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(54) Title: A CONDENSER CLEANING SYSTEM

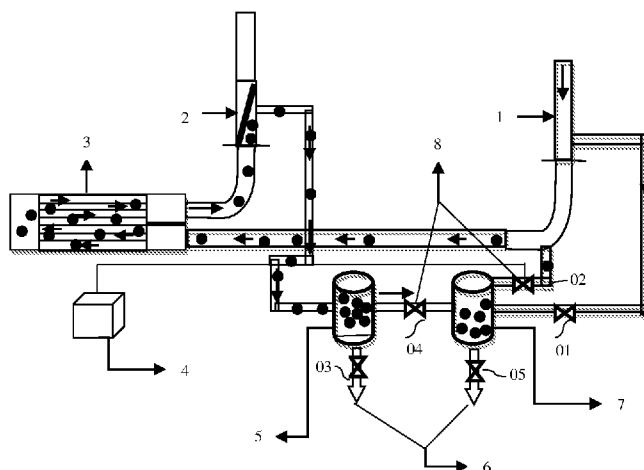


FIG 1

(57) Abstract: An online condenser cleaning system (Whirler) in which a shell and tube type condenser/ heat exchanger tubes are cleaned by using sponge balls is disclosed. The condenser cleaning is carried out without the help of high pressure pump as the unique design of the intermediate ball storage tank along with ball arrestor enables easy recovery of around 99–100% sponge balls. The ball arrestor is installed on the condenser outlet pipe which is provided with a perforated sheet/ wire mesh/ strainer that arrests the sponge balls which are injected in the condenser inlet line and restricts them from reaching the cooling tower. The arrested balls are recovered by an intermediate ball storage tank and are sent back to the main ball storage tank and the cycle repeats. The system uses internal pressure and flow of the condenser line for its function.

Declarations under Rule 4.17:

- *as to the identity of the inventor (Rule 4.17(i))*
- *as to applicant's entitlement to apply for and be granted a patent (Rule 4.17(ii))*
- *of inventorship (Rule 4.17(iv))*

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A CONDENSER CLEANING SYSTEM

Technical field

The present invention relates to a cleaning system and, more particularly to an online condenser cleaning system using sponge balls to clean the condenser/heat exchanger tubes to prevent fouling of the condenser tubes.

Background Art

In the water treatment field, the common problems that are faced during the process is the scaling or fouling across the condenser. The scaling or fouling of the condenser tubes are seen even after proceeding with the chemical water treatment. Condensers are widely used in many fields in like power plant equipment, surface condensers, chillers, HVAC, process coolers in chemical plant, refineries and so on. The scaling seen in the condenser pipes increases downtime, consumes more power, use of chemicals for de-scaling reduces the efficiency of the power plant.

The condenser tubes which are blocked due to scaling effect reduces heat transfer, results in increase of internal temperature, increase in exhaust temperature, decrease in vacuum which together causes decrease in the efficiency of the system. In addition to the decrease in the efficiency, another serious problem which is seen in the system is the corrosion of the tubes. Under the corrosion deposits was the main form of corrosion of condenser tubes. The corrosion is caused due to the deposits which are caused due to oxygen concentration differences.

Thus cleaning the condenser unit might reduce the problem of the scaling. To solve this problem, a lot of research is being carried out and remedies such as manual cleaning, cleaning with chemical agents, cleaning with high pressure water jets with rubber ball cleaning, streamer cleaning etc.

The rubber ball cleaning and streamers cleaning can run online and can be maintained by using the software programs. The cleaning equipment has to be installed inside the condenser which might not be convenient. Also the rubber balls which are used for cleaning reduce the rate of cleaning and also the cleaning balls are highly expensive, the operating costs are also high.

The rubber balls which when used with water cannot be controlled manually and each tube has to be washed separately and until the complete removal of the rubber balls the cleaning remains incomplete. Another disadvantage which comes along with this system is the filter clogging, mechanical failure and more, most of the unit cannot be properly put into operation.

The currently known systems do not clean the condenser continuously. Such systems include that of Miller, U.S. Pat. No. 1,589,980, directed to a washer which directs a stream of water, under

pressure, between the condenser tubes. The washer travels in a circle and all the tubes in the circumference of such circle are washed consecutively.

