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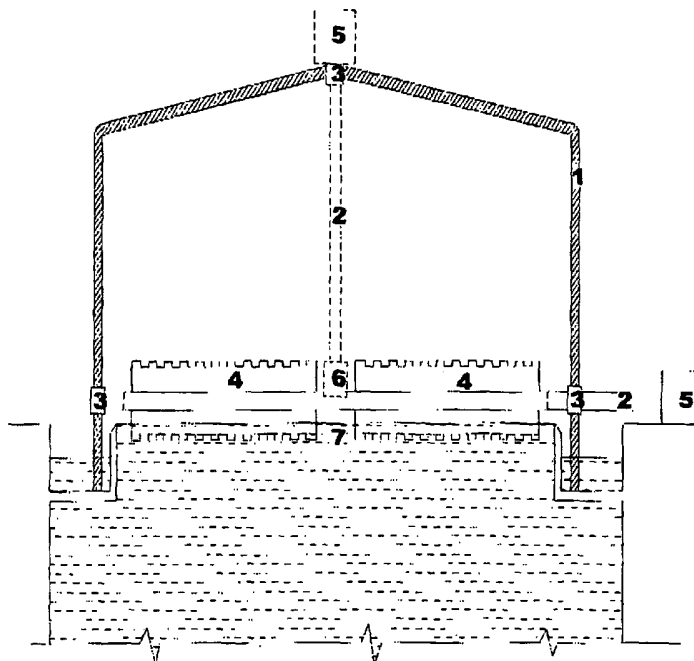
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[Continued on next page]

(54) Title: APPARATUS FOR SCUM REMOVAL



(57) Abstract: An apparatus for scum removal is disclosed wherein toothed paddle induces turbulent effect on the fluids present in the reactor by means of its rotary motion. This results in both breaking and radial displacement of the scum, accumulated on the fluid during the course of the biochemical or chemical reaction, towards the outlet of the reactor, thereby ensuring that the reaction continues in scum free environment uninterruptedly.

**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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APPARATUS FOR SCUM REMOVAL**Field of the invention**

The present invention relates to a novel apparatus for scum removal for industrial application. More particularly, the present invention relates to an apparatus for incorporating
5 in a reactor for destruction and removal of scum and foam, generated therein during the course of reactions. The apparatus of the invention has tremendous application in biochemical and chemical industries for sustaining reactions, which are otherwise likely to get slowed down or terminated due to the formation of scum in the system. It also finds potential application in wastewater treatment plants and solid waste treatment digesters.

10 Background of the Invention

Scum is essentially a frothy substance formed in reactors during the course of any biochemical or chemical reaction and is responsible for hindering the reaction rate. The reaction even gets terminated with the accumulation of scum in the reactor. This has been a serious problem of much concern for any biotechnological and chemical industry. Treatment
15 of wastewater and industrial effluent through biotechnological process has attained much focus in the present day scenario. Formation of scum during the course of waste treatment poses a major challenge to the environmental scientists too.

The performance of biochemical/biotechnological process depends mainly on the organic constituents, essentially of lipid, protein and carbohydrates present in the feed
20 material. In the case of wastes treatment, industrial and municipal solid wastes are in general mixtures of biodegradable and non-biodegradable matters and the organic matter contents in the raw feed fluctuate widely. In view of the fluctuations in the constituents of the organic matter, and variation in organic loading rates to the reactors, scum formation and foam generation are bound to take place within the digester. The scum layer formed on the surface
25 of liquid aids foaming when the gas evolution rate is high. The accumulation of foam in the gas space inside the reactors prevents the release of gas from the liquid and also the flow of gas from the reactor to the gas collection facility. The formation of scum layer and foaming leads to increase of backpressure inside the reactor and causes discharge of scum and foamy materials through the overflow arrangement of the reactor. In this situation the reactor cannot
30 be operated at the designed feed rate. The feeding can be resumed only after removal of foam and scum layer from the reactor. This has prompted research into providing options to carry out aforesaid reactions in scum free environment to ensure that reaction is not hindered.

