, depending on the type of oilfield and other factors: Also, it has typically an acidic pH, for example between 5 and 6. Oil content may vary from a few hundreds parts per million (ppm) such as 100-500 ppm, to large amounts such as up to 5% by volume or more. After separation from the extracted oil and/or gas and having undergone a separation of coarse solids such as stone, sand and the like, as known in the field, the produced water is treated according to the process of the invention.

A combined use of activated silica and of a polyelectrolyte as flocculating agent in a process for the treatment of produced water allows to achieve an almost complete removal of oil and hydrocarbon from produced water, as well as of any suspended matters. Use of organic flocculating agents alone does not allow to achieve a similar result. The process proved to be efficient from an economic point of view.

A preferred embodiment of the process and of the apparatus for preparing activated silica according to the invention is disclosed in the following description.

With reference to FIG. 1, the only reactants used to prepare activated silica in the process of the invention are sulphuric acid and a solution of sodium silicate. Sulphuric acid, typically at a concentration of 98%, is stored in a tank 10. A solution of sodium silicate, typically with an SiO_2 content of about 28-30%, is stored in a tank 12.

In a first step of the process, a solution of sulphuric acid with a concentration of from 1 to 2 % is prepared in a dilution tank 20. Such solution is prepared by introducing a suitable amount

of water in tank 20, then withdrawing from tank 10 a metered amount of concentrated sulphuric acid so that dilution tank 20 contains a metered volume V_1 of diluted sulphuric acid with a concentration of from 1 to 2 %. The metered amount of sulphuric acid from tank 10 is metered by metering means constituted by a graduated cylinder 14 and transferred to dilution tank 20 by pumping means constituted by a membrane pump 16.

In a second step of the process a metered volume V_2 of water is introduced in a reaction tank 30, located below the dilution tank 20 and connected to the dilution tank via a conduit 22 equipped with a valve 24. Reaction tank 30 is equipped with a stirrer 26 actuated by a motor M1.

In a third step of the process the metered volume V_1 of solution of sulphuric acid is discharged by gravity from the dilution tank 20 into the reaction tank 30, by opening the valve 24. This results in a further dilution of sulphuric acid in the total volume $V_1 + V_2$ of solution. This operation is carried out under stirring conditions.

In a fourth step of the process a metered volume V_3 of a solution of sodium silicate is withdrawn from tank 12 and introduced into the reaction tank to form a solution of sodium silicate having a concentration of from 3 to 8 % by wt. with respect to the sum of volumes $V_2 + V_3$ %. The metered volume V_3 of a solution of sodium silicate from tank 12 is metered by metering means constituted by a graduated cylinder 14' and transferred to the reaction tank 30 by pumping means constituted by a membrane pump 16'. The solution of sodium silicate has a strongly basic pH value, thus the pH of the solution in the reaction tank 30 is still above 7. Under stirring conditions a suspension of activated silica is formed. The metered volumes and concentration of the reactants, as well as the volumes of dilution water, are selected in order to produce a suspension of activated silica having a concentration of from 0.5 to 2 expressed as percentage by weight of SiO_2 on the total volume $V_1 + V_2 + V_3$. Such concentration range proves to be optimal in terms of both stability and performance for use in the waste water treatment.

In a fifth step of the process the suspension of activated silica is transferred from the reaction tank 30 to an aging tank 40 equipped with a stirrer 42 actuated by a motor M2. The aging tank 40 is located below the level of the reaction tank 30, so that the suspension of activated silica is transferred by gravity through a discharge line 32 equipped with a valve 34. In the aging tank 40 the suspension of activated silica is maintained under stirring conditions.

Preferably a second aging tank 50 is located downstream tank 40 and connected to tank 40 so that the suspension of activated silica overflows from tank 40 into tank 50. Also the second aging tank 50 is equipped with a stirrer 52 actuated by a motor M3.