Another prior art patent US4234993 describes A Condenser cleaning system using sponge balls describes a system for cleaning the tubes of a condenser or other heat exchanger unit by circulating sponge balls therethrough by a circulating pump, comprising the improvement in the form of a screen assembly including four vertical screens about 90° apart, two of which confront the discharge end of said condenser to divert the sponge balls downwardly through an internally spiralled stationary tube, while the other two screens confront the discharge pipe of the system. By turning the screens 180°, they are completely flushed of debris without the need of removing the balls to an accumulator and stopping circulation of the balls during the screen cleaning operation. Higher efficiency, elimination of down time and lower maintenance costs are provided.

Another prior art patent US5336331 describes A Continuous condenser backflush and cleaning systems and methods for use thereof which describes a continuous condenser backflush system that includes a hollow wand attached perpendicularly to a hollow shaft. The wand is moved in lateral increments across the condenser face. The wand is retracted from the condenser face for moving laterally to a new position before again being extended to the condenser face to collect and dispose of the trash caught under the wand. Trash caught on the condenser face is flushed by a stream of water back through the shaft to a mesh basket where it is separated from the water. A pump may be provided on the shaft for injecting and circulating cleaning fluids (such as chemical and/or abrasive fluids) through the condenser. A similar wand system may be provided on the remote face of the condenser to receive the fluids and return them to a recovery tank for recycling. The pump may also circulate dehumidified air through the system to keep the condenser dry when the cooling water circulating pump is shut down. A method of using the system is described.

The conventional methods that are used for condenser cleansing for scaling issue are condenser de-scaling, manual brushing, chemical circulation, hydro-jet cleaning and bullet cleaning. The limitations that are associated with these conventional methods are that all the above mentioned methods comes under Break-Down maintenance activity, the condenser life reduces because of chemical circulation, these methods makes it difficult to maintain condenser performance throughout the year, power consumption increases due to increment of scaling across the condenser and in condenser de-scaling with manual brushing requires plant shut down every time which decreases the efficiency and lot of time is wasted.

Therefore there is a need for an improved an eco-friendly online condenser cleaning system for cleaning the condenser pipes using sponge balls to prevent fouling of the condenser tubes.

Objectives of the Invention

The primary objective of the present invention is to provide an online condenser cleaning system for cleaning the condenser pipes using sponge balls to prevent fouling of the condenser tubes

- Another objective of the present invention is to provide an online condenser cleaning system comprising of an intermediate ball storage tank for storing the sponge balls temporarily.

Summary of the Invention

- The present invention describes an online condenser cleaning system comprising of two elbow tapping, a smart controller or control panel, control valves, sponge balls, ball arrester, main ball storage tank, intermediate ball storage tank, water inlet line, wire mesh, drain line, glass, drain valve and a condenser. The online condenser cleaning system uses the sponge balls to eliminate the fouling in the condenser tubes.

- The sponge balls are used in cleaning of the condenser system which are slightly bigger in size than the condenser tube inner diameter i.e. around 1 mm bigger in size than condenser tube ID and they pass through the condenser tubes to clean the interior side of the tubes. The smart controller or control panel of the present invention gives command to control valves to open or close.

When the control valves i.e. Valve No. 01, 02 of the injection line and valve no. 03 of intermediate ball storage tank drain valve opens, the sponge balls travels from main ball storage tank to the condenser water inlet line, reaches the condenser and passes through the condenser tubes, travels through the ball arrester & finally to the intermediate ball storage tank.

