SLUDGE EXTRACTION APPARATUS AND METHOD

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ABSTRACT

There is provided sludge extraction apparatus (10) including a collection pipe (13) having a plurality of spaced, a suction pump (23), a suction pipe (15) with an end connected to the suction pump (23) and a suction head assembly (16) connected to the other end and slideable through the collection pipe (13) from an end, the suction head assembly (16) including a leading body portion (17) spaced from and connected to a trailing body portion (21) having an axial bore (19) connected to a suction pipe (15), the leading (17) and trailing (21) body portions substantially occluding the collection pipe (13) in use and defining there between a suction zone (22) of a length selected to open to at least one said opening at selected positions of the suction head assembly along the collection pipe.
SLUDGE EXTRACTION APPARATUS AND METHOD

This invention relates to a sludge extraction apparatus and method.

This invention has particular but not exclusive application to sludge extraction apparatus and method for extraction of sludge from palm oil waste settling ponds, 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 pit sludge extraction generally.

PRIOR ART

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

In the conventional processes for extraction of palm oil from oil palm kernels, a waste stream is generated including water and fibrous and other particulate organic materials, dirt and other minerals, filter cakes and the like. The wastes are piped to lined or unlined open pits where the waste undergoes environmental degradation to produce CO₂ and other digestion gases and a sludge residue. Periodically the sludge requires removal. In more recent times covered pits have been used as part of a carbon capture program. The pits are covered by a membrane that sits on top of the liquid medium in the pit. Once the membrane is in place the access to de-sludge is limited.

One method used to manage sludge removal in covered pits is installing a fixed manifold of perforate collection pipes in the bottom of the pit. Periodically suction is applied to the manifold to extract sludge. This fixed manifold arrangement has its limitations due to suction efficiency falling off with distance in the pit, as the apertures closer to the suction pump draw liquid with little entrained sludge at the expense of suction at the remote apertures. The sludge can maintain a significant batter angle about the apertures, thus permitting considerable fluid flow for limited sludge recovery.

One attempt to overcome these disadvantages uses a "pipe-in-pipe" arrangement where the suction pipe arrangement comprises an outer, perforate sleeve located on the floor of the pit and into which is progressively slid a suction tube. The suction tube is fed from and retrieved to a rotating drum which terminates the suction tube to a rotating coupling to a suction pump. The head or suction nozzle of the suction tube depresses the space in the outer sleeve ahead of the head or suction nozzle only. In use, the suction tube is fed through the perforate sleeve (with suction to effect sleeve clearance and aid feeding). Thereafter the suction tube is withdrawn under suction, the plug effect of the head or suction nozzle meaning that the suction is confined to the perforate sleeve portion ahead of the head or suction nozzle.

The disadvantage is that at any point in the outer, perforate sleeve the nozzle is attempting to depress the pressure in the whole of the sleeve ahead of the nozzle. Suction efficiency falls off with distance from the nozzle but inefficient suction at a distance robs the suction zone near the nozzle of power.

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 sludge extraction apparatus including:

A collection pipe having a plurality of openings through the wall thereof at selected spacings;
A suction pump;
A suction pipe having one end connected to the suction pump;
A suction head assembly connected to the other end of the suction pipe and slidable through the collection pipe from one end thereof, the suction head assembly including a leading body portion spaced from and connected to a trailing body portion having an axial bore connected to a suction pipe, the leading and trailing body portions substantially occluding the collection pipe in use and defining therebetween a suction zone of a length selected to open to at least one said opening at selected positions of the suction head assembly along said collection pipe.

The collection pipe may be of metal, polymer or composite. The collection pipe should be selected to substantially maintain its form under the expected pressure gradient. Accordingly elastomeric composite pipe such as fabric reinforced rubber is preferably wire reinforced against collapse. In view of the chemically aggressive environment in some settling ponds, metal collection pipe is preferably coated with a chemically resistant coating such as thermally bonded polyethylene or epoxy coating. Advantageously the collection pipe is formed of a stock engineering thermoplastic such as HDPE.

