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— *as to the identity of the inventor (Rule 4.17(i))*

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(54) Title: CUTTINGS WASH APPARATUS AND METHOD

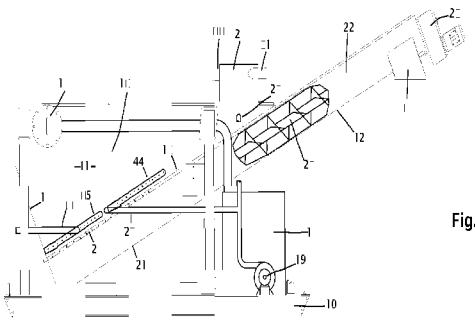


Fig. 1

(57) Abstract: Cutting wash apparatus includes a wash tank (11) having side walls (15) converging to an inclined lower floor (16) and containing an air agitated wash solution including a surfactant. A cyclone separator (27) receives an oil-based mud and cutting-containing slurry through inlet (30), passing mud to an outlet (31) and a cuttings-rich component to the wash tank (11). A skimmer (13) removes wash overflow and a mud and slurry fines raft floated by the agitation, and passes this to a separator (18). Separated wash liquid is aerated and returned by pump (19) to injection points (28, 29) to recycle wash and provide the agitation. An auger (23) operates in a casing (21) opening into the tank (11) and extending upward of the wash tank and having an upper end discharge outlet (38). Additional aeration and agitation air is injected through air injection bars (45).

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CUTTINGS WASH APPARATUS AND METHOD

This invention relates to a cuttings wash apparatus and method.

This invention has particular but not exclusive application to a cuttings wash apparatus and method for use on drilling rigs permitting proper disposal and/or recycling of spent drilling mud compositions, and for illustrative purposes reference will be made to such application. However, it is to be understood that this invention could be used in other applications, such as entrained particulates washes generally generally.

PRIOR ART

Unless explicitly indicated to the contrary, none of the following prior art constitutes common general knowledge in the art.

The current processing systems for the capture of drill cuttings contaminated with drilling mud are generally very large and are suitable only for terrestrial sites. They are generally impractical to operate on either platforms or rigs. Current practice on platforms and rigs generally involves the use of skips with a ship to shore operation. Alternatively bulk storage and bulk transport are employed at a significant cost. Centrifuge/dryer processing may be followed by transfer of clean cutting to a skip for transport. However, where laws permit the particulate cuttings waste is dumped overboard on economic grounds.

The main problem in the application of terrestrial apparatus and methods to platform and rig situations is processing during drilling in real time. Generally a rig produces around 20-24 tonnes of exhausted muds per hour at 350 feet per hour rate of penetration (ROP) of a 12¾“ drill

Several solutions are in experimentation or early adoption. Options like cuttings re-injection (CRI) are known but very expensive. Microwave processing is under investigation but is scalable to about 5 tonnes per hour. The current dryers and the like work very well but the drilling process guarantees a huge variance in the material to be processed, thus the units tend to struggle with screens binding up and other throughput-related process issues.

There is accordingly a need for a cuttings wash system suitable for drilling platforms and rigs, which maximises the performance of available equipment, minimises waste and its associated costs and operates at real time speed relative to the drilling operation.

DESCRIPTION OF INVENTION

As used herein the word "comprising" and its parts is to be taken as non-exclusive, unless context indicates clearly to the contrary. This invention in one aspect resides broadly in cutting wash apparatus including:

a wash tank having side walls at least the lower portions of which converge to an inclined lower floor and containing an air agitated wash solution including a surfactant;

a cyclone separator adapted to receive an oil-based mud and cutting-containing slurry and passing a particulates-rich separated component of said slurry to said wash tank;

a skimmer operable to remove a raft formed at the surface of the wash solution including emulsified oil based mud and slurry fines floated by said agitating;

an auger casing below said inclined floor and opening into said tank at a lower portion of the floor, the auger casing extending upward of a top of the wash tank and having an discharge outlet toward its upper end; and

an auger located in the auger casing and extending from the opening into said inclined floor to said discharge outlet.