Reference is made to Lingappa et al (US Patent 4,349,355 9, 1982), who worked on Methane generator wherein the gas collector slidably mounted in the upper portion of the

generator is provided with rods that extend downward through slotted retainer into the organic material for agitating the organic material within the liquid slurry. The characteristic feature of the system is that the scum formed on the surface is only pierced by the rods and its effect is intermittent as the rate of movement of rods again depends on the rate of gas
5 production and the rotating movement of to and fro in the slots causes piercement of scum only in the surface area covered by the slots where the rods are rotating and the remaining area is undisturbed. The major limitation associated with this arrangement is that it does not remove scum from the surface and it aids gas production only in the area where the surface is pierced and other areas the scum builds up on the surface.

10 Reference is made to Tamura Tadao (JP6210296, 08, 1994), who worked on scum removal device of purification tank, wherein scum removal device ejects pressurised water to remove the scum only from the wall surface of the overflow trough. The major limitation is that this device does not effectively remove the scum from the surface of liquid where the scum is generated in the purification tank, as the blowing pressurised water cannot cover the
15 entire liquid surface area and physically break the entire scum layer for its efficient removal along with overflow water.

Reference is made to Abe Takao et al (JP2002348948, 12, 2002), who worked on a scum removal system wherein the scum removal device removes the scum in the sewerage. The major drawback is that this system is not provided with any arrangement to break the
20 scum formed in the liquid surface or prevent the scum formation.

Reference is made to Tuomikoski Pekka (WO03045526, 06, 2003), who worked on apparatus for removal of surface scum wherein a scraper assembly pushes the surface scum or supernatant sludge in a rectangular settling tank or clarification basin. The apparatus described is designed only to scrap the scum from the surface to the discharge point. The
25 major limitation associated with this is that this apparatus operates only to push the scum formed on the surface towards the discharge point and it does not have any arrangement to prevent scum formation on the liquid surface itself where the scum layer is formed.

Reference is made to Tuomikoski Pakka (WO03095061, 11, 2003), who worked on apparatus for the removal of surface scum in a circular processing space wherein the surface
30 rake fitted with mechanical aerating device enhances the passage of floating scum to the outlet mechanism in a circular processing space such as settling tank or the like. The major drawback is that this apparatus does not break the scum or prevent formation of scum layer.

In hitherto known devices main drawbacks are inadequate components in the apparatus to prevent formation of scum layer leading to incomplete removal of scum from the

liquid surface. In hitherto known devices attempts have been made only to enhance passage of floating scum to the discharge point but not prevention of scum layer formation.

Objects of the Invention

The main object of the present invention is to provide a novel apparatus for scum removal for industrial application, which obviates the limitation as stated above.

Another object of the present invention is to eliminate building up of the foam and to eliminate the formation of scum blanket.

Still another object of the present invention is to renew the surface to aid release of gas from liquid phase.

Yet another object of present invention is to enhance the separation of gas from solid and liquid phase in the reactor.

Summary of the Invention

Accordingly, the present invention provides an apparatus for scum removal for industrial application, which comprises a toothed paddle arm (4) supported on a shaft (2) and connected to the shaft (2), provided with bearing (3), the shaft being connected to a reversible prime mover (5), the whole attachment being incorporated on liquid reactants (7) contained inside a conventional reactor (1), the drive being driven by a reversible prime mover (5) from a source (not shown in figure), and transmitted through shaft-bearing arrangement, the rotary motion horizontally to the paddle or vertically through a transmission mechanism (6), to the paddle, thereby displacing scum radially to the outlet of the reactor.

In an embodiment of the present invention, the teeth in the toothed paddle arm is positioned at a pitch of 5 – 30 cm.

In another embodiment of the present invention the prime mover is selected from an electric motor, which can rotate in clockwise and anticlockwise directions to simultaneously revolve the toothed paddle in clockwise or anticlockwise directions.