The apertures may be single apertures spaced in a line along the pipe. Alternatively the apertures may be arranged in groups around the pipe with the groups spaced along the pipe. The apertures may be any suitable shape. For example, where the apertures are in groups the apertures may be elongate in the direction of the pipe axis to preserve cross section for a given aperture area.

The collection pipe may be permanently installed in the sludge pond or pit, or may be removable, or at least relocatable, in the pit.

The selected spacing of the apertures may comprise even spacing or may be uneven spacing. For example the spacing may be selected whereby a single aperture or group of apertures are open to the suction zone and any given position of the suction head assembly in the collection pipe. Alternatively, the collection pipe may traverse areas of lesser or greater deposition of solids, wherein there may be advantage in two or more apertures or groups of apertures being exposed to the suction zone simultaneously.

The suction pump may take any form suitable for handling the sludge or entrained particulates to be settled. The suction pump may be selected from positive displacement pumps such as peristaltic pumps or impeller pumps. In the alternative, the suction pump may comprise a compressed air operated venturi vacuum/pressure cycle pump. The pump may be a fixed installation or may be mobile or transportable. The pump may be powered by independent power or from mains. An independently powered pump may be powered by an internal combustion engine providing direct drive or indirect drive. Indirect drive may be hydraulic or pneumatic. In the case of a compressed air operated venturi vacuum/pressure cycle pump, this may be associated with a mobile compressor pack or may be co-mounted with a compressor.

The suction pipe may take any suitable form. The suction pipe may be formed of polymer or polymer composite. The suction pipe should be selected to substantially main-
tain its form under the expected pressure gradient. Accordingly elastomeric composite pipe such as fabric reinforced rubber is preferably wire reinforced against collapse. Advantageously the suction pipe is formed of a stock engineering thermoplastic such as HDPE.

0019] The connection of the suction pipe to the suction pump may be a direct, fixed union. However, in order that the suction pipe may be spooled on and off a spooler, the suction pipe is preferably connected to a rotating coupling to the suction pump associated with the spooler. The spooler is preferably co-mounted with the suction pump to form a transportable assembly.

0020] The suction head assembly may be close fitting to the bore of the collection pipe and accordingly rely on low friction surfaces and/or water lubrication to slide freely. However, it is not necessarily so and the suction head assembly may run at a working clearance in to bore while maintaining a substantial occlusion to the bore of the pipe separating the suction zone from the collection pipe upstream and downstream of the suction head assembly. The connection of the suction head assembly may be a fixed coupling or may be a rotatable coupling.

0021] The leading and trailing body portions may be of the same or different materials and may be selected from metal and plastic construction. For example, the respective portions may be formed of cast resin or thermoplastic moulding, or formed from a free-machining polymer such as DELRIN®. The leading body portion may be spaced from the trailing body portion by any suitable means consistent with providing an open suction zone therebetween. For example the leading and trailing body portions may be integrally formed with interconnecting web portions. Alternatively the leading and trailing portions may be leading and trailing members interconnected by one or more interconnecting strut members. In the case of leading and trailing portions of suitable material, the strut members may comprise an array of two or more metal rods threaded or otherwise affixed at their ends to the respective body members.

0022] The interconnection may comprise a hollow tubular member in communication with the suction pipe via the trailing body member and having wall apertures whereby the suction zone may be depressed. Otherwise, the trailing portion or member may have an axial bore or other passage therethrough connecting the suction pipe with the suction zone directly.

0023] The suction zone defined between the leading and trailing body portions is of a length selected to open to at least one collection pipe opening at substantially all positions along the collection pipe as described above. At certain points along the collection pipe there may be places or circumstances where the depression invoked by the suction pump needs to be relieved somewhat to avoid stalling the pump. In addition, to advance the suction head assembly along the collection pipe, it may be desirable to reduce resistance to movement ahead of the suction head assembly. To this end there may be provided an equalization port passing through the leading body portion and connecting the suction zone to the collection pipe ahead of the suction head assembly. For example there may be provided a substantially axial equalization port between the suction zone and the collection pipe ahead of the suction head assembly.