The wash tank may be of a hopper or hod-like configuration. For example the wash tank may have a generally rectangular upper portion having a pair of side walls that converge downward and are closed together by the inclined floor forming both front and lower closure for the tank. The rear of the tank may have an end wall which is substantially vertical or which converges with the opening into the inclined floor at its lower end to guide washed cuttings into the opening.

The wash solution will be selected according to the nature of the continuous phase entraining the drill cuttings. For example in the case of oil based muds (OBM), the mud residue requires the use of a water wash containing surfactants to clean the bulk of the mud residue from the cuttings. The water wash may be made up with a surfactant composition selected from cationic surfactants selected to wet oily clay particles. The water wash may be selected to work in salt water. The air injection/surfactant combination may be selected in order to promote froth flotation of especially clay minerals cleaned from the drill cuttings.

The auger may be a shaftless auger. The auger is preferably driven from its upper end.

The cyclone separator may be mounted directly to the wash tank or its supporting structure in order that it may discharge separated cuttings directly into the wash tank. The cyclone separator may be internally screened to separate residual particulates from the mud overflow. This mud is directed directly back to mud tanks for re-blending and re use. For example, the inlet to the cyclone separator may be a tangentially directed inlet directing flow in the direction of rotation of the cyclone action. The tangential flow may impinge on a curved screen whereby the entrained cuttings are screened to the cyclone underflow and the spent mud directed to the cyclone overflow.

The cyclone separator may be in the form of a simple turret fitted to the wash tank and screened internally with a replaceable mesh liner. The cuttings and mud may enter tangentially and the inertia sees the mud expelled through the mesh liner where it is collected and redirected via gravity into a mud reprocessing tank. With inertia spent, the cuttings may fall under their own weight into the wash tank. The screen plays a minor part during normal operation but comes to play a significant role when drilling trips or a shaker screen breaks and the system has to cope with a large inflow of mud relative to the cuttings load.

The cyclone separator may be selected to match the particular charge characteristics of the slurry delivery system. For example, the slurry delivery system may involve the use of a slurry pump such as that described in WO 2006/037186.

The pump may consist of a pressure vessel, an inlet nozzle, and an ejector nozzle by which vacuum and pressure are applied, and an outlet nozzle, in this case connected via a discharge line connected to the inlet of the cyclone separator line. The inlet and outlet nozzles are selectively closed by interconnected knife gate valves, operated in tandem by a pneumatic cylinder whereby when one valve is closed, the other is open, and vice-versa. An ejector valve located in the ejector nozzle alternately creates vacuum and generate air flow through the vessel. The air from the ejector may be introduced into the discharge line after closure of the outlet valve, if the discharge line requires the boost.

Drilling mud entraining cuttings may be captured by the pump via either a gravity feed from a hopper or alternatively under vacuum.

The pump may deliver the slurry in a pump-and-fill cycle. Accordingly the cyclone separator is preferably selected as to static capacity and throughput to match

the discharge rate of the pump. In the case of the pump described above, it is preferable that the throughput of the cyclone be in the region of 24 tonnes per hour.

Cuttings in the wash tank pass under gravity along the inclined floor and into the path of the auger through the lower opening. The cuttings are exposed to agitation which enhances the wash effect. The air agitation may be provided by air injection a bottom portion of the wash tank from a compressed air supply. Alternatively, or in addition, the wash solution may be recycled and the recycled wash solution and air combined and injected along the inclined floor to provide the agitation.

Air bubbles from the agitation entrains emulsified oil based mud and other pollutants to form a raft at the surface of the wash solution to be removed by a skimmer. The skimmer may comprise an overflow system whereby floating sludge and wash liquid is delivered to separator means whereby the sludge may be stripped and the polished wash liquid returned by pump to the wash tank. For example, the overflow may pass into a tank across a stripper belt trapping sludge on top of the belt and allowing the polished wash liquid to pass through the belt. The belt may be a one-pass disposable web or a strippable recirculating web. The recycled wash solution may again be entrained with air and injected along the inclined floor to provide the agitation.