In yet another embodiment of the present invention, the transmission mechanism is selected from belt drive, rope drive, gear drive.

In still another embodiment of the present invention the angle of positioning of the shaft-bearing-prime mover with respect to the axis of the reactor is either 0° or 90°.

Brief description of accompanying drawing

Figure 1 represents a cross-section of the apparatus for scum removal. The components of Figure 1 are referenced by the following numerals:

1 refers to conventional reactor

2 refers to shaft

3 refers to bearing

4 refers to toothed paddle arm

5 refers to prime mover

6 refers to transmission mechanism

5 7 refers to liquid reactants

Detailed description of the Invention

The apparatus of the invention will now be described with reference to the accompanying drawing in Figure 1.

The apparatus of the present invention comprises of toothed paddle arm (4) supported
10 on a shaft connected to the shaft (2), provided with bearing (3). The shaft is connected to a reversible prime mover (5) and the assembly of shaft-bearing-prime mover is positioned at an angle of 0° or 90° with respect to the axis of the reactor in which it is intended to be incorporated. The whole attachment is incorporated on the liquid reactants (7) contained inside a conventional reactor (1). The drive, driven by the reversible prime mover (5) from a
15 source (not shown in the drawing), transmits through shaft-bearing arrangement the rotary motion horizontally to the paddle or vertically through a transmission mechanism (6), to the paddle, that displaces the scum radially to the outlet of the reactor.

The inventive step of the present invention lies in the incorporation of the toothed paddle, which, drawing its rotary motion from the prime mover through the shaft, induces
20 turbulent effect on the fluids present in the reactor, resulting in breaking and radial displacement of the scum, accumulated on the fluid during the course of the biochemical or chemical reaction, towards the outlet of the reactor, thereby ensuring the reaction to continue in scum free environment uninterruptedly.

The following examples are given by way of illustration only and therefore should not
25 be construed to limit the scope of the present invention.

EXAMPLE – I

A scum removal apparatus having toothed paddle of length 30 cm, width 5 cm and the teeth positioned at 30 cm pitch was fixed horizontally in a biomethanation reactor of 1.0 m diameter and 1.0 m height, which was found to produce $2 - 7 \text{ g/m}^3$ of scum layer having solid
30 content of 25 to 35 percent and specific gravity of the scum between 0.93 – 0.95.

The shaft-bearing-prime mover was positioned at an angle of 90° with respect to the axis of the reactor. The paddle was rotated at a speed of 2 rpm once in an hour continuously for a period of 2 minutes using gear drive sourced from a reversible electric motor, which rotated in clockwise and anticlockwise directions to simultaneously revolve the toothed

paddle in clockwise or anticlockwise directions. The turbulence created in the liquid contained in the reactor by the rotation of the paddle was found to break the scum and displace it radially to the outlet of the reactor. Thus the reaction in the reactor continued uninterruptedly.

- 5 The scum removal efficiency was 90% and the rate of gas release from the surface has increased by 15%. The variation observed in the gas production for an organic loading rate of 1.5 kg VS/m³.d was $\pm 1\%$.

EXAMPLE – II

- 10 A scum removal apparatus having toothed paddle of length 30 cm, width 7.5 cm and the teeth positioned at 15 cm pitch was fixed horizontally in a biomethanation reactor of 1.0 m diameter and 1.0 m height, which was found to produce 7 - 12 g/m³ of scum layer having solid content of 35 to 45 percent and specific gravity of the scum between 0.93 – 0.95.

- 15 The shaft-bearing-prime mover was positioned at an angle of 0° with respect to the axis of the reactor. The paddle was rotated at a speed of 5 rpm once in an hour continuously for a period of 3 minutes using rope drive sourced from a reversible electric motor, which rotated in clockwise and anticlockwise directions to simultaneously revolve the toothed paddle in clockwise or anticlockwise directions. The turbulence created in the liquid contained in the reactor by the rotation of the paddle was found to break the scum and displace it radially to the outlet of the reactor. Thus the reaction in the reactor continued
20 uninterruptedly.