0024] In a further aspect this invention resides broadly in a sludge extraction method including the steps of:

0025] installing into the bottom of a settling pit, pond or the like a collection pipe having a plurality of openings through the wall thereof at selected spacings;

0026] connecting a suction pump to one end of a suction pipe;

0027] connecting a suction head assembly including a leading body portion spaced from and secured to a trailing body portion to the other end of the suction pipe by an axial bore through the trailing body portion;

0028] inserting the suction head assembly into an open end of the collection pipe, whereby the leading and trailing body portions substantially occlude the collection pipe and define a suction zone therebetween of a length selected to open to at least one said opening at substantially all positions along said collection pipe; and

0029] moving said suction head assembly through the bore of said collection pipe while operating said suction pump to draw sequentially through said openings.

BRIEF DESCRIPTION OF THE DRAWINGS

0030] 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:

0031] FIG. 1 is a side view of a suction head assembly for use in apparatus in accordance with the present invention;

0032] FIG. 2 is a view of apparatus in accordance with the present invention, deployed in use;

0033] FIG. 3 is a plan view of apparatus in accordance with the present invention;

0034] FIG. 4 is a side view of apparatus in accordance with the present invention;

0035] FIG. 5 is an end view of apparatus in accordance with the present invention, with carriage retracted; and

0036] FIG. 6 is an end view of apparatus in accordance with the present invention, with carriage extended.

DESCRIPTION OF THE EMBODIMENT(S)

0037] In the figures, there is provided a pipe-in-pipe sludge clearance apparatus 10 for periodically removing sludge from a pit 11 having a cover 12. The sludge clearance apparatus 10 includes an indwelling or installed collection pipe 13 having Ø50 mm apertures 14 evenly spaced at 1000 mm centres along it, and a HDPE suction pipe 15 able to be fed into the installed collection pipe 13. The suction pipe 15 is terminated by a suction assembly 16 including a leading pig 17 having an axial equalization port 20 and spaced from and secured to a trailing pig 21 by stainless steel rods 18. The trailing pig 21 has an axial bore 19 providing connection to the suction pipe 15, the pigs 17, 21 defining a suction zone 22 of 940 mm length between them.

0038] When the leading pig 17 passes each of the apertures 14 in the collection pipe 13 over the portion deployed on the bottom of the covered sludge pit 11, the suction zone 22 concentrates the suction at the holes in turn. The 940 mm length of the suction zone maximizes the residence time of the zone over the hole as the suction assembly is advanced.

0039] The collection pipe 13 is 90 mm NB with the holes in the base (underside) only. The suction pipe 15 is 75 mm OD. The diameter of the head and tail are selected to provide a 1.5 mm clearance on the collection pipe 13 bore.

0040] An air operated vacuum/pressure pump 23 is connected to the centre of a suction pipe spool 24 via a swivel
fitting 25. Vacuum is applied to the suction assembly 15 by the pump 23, depressing the suction zone. A small amount of vacuum is directed via the 13 mm axial equalization port 20 to clear the collection pipe 13 as the suction assembly 15 moves forward. The feed rate is about 1 metre per minute or 3-4 full cycles for a typical air operated vacuum/pressure pump 23 operating at 25"Hg and 100 litres each cycle.

[0041] The drop off of the vacuum caused by the 13 mm axial penetration in the cap is negligible compared to the suction confined to the single 50 mm aperture. Almost full vacuum is applied to the 50 mm penetration for the duration of the pass, the combination of vacuum and pressure supplied by the typical 6+ metre head of the pond itself results in excellent inflows.

[0042] The pump 23 is conveniently mounted on a wheeled chassis 26 which also mounts the suction pipe spool 24. The spool 24 is reversibly driven to deploy and retrieve the suction pipe 15. The wheels 27 of the chassis 26 are retractable to provide stability in use. A diesel powered air compressor 30 stages drives the pump 23. Fire extinguishers 31 are mounted. The front wheels 33 are steerable.

[0043] 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.