Drag through losses of the wash liquid to either the sludge removal or auger delivery of washed cuttings may be made up by any suitable means. For example, making up may be done in the sludge separator or the wash tank

Washed cuttings may be slowly transported up the auger. This dewaters the cuttings allowing solution to drain back into the main body of the tank.

The cuttings may be delivered from the auger outlet either directly or indirectly to a dryer assembly. The dryer may receive cuttings as a uniform continuous feed at a controlled rate because the cyclone and wash actions smooth out the pulsed delivery from the preferred pump. The dryer's operational performance band is preferably honed allowing optimum performance to be achieved and maintained throughout the entire operation.

Cuttings may now be discharged from the dryer and depending on environmental constraints can be returned to the ocean floor or alternatively transported back to shore for further processing.

BRIEF DESCRIPTION OF THE DRAWINGS

In order that this invention may be more readily understood and put into practical effect, reference will now be made to the accompanying drawings which illustrate a preferred embodiment of the invention and wherein:

FIG. 1 is a side view of apparatus in accordance with the present invention;

FIG. 2 is a front view of the general arrangement of a pump for use with the apparatus of FIG. 1; and

FIG. 3 is a side view of the pump of FIG. 2.

DESCRIPTION OF THE EMBODIMENT

In the figures, there is provided a cuttings wash apparatus including a supporting, crane hoistable frame 10 supporting a wash tank 11 and auger 12 assembly. The top of the tank 11 is provided with an overflow skimmer assembly 13. Remote from the supporting frame 10 there is provided a pump assembly 14 as illustrated in Figs. 3 and 4.

The wash tank 11 has a pair of opposed side walls 15 that converge to meet an inclined floor portion 16 which forms both front and bottom wall of the tank 11. An inclined rear wall 17 closes the back of the tank. The cuttings settle passing across the inclined floor portion 16 to a lower opening 20.

The lower opening 20 admits the cuttings to an auger housing 21 mounted beneath the floor portion 16 and extending to an upper portion 22 above the level of the tank 11 top. The auger housing 21 contains an auger 23 which is driven from its upper end by a motor and gearbox assembly 24.

The wash liquor 25 includes a cationic surfactant/flotation agent which causes the oil component of OBM to float as a raft 26 with other contaminants to be skimmed off by the overflow skimmer assembly 13. The surfactant composition of this example is capable of use in salt water and comprises 220 ppm Wildcat Concentrate (Wildcat Chemicals Australia Pty Ltd) of notional composition:

Chemical Components	
Cationic surfactant	20 - 25%
d-Limonine	0 - 5%
Acetic Acid	0 - 2%
Monobutyl Glycol Ether	0-15%
Sodium hexametaphosphate	0-2%

Monoethylene Glycol	0-5%
	Water Balance

A wash recycle tank 18 takes wash liquid and sludge from the overflow skimmer 13 and separates the sludge to waste, entrains air and pumps the polished wash liquid via pump 19 to the tank 11. Part of the recycled liquid is returned via upper port 28 to cuttings passing into the tank and part is directed through lower port 29 to a pair of spaced, longitudinal agitator bars 44 each having a plurality of approximately 1.0mm agitator holes. Wash liquid and entrained air projected from the agitator holes agitates the cuttings passing down the tank floor 6 to provide agitation, wash enhancement and flotation raft formation. Further agitation and froth flotation action is provided by air injection through port 39 to a pair of spaced, longitudinal injection bars 45 each having a plurality of approximately 0.2mm air injection holes.

A cyclone separator 27 comprises a cylindrical turret having a tangential slurry inlet 30 through which slurry passes from the slurry pump 14 to impinge on a curved screen, allowing cuttings to drop into the tank 11 while the mud passes centrifugally about the turret to a mud exit 31 to reclamation and blending.