In a sixth step of the process the suspension of activated silica is transferred from the aging tank 50 to a metering tank 60 located downstream tank 50 and connected to tank 50 so that the suspension of activated silica overflows from tank 50 into tank 60. The metering tank 60 is equipped with a stirrer 62 actuated by a motor M4 and is connected to pumping and metering means to withdraw a metered amount of suspension of activated silica. The pumping and metering means are membrane pumps 64, 64'.

The total residence time of said solution of activated silica in the aging and metering tanks 40, 50, 60 is from 2 to 12 hours.

In a seventh step of the process the suspension a metered volume of activated silica is transferred from the metering tank 60 to a suitable step of a process for treating waste waters. The apparatus for the preparation of silica as described above is efficient and reliable. It allows to carry out the preparation process in a flexible way, in particular to adjust the concentration of activated silica depending on the needs. Also, the apparatus is compact and is designed to maximize transfer of liquids by gravity, so that the number of pumps is minimized and limited to metering of reactants and end products.

Use of a suspension of activated silica as coagulant and/or flocculant in the treatment of waste waters within 12 hours from preparation as described above is very effective in clarifying the waste waters and promoting separation of suspended matters, oils and other hydrocarbons.

Depending on the type of waste water and other factors the suspension has a silica content expressed as percentage by weight of SiO_2 of from 0.5 to 2%, preferably from 0.8 to 1.2 %.

Such suspension is added to the treated water in an amount from 10 to 300 ppm.

Use of a suspension of activated silica as coagulant and/or flocculant in the treatment of waste waters is preferably combined with the use of an organic flocculating agent, preferably a polyelectrolyte selected from linear or branched organic polymers that form complex ions in solution, more preferably a polymeric cationic or amphoteric flocculant, such as the flocculants commercialized under the trade name "Kurifix" and available from Kurita Water Industries Ltd. The flocculating agent is added to the water to be treated in an amount of from 2 to 20 ppm, preferably from 5 to 10 ppm.

Use of a suspension of activated silica prepared according to the process of the invention is made also by adding a suspension of activated silica downstream a flocculation, flotation and separation step of suspended matters carried out essentially by gravity and upstream a filtration step. In such case activated silica is preferably added in an amount of from 20 to 100 ppm, more preferably from 30 to 80 ppm, more preferably from 40 to 60 ppm.

To ensure that any suspended material still present in the treated water has a particle size not greater than 5 microns, an ultra-filtration step may be included in the process.

The filtration step is carried out through a filtration means that comprises a double layer of quartz sand and hydroanthracite. The ultrafiltration step is carried out through a filtration means that comprises active carbon.

Use of such suspension of activated silica within a period from 2 to 12 hours from the preparation, as described above, has surprisingly improved also the performance of the filtration and ultra-filtration step of waste waters downstream a step of separation by gravity of suspended matters, oils and other hydrocarbons.

Examples

Example 1: preparation of activated silica

The apparatus of FIG. 1 was used to prepare a suspension of activated silica.

0.81 l of sulphuric acid having a concentration of 98% were transferred from tank 10 into dilution tank 20, in which 63 l of water had previously been introduced. 63.81 l (V_1) of a solution of sulphuric acid having a concentration of 1.5% were thus obtained.

167 l (V_2) of water were introduced in the reaction tank, then the solution of 63.81 l (V_1) of sulphuric acid was discharged by gravity from the dilution tank 20 into the reaction tank 30, under stirring conditions. 4.6 l (V_3) of a solution of sodium silicate containing 28% by wt. of SiO_2 was introduced into the reaction tank from storage tank 12. A solution of sodium silicate having a concentration of 5% by wt. with respect to the sum of volumes $V_2 + V_3$ % was formed. The pH of the solution in the reaction tank 30 was above 7. The reaction of the solution of sulphuric acid having a concentration of 1.5% with the solution of sodium silicate having a concentration of 5% by wt. under stirring conditions produced a suspension of activated silica having a content of 1% of SiO_2 . Such suspension was then discharged into the an aging tank 40 and maintained under condition of mild stirring. The suspension was then transferred to a second aging tank 50 and finally to a metering tank 60, while it was maintained under mild stirring conditions. The suspension of activated silica in the metering tank 60 had a pH from 8 to 9. It was added to a flocculation step of the treatment of waste waters in a concentration of 100 ppm of SiO_2 . Within 2 to 12 hours of total residence time in tanks 40, 50, 60 the suspension was withdrawn from the metering tank 60 and delivered to a desired step of a process for the treatment of waste waters.