- Once all the sponge ball from the ball storage tank get injected into the condenser, the control valves i.e. Valve No. 01, 02 and 03 gets closed. After reaching the intermediate ball storage tank, the sponge balls return to the initial position when the drain line control valve 04 and 05 are opened. The sponge balls then reach the main ball storage tank which completes once cleaning cycle. This cycle repeats at the time interval of every after 30 minutes or as per requirement.
- The working of the present invention is carried out without the help of high pressure pump as the unique design of the ball arrester along with intermediate ball storage tank easily recovers around 99–100% sponge balls. The ball arrester is installed on the condenser outlet pipe which is provided with a perforated sheet/ wire mesh/ strainer that arrests the sponge balls which are injected in the condenser inlet line and restricts them from reaching the cooling tower.
- After this process, when the drain line valve of main ball storage tank opens, the water flows from the intermediate ball storage tank to the drain line of main ball storage tank and finally to the

condenser pump. Now the sponge balls along with water, flows from the intermediate ball storage tank to the main ball storage tank and the balls gets trapped in the ball storage tank due to strainer provided and restricts their flow to the condenser pump along with water. The process of condenser tube cleaning cycle completes one cycle and the sponge balls are ready for next cleaning cycle.

5 **Brief description of the drawings**

FIG 1 illustrates the schematic representation of The Whirler- an online condenser cleaning system.

FIG 2 illustrates the design 1 of the intermediate ball storage tank.

FIG 3 illustrates the design 2 of the intermediate ball storage tank.

10 FIG 4 illustrates the design 3 of the intermediate ball storage tank.

Description of the Invention

The present invention describes an eco-friendly online condenser cleaning system which uses the sponge balls to eliminate the fouling in the condenser tubes. The online condenser cleaning system comprises of two elbow tapping, a smart controller or control panel, control valves, sponge balls, 15 ball arrester, main ball storage tank, intermediate ball storage tank, water inlet line, wire mesh, drain line, glass, drain valve and a condenser.

FIG 1 illustrates the schematic representation of the online condenser cleaning system. The water enters the system from the condenser water inlet 1 travels through the piping which reaches the condenser 3. The sponge balls are stored in the main ball storage tank 7 which enters the condenser 20 3 along with the water through the pipes when the valve 02 is open. The sponge balls along with the water travel through the condenser 3, cleans the condenser 3 thoroughly and then exits the condenser 3 through the pipe which leads to the ball arrester 2. When the water and sponge balls enters the ball arrester 2, the sponge balls gets separated and move to the intermediate ball storage tank 5 where the sponge balls are temporarily stored. A drain valve from the main ball storage tank 25 7 and the intermediate ball storage tank 5 is connected to the condenser pump or the cooling tower sump 6 which is operated through valve no 05 and valve no 03 respectively.

The water from the intermediate ball storage tank 5 exits through the mesh which is present inside the intermediate ball storage tank 5 and through the valve no 03. The auto valves are operated by the control panel which open and close automatically as per instructions. The water from condenser 30 water inlet 1 also enters the main ball storage tank 7 through a separate pipe which is operated

through the valve no 01 and the water exits the main ball storage tank 7 to the condenser pump or the cooling tower sump 6 through the valve no 05.

The preferred embodiment of the present invention discloses the intermediate ball storage tank which is uniquely designed to collect the balls from the ball arrestor. The main ball storage tank has one inlet, one outlet and one drain line and wherein the inlet line is connected to the ball arrestor, the outlet line is connected to the main ball storage tank. When the ball injection starts, the intermediate tank drain also starts on the same time. Due to this, when the balls comes in ball strainer, it directly comes out from strainer and gets accumulated in the intermediate ball storage tank.

- 10 According to the present invention, the intermediate ball storage tank does not allow the sponge balls to stop in the strainer and due to the continuous flow, it nullifies the chances of balls to get stuck in the strainer.

Another component of the present invention is the main ball storage tank which is primarily designed to store the sponge balls in it. The main ball storage tank has 4 tapping i.e. water inlet line, ball injection, return line and a drain line. The sponge balls are used as the cleaning aid which passes through the condenser tubes in order to clean the interior side of the tubes. The sponge balls are slightly bigger in size than the condenser tube inner diameter i.e. around 1 mm bigger in size than condenser tube ID. The sponge balls are initially injected and stored into the ball storage tank manually which are then dispensed into the system.