The slurry inlet 30 is connected to the outlet 32 of the pump assembly 14 via a flexible hose (not shown). The pump comprises a steel vessel 34 having a tapered lower body 35 to the outlet 32 which has a knifegate valve closure 28. The vessel has an inlet 36 controlled by an inlet knifegate valve 37 operated in concert with the outlet knifegate valve 28 to effect cycling of the pump. An ejector assembly 40 includes a compressed air supply 41 feeding an internal venturi which is selectively valved whereby it depresses the housing via conduit 42 when the inlet knifegate 37 is open and the outlet knifegate valve 28 is closed to charge the vessel 34 and pressurizes the vessel when the inlet knifegate 37 is closed and the outlet knifegate valve 28 is open to discharge the vessel into the slurry inlet 30.

The pump assembly has a pallet frame assembly 43 and may be moved by forklift.

Washed cuttings are slowly transported up the auger 23 which dewaters the cuttings allowing solution to drain back into the main body of the tank 11. The cuttings are then delivered directly into a dryer assembly (not shown) via gravity outlet 38 which now receives a uniform continuous feed at a controlled rate. The

dryer's operational performance band has been honed allowing optimum performance to be achieved and maintained throughout the entire operation.

Cuttings are now discharged from the dryer assembly 13 and depending on environmental constraints can be returned to the ocean floor or alternatively transported back to shore for further processing.

The main objectives of this system are:

1. To reduce the amount of contaminants entering the environments where zero discharge limits do not apply.
2. To facilitate the removal of a significant amount of OBM and associated contaminants from the drill cuttings at "real time" drilling rates (Approx 24 tonnes per hour)
3. To deliver drill cuttings for further on shore processing whereby the associated volume and costs have been significantly reduced.
4. To deliver a cost effective "real time" process significantly enhancing current global practices.

Each of the components below work at their optimum at 25 tonnes per hour, and the methodology ensures each is delivering just that.

It will of course be realised that while the above has been given by way of illustrative example of this invention, all such and other modifications and variations thereto as would be apparent to persons skilled in the art are deemed to fall within the broad scope and ambit of this invention as defined in the following claims.

CLAIMS

1. Cutting wash apparatus including:

a wash tank having side walls at least the lower portions of which converge to an inclined lower floor and containing an air agitated wash solution including a surfactant;

a cyclone separator adapted to receive an oil-based mud and cutting-containing slurry and passing a particulates-rich separated component of said slurry to said wash tank;

a skimmer operable to remove a raft formed at the surface of the wash solution including emulsified oil based mud and slurry fines floated by said agitation;

an auger casing below said inclined floor and opening into said tank at a lower portion of the floor, the auger casing extending upward of a top of the wash tank and having an discharge outlet toward its upper end; and

an auger located in the auger casing and extending from the opening into said inclined floor to said discharge outlet.

2. Cutting wash apparatus according to claim 1, wherein the wash tank is of a hopper or hod-like configuration.

3. Cutting wash apparatus according to claim 2, wherein the wash tank has a generally rectangular upper portion having a pair of side walls that converge downward and are closed together by the inclined floor forming both front and lower closure for the tank.

4. Cutting wash apparatus according to claim 2, wherein the rear of the tank has an end wall selected from a substantially vertical wall and a wall which converges with the opening into the inclined floor at its lower end to guide washed cuttings into the opening.

5. Cutting wash apparatus according to claim 1, wherein the slurry includes an oil based mud and wherein the wash solution is a water wash containing cationic surfactants.

6. Cutting wash apparatus according to claim 1, wherein the auger is a shaftless auger.

7. Cutting wash apparatus according to claim 6, wherein the auger is driven from its upper end.

8. Cutting wash apparatus according to claim 1, wherein the cyclone separator is mounted directly to the wash tank.

9. Cutting wash apparatus according to claim 8, wherein the cyclone separator is internally screened to separate residual particulates from a mud overflow.

10. Cutting wash apparatus according to claim 8, wherein the inlet to the cyclone separator is a tangentially directed inlet directing flow in the direction of rotation of the cyclone action.