1. Sludge extraction apparatus including:
   a collection pipe having a plurality of openings through the wall thereof at selected spacings;
   a suction pump;
   a suction pipe having one end connected to the suction pump;
   a suction head assembly connected to the other end of the suction pipe and slideable through the collection pipe from one end thereof, the suction head assembly including a leading body portion spaced from and connected to a trailing body portion having an axial bore connected to a suction pipe, the leading and trailing body portions substantially occluding the collection pipe in use and defining therebetween a suction zone of a length selected to open to at least one said opening at selected positions of the suction head assembly along said collection pipe.

2. Sludge extraction apparatus according to claim 1, wherein the collection pipe is of a polymer material or composite thereof.

3. Sludge extraction apparatus according to claim 2, wherein the polymer is HDPE.

4. Sludge extraction apparatus according to claim 1, wherein the apertures are selected from single apertures spaced in a line along the pipe and apertures arranged in groups around the pipe with the groups spaced along the pipe.

5. Sludge extraction apparatus according to claim 4, wherein the apertures are in groups and the apertures are elongate in the direction of the pipe axis to preserve cross section for a given aperture area.

6. Sludge extraction apparatus according to claim 1, wherein the collection pipe is permanently installed in a sludge pond or pit.

7. Sludge extraction apparatus according to claim 1, wherein the collection pipe is relocatable in a sludge pond or pit.

8. Sludge extraction apparatus according to claim 1, wherein the selected spacing of the apertures comprises even spacing.

9. Sludge extraction apparatus according to claim 1, wherein the suction pump is selected from positive displacement pumps.

10. Sludge extraction apparatus according to claim 1, wherein the suction pump is a compressed air operated venturi vacuum/pressure cycle pump.

11. Sludge extraction apparatus according to claim 1, wherein the suction pump is mobile or transportable.

12. Sludge extraction apparatus according to claim 1, wherein the suction pipe is formed of polymer or polymer composite.

13. Sludge extraction apparatus according to claim 1, wherein the connection of the suction pipe to the suction pump is a rotating coupling to the suction pump associated with a spooler, whereby the suction pipe may be spooled on and off the spooler.

14. Sludge extraction apparatus according to claim 13, wherein the spooler is co-mounted with the suction pump to form a transportable assembly.

15. Sludge extraction apparatus according to claim 1, wherein the suction head assembly runs at a working clearance in to bore while maintaining a substantial occlusion to the bore of the pipe separating the suction zone from the collection pipe upstream and downstream of the suction head assembly.

16. Sludge extraction apparatus according to claim 1, wherein the leading and trailing body portions are each of plastic construction selected from cast resin, thermoplastic moulding, and a free-machining polymer.

17. Sludge extraction apparatus according to claim 1, wherein the leading body portion is spaced from the trailing body portion by being integrally formed with interconnecting web portions.

18. Sludge extraction apparatus according to claim 1, wherein the leading body portion and the trailing body portion comprise respective leading and trailing members spaced apart and interconnected by one or more interconnecting strut members.

19. Sludge extraction apparatus according to claim 1, wherein there is provided an equalization port passing through the leading body portion and connecting the suction zone to the collection pipe ahead of the suction head assembly.

20. Sludge extraction apparatus according to claim 19, wherein the port is a substantially axial equalization port between the suction zone and the collection pipe ahead of the suction head assembly.

21. Sludge extraction method including the steps of:
   installing into the bottom of a settling pit, pond or the like a collection pipe having a plurality of openings through the wall thereof at selected spacings;
   connecting a suction pump to one end of a suction pipe;
   connecting a suction head assembly including a leading body portion spaced from and secured to a trailing body
portion to the other end of the suction pipe by an axial
bore through the trailing body portion;
inserting the suction head assembly into an open end of the
collection pipe, whereby the leading and trailing body
portions substantially occlude the collection pipe and
define a suction zone therebetween of a length selected
to open to at least one said opening at substantially all
positions along said collection pipe; and
moving said suction head assembly through the bore of
said collection pipe while operating said suction pump
to draw sequentially through said openings.

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