- 20 The ball arrestor is a rectangular fabricated box type component which is installed on the condenser outlet pipe. The ball arrestor is provided with a strainer which arrests the sponge ball which are injected in the condenser inlet line and restricts them from reaching the cooling tower. The ball arrestor comprises of two guides of triangular or rectangular shape that are placed above the strainer. These guides create an area which restricts the water pressure and the flow behind the guide. The gap maintained between the strainer & the guide is around 17-24 mm which depends upon the ball size. When the sponge balls travel along with water, reaches the ball arrestor, the water pushes the sponge balls inside the guides through the created gap. As the sponge balls travels through the guide, they reach the ball arrestor and exit from the ball arrestor to the intermediate ball storage tank as the drain starts during the time of ball injection only. Hence the sponge balls get recovered during the time of injection and collected in the intermediate tank.

The smart controller or control panel gives command to control valves i.e. Valve 01, 02 and 03 for opening and closing. The auto valves i.e. Valve 01, 02 and 03 are electrically or pneumatically operated and are controlled through control panel. The program is developed to open & close the

valve as per requirement. The PLC based or timer based or any type of control panel can be used for the auto valve operations. The functions of all the five valves used in the present invention are described below.

5 Valve no. 01 is the water inlet valve. During the time of injection, this valve opens & the water enters the system from the main water inlet line to the main ball storage tank. The water helps to carry the sponge balls from the main ball storage tank and is injected into the condenser inlet line.

Valve no. 02 is the ball injection valve. This valve allow the sponge balls to flow from main ball storage tank to the condenser inlet line.

10 Valve no. 03 is the intermediate drain valve. This valves opens during the time of injection which help balls to exit from the ball arrestor or the strainer directly and does not give enough time for sponge balls to rest in the strainer which improves ball recovery efficiency. The intermediate drain line is connected to the condenser pump suction or cooling tower sump, so the water does not waste during drain.

15 When the valve no. 01 & 02 opens, water comes from valve no 01 to the main ball storage tank, takes the sponge balls present in main ball storage tank and the sponge balls are injected through the valve no 02 and goes in the condenser inlet line. Then balls passes through the condenser tubes, cleans the tubes, enters the condenser outlet line & then get arrested in the ball arrestor. Then they immediately flow from the ball arrestor to the intermediate ball storage tank as the drain valve of intermediate tank opens and the balls get arrested in the intermediate tank.

20 Valve no. 04 is the ball recovery valve which is installed in between the intermediate ball storage tank and the main ball storage tank. Once the injection of the balls is completed, the drain valve of main ball storage tank (i.e. Valve no. 05) and this valve opens together in order to transfer the balls from the intermediate ball storage tank to the main ball storage tank.

25 Valve no. 05 is the main ball storage tank drain valve. This valve drains the water from the main ball storage tank to the condenser pump suction to the cooling tower sump. The main ball storage tank drain line is connected to the condenser pump suction or cooling tower sump, so the water does not go waste during draining.

30 When the control valves i.e. Valve No. 01, 02 and 03 of injection line opens, the sponge balls travels from main ball storage tank to the condenser water inlet line, reaches the condenser and passes through the condenser tubes, travels through the ball arrestor & finally to the intermediate ball storage tank. As the sponge balls are slightly bigger in size than the condenser tubes, it cleans all the dust, dirt, scaling, slime deposited on the inner surface of condenser tubes.

Once all the sponge ball from the ball storage tank get injected into the condenser, the control valves i.e. Valve No. 01, 02 and 03 gets closed. The sponge balls passes from the condenser tubes, reaches the condenser outlet line, travels through the ball arrester & then through the intermediate ball storage tank which is installed in between the ball arrester & the main ball storage tank. Then the sponge balls return to the initial position when the drain line control valve 04 and 05 are opened and the sponge balls passes from intermediate ball storage tank to main ball storage tank. Thus the cycle completes resulting in the complete cleaning of the condenser tubes. This cycle repeats at the time interval of every after 30 minutes or as per requirement.

The opening and closing sequence of the valves and the ball location during the sequence is described below. The initial position or location of the sponge balls is in the main ball storage tank. When the system starts for ball injection, the auto valve no 01, 02 and 03 are in open condition whereas the valve no 04 and 05 are in closed condition. The position of the sponge balls at this stage is in the intermediate ball storage tank. After the completion of the ball injection, the ball recovery process starts in which the valve no. 01, 02 and 03 remains closed and the valve no 04 and 05 remain opened. The ball position at this stage is in the main ball storage tank. Once the ball recovery is completed, the valve no 01,02,03,04 and 05 are in closed condition. This complete process is collectively called as one cycle and this cycle repeats after 15-30 minutes. The cycle time is flexible and can be changed as per requirement by the user. Also the combinations of valve operation can be changed accordingly for the better system performance.