Example 2: use of activated silica in the waste water treatment

The water to be treated were produced waters from an oilfield having an oil content of 2% vol. The suspension of activated silica had a SiO_2 content of 1% and a pH from 8 to 9. It was

added to a flocculation step of the treatment of waste waters in a concentration of 100 ppm of SiO_2 . It was also added downstream the flocculation step but upstream a filtration step in the amount of 50 ppm.

An aqueous solution containing 0.1% by weight of the polyelectrolyte flocculating agent commercialized under the trade name "Kurifix" and available from Kurita Water Industries Ltd was prepared. Such solution was added in the flocculation step of the water under treatment in an amount of 8 ppm.

The clear and clean water after treatment had a oil content of less than 10 ppm, and no suspended matters having a size greater than 5 microns. The only chemicals used were activated silica and a polyelectrolyte flocculating agent. The other treatments of the process were physical treatment such as flotation, sedimentation by gravity, filtration and ultrafiltration.

Comparative Example

The same water treatment process of Example 2 was performed without use of activated silica.

The water after treatment had a oil content of from 80 to 100 ppm. About 50% of the suspended matters had a size greater than 5 microns.

As it can be appreciated from the foregoing description and examples, the combined use of activated silica and of a polyelectrolyte as flocculating agent in the flocculation step of the process allows to achieve an almost complete removal of oil and hydrocarbon from produced water, as well as of any suspended matters. Use of a flocculating agent alone does not allow to achieve a similar result. The process proved to be efficient from an economic point of view. Also, the pH of the treated water was not altered.

Use of conventional acidic activated silica is not desirable and use of metal stabilized activated silica is more costly. In situ preparation of activated silica having a concentration from 0.5 to 2% of SiO_2 content allows to select the optimal concentration as a function of the type of waste water to be treated without a need for storing a concentrated suspension to be diluted in situ, since this could promote gelling and other undesirable phenomena.

CLAIMS

1. Process for preparing activated silica by reacting a solution of sulphuric acid and a solution of sodium silicate in water, characterized by comprising the following steps:
 - a) preparing a metered volume V_1 of a solution of sulphuric acid with a concentration of from 1 to 2 % by vol. in a dilution tank (20);
 - b) introducing a metered volume V_2 of water in a reaction tank (30);
 - c) discharging said metered volume V_1 of said solution of sulphuric acid from said dilution tank (20) into said reaction tank (30) to form a total volume $V_1 + V_2$ of solution, under stirring conditions;
 - d) introducing into said reaction tank (30) a metered volume V_3 of a solution of sodium silicate to form a solution of sodium silicate having a concentration of from 3 to 8 % by wt. with respect to the sum of volumes $V_2 + V_3$, whereby a suspension of activated silica is formed under stirring conditions, said activated silica having a concentration of from 0.5 to 2 expressed as percentage by weight of SiO_2 on the total volume $V_1 + V_2 + V_3$;
 - e) transferring said suspension of activated silica from said reaction tank (30) to at least one aging tank (40) under stirring conditions;
 - f) transferring said suspension of activated silica from said aging tank (40) to a metering tank (60) under stirring conditions;
 - g) delivering a metered volume of said suspension of activated silica from said metering tank (60) to a process for treating waste water;
 - wherein the pH of said suspension of activated silica in said reaction tank (30) is above 7 and is maintained above 7 in said aging (40) and metering (60) tanks, and;
 - wherein the residence time of said suspension of activated silica in said at least one aging tank (40) and metering (60) tanks is from 2 to 12 hours.
2. Process according to claim 1, characterized in that said step e) comprises transferring said suspension of activated silica from said first aging tank (40) to a second aging tank (50) under stirring conditions.
3. Process according to claim 1, characterized in that in said step c) said solution of sulphuric acid is discharged from said dilution tank (20) into said reaction tank (30) by gravity.
4. Process according to claim 1, characterized in that in said suspension of activated silica in said metering tank (60) had a pH from 8 to 9.
5. Apparatus for preparing activated silica by reacting a solution of sulphuric acid and a solution of sodium silicate in water, characterized by comprising:

- a storage tank (10) for concentrated sulphuric acid and a storage tank (12) for a water solution of sodium silicate, said storage tanks being provided with metering means (14, 14');
 - a dilution tank (30) connected to said storage tank (10) for concentrated sulphuric acid and pumping means (16) connected to said storage tank (10) and said dilution tank (20) to transfer said concentrated sulphuric acid into said dilution tank (20);
 - a reaction tank (30) to produce activated silica, connected to said dilution tank (20) and to said storage tank (12) for a water solution of sodium silicate, pumping means (16') being connected to said storage tank (12) for a water solution of sodium silicate and said reaction tank (30) to transfer said water solution of sodium silicate to said reaction tank (30), said reaction tank being equipped with stirring means (26);
 - at least one aging tank (40, 50) connected to said reaction tank (30) and equipped with stirring means (42, 52);
 - a metering tank (60) equipped with stirring means (62) and connected to pumping and metering means (64, 64') to deliver a metered amount of activated silica from said metering tank (60) to a process for treating waste water.
6. Apparatus according to claim 5, characterized in that said dilution tank (20) is above said reaction tank (30) and said reaction tank (30) is above said metering tank (40), so that transfer from one tank to the following tank is effected by gravity.
 7. Apparatus according to claim 5, characterized in that a second aging tank (50) is provided downstream said first aging tank (40) and upstream said metering tank (60).
 8. Apparatus according to claim 7, characterized in that said first aging tank (40), said second aging tank (50) and said metering tank (60) are connected to each other to allow overflow of the suspension of silica from one to the other.
 9. Use of a suspension of activated silica prepared according to any of claims 1-4 in a process of treatment of waste water.
 10. Use according to claim 9 characterized by being made in a time frame from 2 to 12 hours from preparation of said suspension of activated silica.
 11. Use according to claim 9 characterized in that said suspension is added in the flocculation step of a process of treatment of waste water.
 12. Use according to claim 9 characterized in that said suspension is added upstream a filtration step of a process of treatment of waste water.
 13. Use according to claim 9 characterized in that said suspension of activated silica has a concentration from 0.5 to 2% by wt. of SiO_2 and a pH above 7.