11. Cutting wash apparatus according to claim 10, wherein the tangential flow impinges on a curved screen whereby the entrained cuttings are screened to the cyclone underflow and the spent mud directed to the cyclone overflow.

12. Cutting wash apparatus according to claim 9, wherein the cyclone separator is a turret fitted to the wash tank and with the internal screen is a replaceable mesh liner, whereby the inertia of the tangential flow sees the mud expelled through the mesh liner where it is collected and redirected via gravity into a mud reprocessing tank, whereupon the cuttings fall under their own weight into the wash tank.

13. Cutting wash apparatus according to claim 1, wherein the cyclone separator receives slurry from pump apparatus including:

a housing having an inlet for admitting to the housing a material to be pumped, and a delivery outlet connected to the inlet of said cyclone separator;

a valve on each of said inlet and said outlet;

control means adapted to selectively open and close respective said valves;

pressure reduction means under the control of said control means and adapted to reduce the pressure in said housing while said inlet valve is open to admit said material to said housing, said control means being adapted to close said inlet gate means on admission of a selected charge of said material to said housing; and

pressurizing means under the control of said control means and adapted to increase the pressure in said housing while said outlet valve is open to discharge said material from said housing to said cyclone separator.

14. Cutting wash apparatus according to claim 13, wherein the cyclone separator is selected as to static capacity and throughput to match the discharge rate of the pump.

15. Cutting wash apparatus according to claim 1, wherein said air agitation is provided by air injection to a bottom portion of the wash tank from a compressed air supply.

16. Cutting wash apparatus according to claim 1, wherein the wash solution is recycled and wherein recycled wash solution and air are combined and injected along the inclined floor to provide said air agitation.

17. Cutting wash apparatus according to claim 16, wherein the skimmer comprises an overflow system whereby floating sludge and was liquid is delivered to separator means whereby the sludge is stripped and the polished was liquid returned by pump to the wash tank.

18. Cutting wash apparatus according to claim 17, wherein the recycled wash solution and air are combined and injected along the inclined floor to provide said agitation.