FIG 2 illustrates the design 1 of the intermediate ball storage tank which comprises of a water inlet line 8 that exits from the ball arrester, wire mesh or a perforated sheet 09 which allows to drain water and keeps only the sponge balls in the tank, valve no.03 10 which opens during the time of injection i.e. when the valve no. 02 and 02 opens, a drain line 11 which opens during the tie of ball injection from the main ball storage tank, the valve no.04 12 which opens during the time of recovery i.e. when the valve no 05 opens, water outlet line 13 that is attached to the main ball storage tank and sight glass 14 that is provided to see the ball recovery or the bling flange can be put. The intermediate ball storage tank is uniquely designed to collect the balls from the ball arrester.

FIG 3 illustrates the design 2 of the intermediate ball storage tank which comprises of a water inlet line 15 that exits from the ball arrester, wire mesh or a perforated sheet 16 which allows to drain water and keeps only the sponge balls in the tank, valve no.03 17 which opens during the time of injection i.e. when the valve no. 02 and 02 opens, a drain line 18 which opens during the tie of ball injection from the main ball storage tank, the valve no.04 19 which opens during the time of recovery i.e. when the valve no 05 opens, water outlet line 20 that is attached to the main ball

storage tank and sight glass 21 that is provided to see the ball recovery or the bling flange can be put. The intermediate ball storage tank is uniquely designed to collect the balls from the ball arrestor.

FIG 4 illustrates the design 3 of the intermediate ball storage tank which comprises of a sight glass 22 at the top of the intermediate ball storage tank which is provided to see the recovery of the sponge balls, water outlet line 23 that is connected to the main ball storage tank, wire mesh or the perforated sheet 24 which allows the water to drain from the tank and retain only the sponge balls, the drain line 25 which opens during the tie of the ball injection from the main ball storage tank and the water inlet line 26 which is coming from the ball arrestor.

- 10 The present invention describes the unique design of the ball arrestor along with intermediate ball storage tank which recovers around 99–100% sponge balls without using any high pressure pump. After this process, when the drain line valve of main ball storage tank opens, the water flows from the intermediate ball storage tank to the drain line of main ball storage tank and finally to the condenser pump. Now the sponge balls along with water, flows from the intermediate ball storage
15 tank to the main ball storage tank and the balls gets trapped in the ball storage tank due to strainer provided and restricts their flow to the condenser pump along with water. The process of condenser tube cleaning cycle completes one cycle and the sponge balls are ready for next cleaning cycle.

Minor difficulties that are experiences at the initial stages of the system installation are the improper ball injection and the uneven and less ball recovery from strainer. The improved design
20 of the ball storage tank from the vertical type to the horizontal improved the ball recovery and the ball arrestor internal design comprising of two flaps with a gap of around 18 - 25 mm in between the flap and the perforated sheet helps to trap the balls behind the flap.

- The unique feature of the present invention is the presence of the intermediate ball storage tank which can be designed in different ways as shown in FIG 1- FIG 4. The intermediate ball storage
25 tank collects the balls which exits from the ball arrestor before leading them to the main ball storage tank. The presence of the intermediate ball storage tank improves the ball recovery efficiency of the online condenser cleaning system. When the ball injection starts, the intermediate tank drain also starts on the same time. Due to this, when the balls comes into the ball strainer and exits directly from the ball strainer, they gets accumulated in the intermediate ball storage tank.
- 30 The intermediate ball storage tank does not allow the sponge balls to stop in the strainer and due to the continuous flow, it nullifies the chances of balls to get stuck in the strainer. This completely eliminates the time which gets wasted in cleaning the balls which are stuck in the system after completion of a cycle. The sponge balls then move into the main ball storage tank from the

intermediate ball storage tank and are ready for next cycle. The presence of intermediate ball storage tank alone can save lot of time, improves cleaning of the tubes and increases the efficiency of the system.