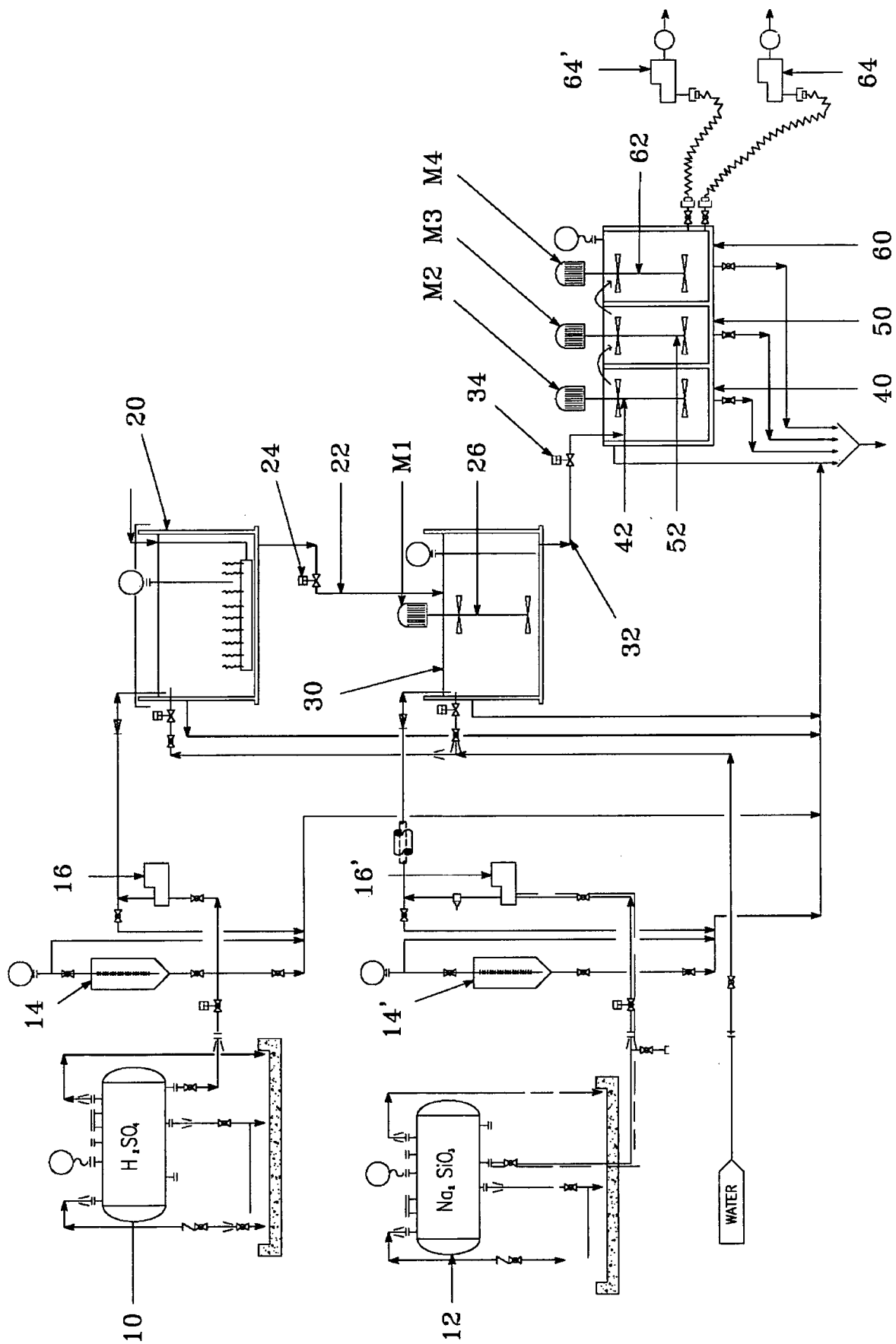


FIG. 1

INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2010/000131

A. CLASSIFICATION OF SUBJECT MATTER

INV. C01B33/142 C01B33/193 C02F1/52
ADD.

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

C01B C02F

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, INSPEC, COMPENDEX

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2006/008402 A1 (ROBLES ANTONIO T [CA]) 12 January 2006 (2006-01-12) paragraph [0056] - paragraph [0066] figures 1-2	9,11-13
Y	US 2009/004089 A1 (HUA DUEN-WU [US] ET AL HUA DUEN-WU [US] ET AL) 1 January 2009 (2009-01-01) example 1	1-8,10
Y	EP 1 260 484 A2 (TOKUYAMA CORP [JP]; SUIDO KIKO KK [JP]) 27 November 2002 (2002-11-27) paragraph [0051] - paragraph [0070] figure 2 examples 1, 2	1-8,10
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☒ Further documents are listed in the continuation of Box C.

☒ See patent family annex.

* Special categories of cited documents:

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Date of the actual completion of the international search

10 December 2010

Date of mailing of the international search report

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Name and mailing address of the ISA/

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INTERNATIONAL SEARCH REPORT

International application No
PCT/IT2010/000131

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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