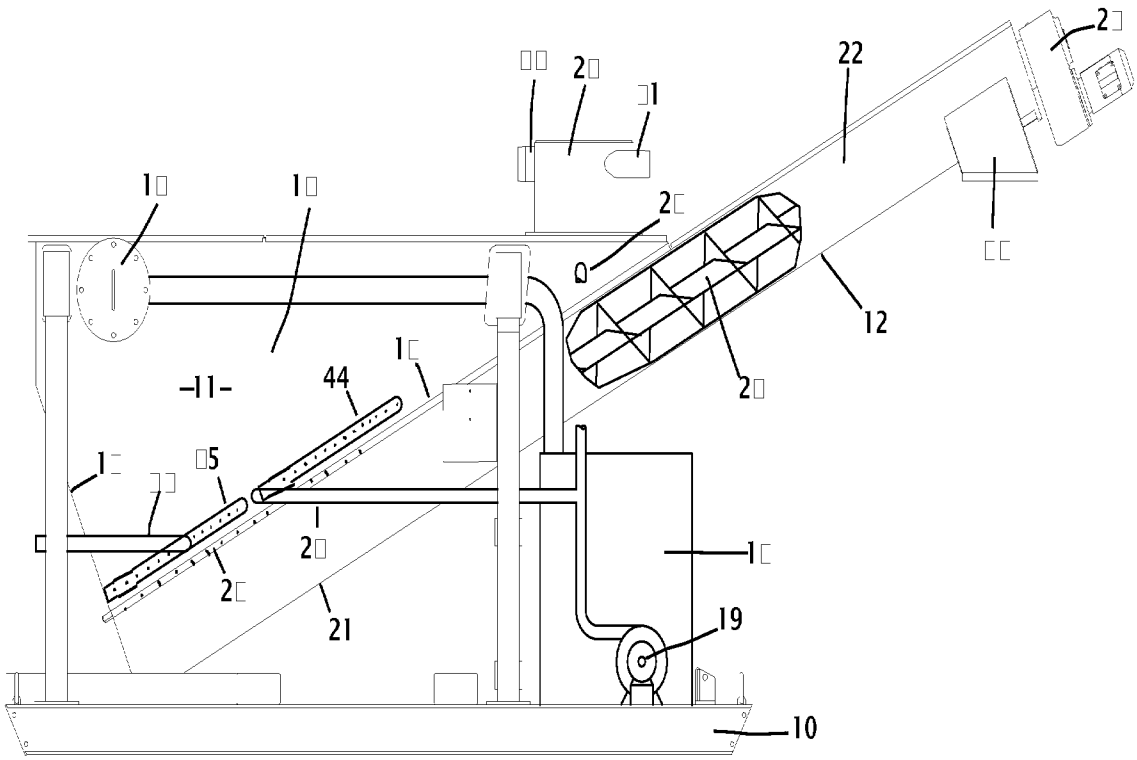


Fig. 1

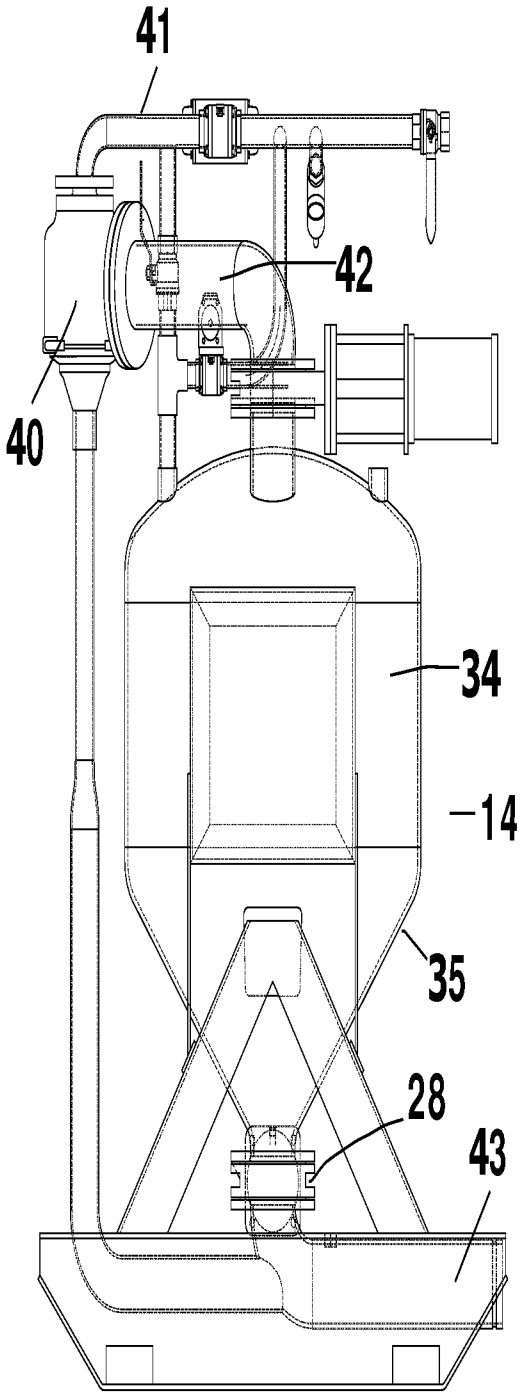


Fig. 2

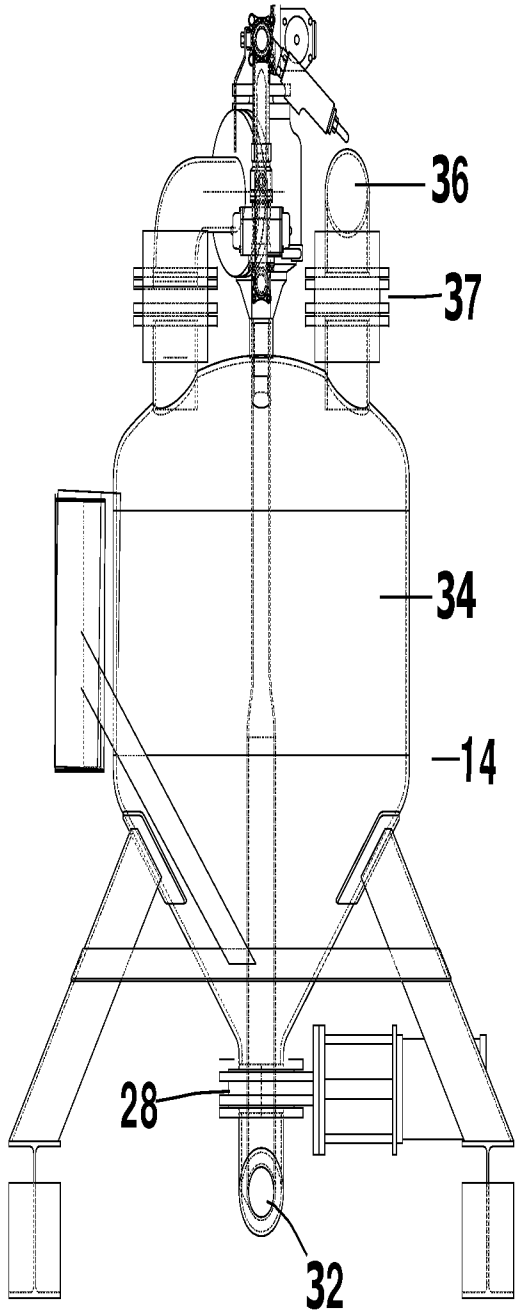


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.
PCT/AU2010/001589

A. CLASSIFICATION OF SUBJECT MATTER

Int. Cl.

B03B 5/28 (2006.01) ***B04C 9/00*** (2006.01) ***B09C 1/02*** (2006.01)
B03D 1/02 (2006.01) ***B08B 7/00*** (2006.01) ***B09C 1/04*** (2006.01)
B03D 1/14 (2006.01) ***B09B 3/00*** (2006.01) ***E21B 21/06*** (2006.01)
B01D 17/00 (2006.01)

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)

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)
EPODOC, WPI IPC Marks (E21B/IC/EC, B03B5/28/LOW/IC/EC, B03D1/14/LOW/IC/EC, B03D1/02/LOW/IC/EC, B08B7/IC/EC, B04C9/IC/EC,B09B3/IC/EC, B09C1/02/IC/EC, B09C1/04/IC/EC, B01D/IC/EC) Keywords (CYCLON+, CENTRIFUG+, HYDROCYCLON+, SURFACTANT+, DETERGENT+, FLOAT+, SLUR+, MUD+, CUT+, SLIT+, GRAVEL+, STONE+ AND SIMILAR TERMS); GOOGLE PATENTS AND ESPACENET USING SIMILAR KEYWORDS AS ABOVE.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 3723309 A (GARCIA J.A.) 27 March 1973 Column 3 lines 50-74; column 4 lines 54-55; figures 2, 3	1-18
Y	US 4274963 A (PURVIS) 23 June 1981 Figures 2, 3	1-18
A	US 7380617 B1 (JAMES) 3 June 2008 Abstract	

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

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 February 2011	18 FEB 2011
Name and mailing address of the ISA/AU AUSTRALIAN PATENT OFFICE PO BOX 200, WODEN ACT 2606, AUSTRALIA E-mail address: pct@ipaustralia.gov.au Facsimile No. +61 2 6283 7999	Authorized officer **GILBERT LIM** AUSTRALIAN PATENT OFFICE (ISO 9001 Quality Certified Service) Telephone No : +61 2 6283 2597

INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/AU2010/001589

This Annex lists the known "A" publication level patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

Patent Document Cited in Search Report	Patent Family Member
US 3723309	NONE
US 4274963	NONE
US 7380617	US 2008135300

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

END OF ANNEX