- 5 The intermediate ball storage tank comprises of a water inlet line joining the ball arrester, wire mesh or a perforated sheet which allows to drain only the water and keeps only the sponge balls in the tank, valve no.03 that opens during the time of injection, a drain line that drains the water from the tank, the valve no.04, a water outlet line that is attached to the main ball storage tank and sight glass that is provided to visualize the process inside tank and to check the ball recovery or the bling flange can be put. Also as the intermediate ball storage tank is in connection with the ball
- 10 arrester, the balls which are injected by the main ball storage tank will be completely recovered by the intermediate ball storage tank. Another advantage of the presence of the intermediate ball storage tank is that it does not allow the sponge balls to be stuck or remain in the ball arrestor compartment. This enables smooth running of the system as no ball remains in the ball arrestor and no ball will be stuck in the system during the operation cycle.
- 15 The present invention is not only limited to water treatment systems, but in future they can also be extended to various systems with high efficiency.

I Claim:

1. An online condenser cleaning system comprising:
 - a. an intermediate ball storage tank to store the sponge balls temporarily used for cleaning the condenser system;
 - 5 b. main ball storage tank to store the sponge balls at the start of the cycle; and
 - c. the ball arrester to stop the sponge balls from moving further in the system;

wherein the water enters the system from the condenser water inlet along with the sponge balls stored in the main ball storage tank which move to the intermediate ball storage tank that stores the sponge balls temporarily before being arrested at the ball arrester.

- 10 2. An online condenser cleaning system as claimed in claim 1 wherein, the intermediate ball storage tank collects the sponge balls from the ball arrester.
3. An online condenser cleaning system as claimed in claim 1 wherein, the intermediate ball storage tank can be designed in different ways which aims in collecting the sponge balls from the ball arrester, thus leading them to the main ball storage tank.
- 15 4. An online condenser cleaning system as claimed in claim 1 wherein, the intermediate ball storage tank improves the ball recovery efficiency of the online condenser cleaning system.
5. An online condenser cleaning system as claimed in claim 1 wherein, the intermediate ball storage tank does not allow the sponge balls to stop in the strainer and due to the continuous flow, it nullifies the chances of balls to get stuck in the strainer, which completely eliminates
20 the time consumed in cleaning the balls which are stuck in the system after completion of a cycle.
6. An online condenser cleaning system as claimed in claim 1 wherein, the sponge balls are used to clean the interior sides of the condenser tubes.
7. An online condenser cleaning system as claimed in claim 1 wherein, the design of the ball
25 arrester along with intermediate ball storage tank helps in recovering around 99–100% sponge balls without using any high pressure pump.
8. An online condenser cleaning system as claimed in claim 1 wherein, the valve no. 01 is the water inlet valve which remains open during the time of injection; valve no. 02 is the ball injection valve which allows the sponge balls to flow from main ball storage tank to the
30 condenser inlet line; valve no. 03 is the intermediate drain valve which opens during the time of injection helping the balls to exit from the ball arrester or the strainer directly; valve no. 04 is the ball recovery valve which is installed in between the intermediate ball storage tank and the main ball storage tank; and valve no. 05 is the drain valve of main ball storage tank which

drains the water from the main ball storage tank to the condenser pump suction to the cooling tower sump.

9. The method of cleaning the condenser comprising:

- a. inlet of water into the system from the water inlet through the piping and the sponge balls
5 from the main ball storage tank which reaches the condenser through the pipes;
- b. exit of the sponge balls along with water from the condenser through the pipe leading to the ball arrester where they are separated from water;
- c. movement of the sponge balls to the intermediate ball storage tank where they are stored temporarily;
- 10 d. drainage of the water from the intermediate ball storage tank through the mesh;
- e. transfer of the sponge balls from the intermediate ball storage tank to the main ball storage tank; and
- f. draining of water from the main ball storage tank to the condenser pump or the cooling tower sump.

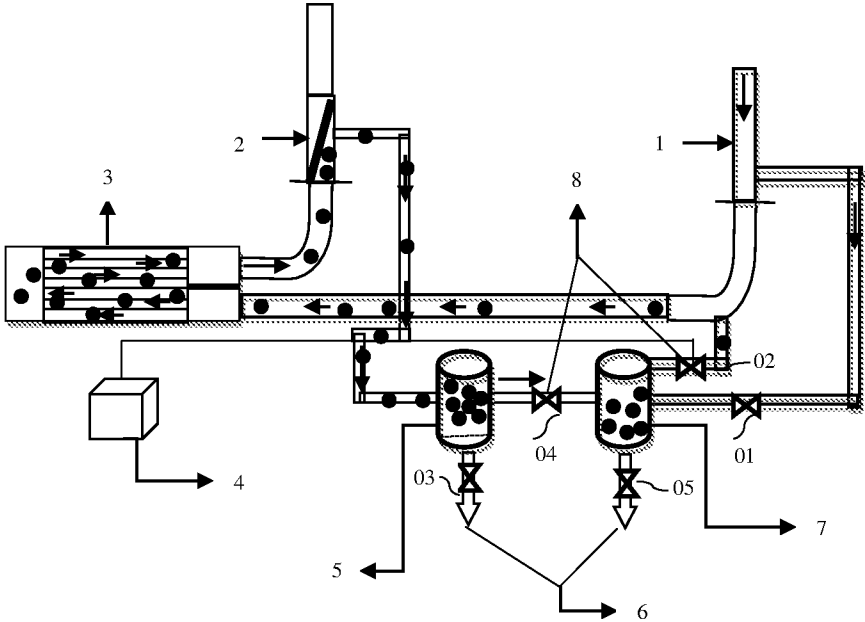


FIG 1

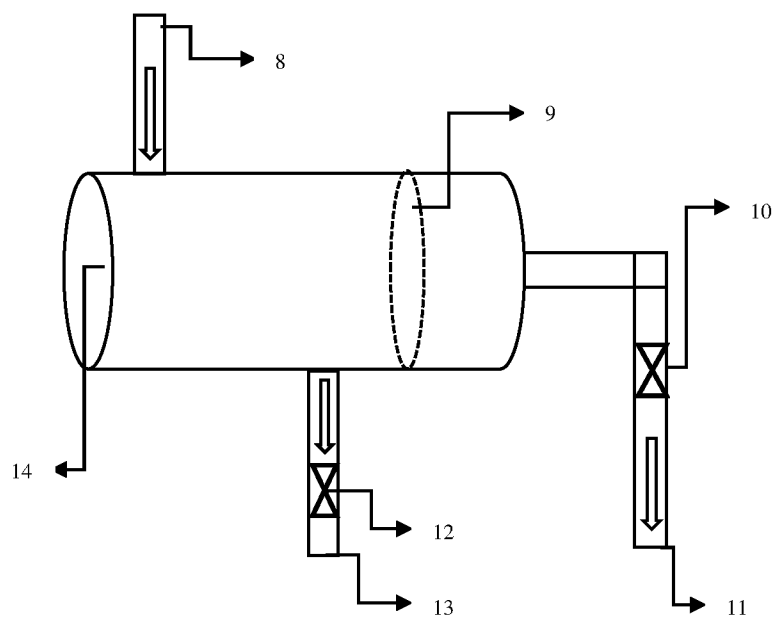


FIG 2

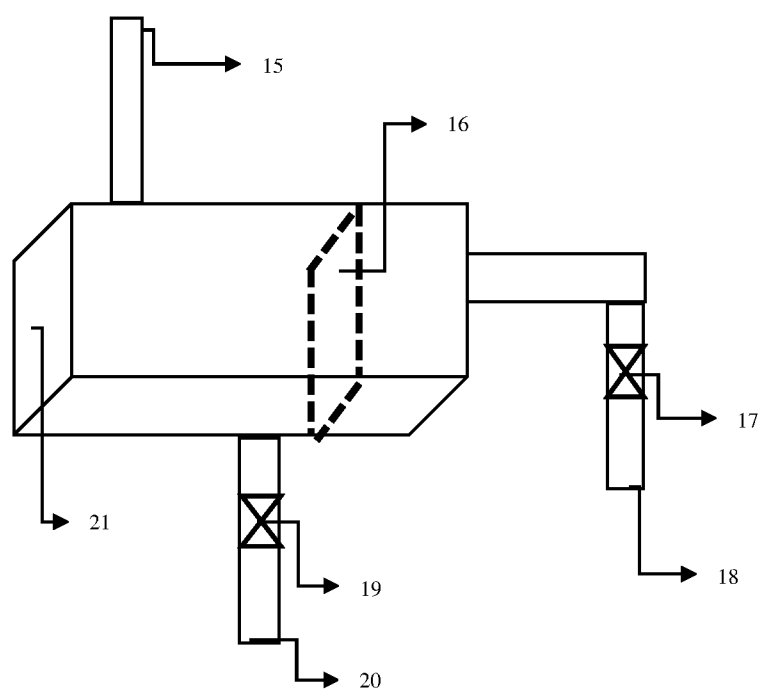


FIG 3

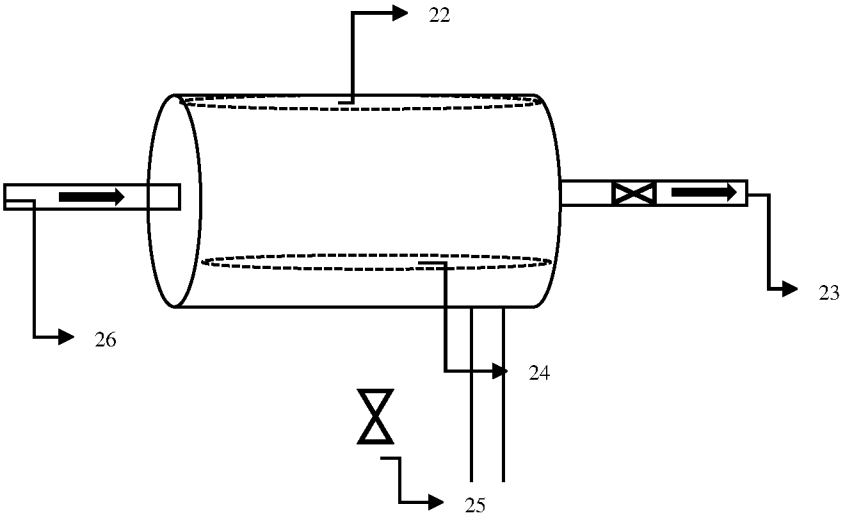


FIG 4

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IN2019/050196

A. CLASSIFICATION OF SUBJECT MATTER
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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)

F28G, B08B

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 practicable, search terms used)

TotalPatent One, IPO Internal Database

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP3168563A1 (DOOSAN HEAVY IND & CONSTRUCTION CO LTD; 17 May 2017) Abstract; para [0045]-[0049]; [0122]-[0128]; Figures 1, 7-13	1-7
Y	Abstract; Figures 1, 11 -----	8, 9
Y	US5388636A (CQM LTD; 14 Feb 1995) Abstract; col.3,ln.63-col.4,ln.10; Figures 1A-1D	8, 9

☐ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

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INTERNATIONAL SEARCH REPORT
Information on patent family members

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Citation	Pub.Date	Family	Pub.Date
EP 3168563 A1	17-05-2017	JP 2017090036 A	25-05-2017
		KR 20170055852 A	22-05-2017
		US 2017138679 A1	18-05-2017
US 5388636 A	14-02-1995	AU 1184795 A	06-06-1995
		BR 9408567 A	05-08-1997
		CA 2174555 A1	26-05-1995
		CN 1135257 A	06-11-1996
		CZ 143996 A3	12-02-1997
		DE 69428207 T2	13-06-2002
		EP 0728286 A1	28-08-1996
		ES 2163491 T3	01-02-2002
		IL 111666 A	31-10-1996
		JP 3306829 B2	24-07-2002
		KR 960706061 A	08-11-1996
		PL 314467 A1	16-09-1996
		RU 2137999 C1	20-09-1999
		US 5447193 A	05-09-1995
		WO 9514205 A1	26-05-1995