 The scum removal efficiency was 93% and the rate of gas release from the surface has increased by 15%. The variation observed in the gas production for an organic loading rate of 2.5 kg VS/m³.d was $\pm 1\%$.

EXAMPLE – III

- 25 A scum removal apparatus having toothed paddle of length 30 cm, width 5 cm and the teeth positioned at 20 cm pitch was fixed horizontally in a biomethanation reactor of 1.0 m diameter and 1.0 m height, which was found to produce 2 – 7 g/m³ of scum layer having solid content of 25 to 35 percent and specific gravity of the scum between 0.93 – 0.95.

- 30 The shaft-bearing-prime mover was positioned at an angle of 90° with respect to the axis of the reactor. The paddle was rotated at a speed of 2 rpm once in an hour continuously for a period of 2 minutes using belt drive sourced from a reversible electric motor, which rotated in clockwise and anticlockwise directions to simultaneously revolve the toothed paddle in clockwise or anticlockwise directions. The turbulence created in the liquid contained in the reactor by the rotation of the paddle was found to break the scum and

displace it radially to the outlet of the reactor. Thus the reaction in the reactor continued uninterrupted.

The scum removal efficiency was 90% and the rate of gas release from the surface has increased by 16%. The variation observed in the gas production for an organic loading rate of 1.5 kg VS/m³.d was $\pm 1\%$.

EXAMPLE – IV

A scum removal apparatus having toothed paddle of length 30 cm, width 7.5 cm and the teeth positioned at 5 cm pitch was fixed horizontally in a biomethanation reactor of 1.0 m diameter and 1.0 m height, which was found to produce 7 - 12 g/m³ of scum layer having solid content of 35 to 45 percent and specific gravity of the scum between 0.93 – 0.95.

The shaft-bearing-prime mover was positioned at an angle of 0° with respect to the axis of the reactor. The paddle was rotated at a speed of 5 rpm once in an hour continuously for a period of 3 minutes using belt drive sourced from a reversible electric motor, which rotated in clockwise and anticlockwise directions to simultaneously revolve the toothed paddle in clockwise or anticlockwise directions. The turbulence created in the liquid contained in the reactor by the rotation of the paddle was found to break the scum and displace it radially to the outlet of the reactor. Thus the reaction in the reactor continued uninterrupted.

The scum removal efficiency was 98% and the rate of gas release from the surface has increased by 18%. The variation observed in the gas production for an organic loading rate of 2.5 kg VS/m³.d was $\pm 1\%$.

Advantages

The main advantages of the present invention are the following.

1. The apparatus of the present invention enhances the efficiency of the process being carried out in a reactor.
2. It is simple to operate, less expensive, easy to maintain and suitable for all kinds of solid/liquid wastes.
3. The installation of the scum removal system in the reactors/digesters would eliminate accumulation of foam and formation of scum blanket and aid release of gas from the liquid surface.
4. The surface renewal caused by the device would enhance the rate of release of gas from the reactor.
5. The rate of generation of gas would become consistent, which would result in more efficient utilisation of gas for energy recovery in the downstream equipment.

We claim:

1. An apparatus for scum removal for industrial application, the apparatus comprising a plurality of toothed paddle arms (4) supported on a shaft (2) and connected to the shaft (2), the shaft being provided with a bearing (3), the shaft being connected to a reversible prime mover (5), the toothed paddle arms, shaft and bearing being incorporated in a mixture of liquid and solid reactants (7) contained inside a reactor (1), the reversible prime mover (5) driving a drive from a source and transmitted through the shaft-bearing arrangement, rotary motion being transmitted horizontally to the paddle or vertically through a transmission mechanism (6), to the paddle, thereby displacing the scum radially to the outlet of the reactor.
2. An apparatus as claimed in claim 1, wherein the toothed paddle arms are provided with teeth positioned at a pitch of 5 – 30 cm.
3. An apparatus as claimed in claim 1, wherein the prime mover is an electric motor, rotatable in clockwise and anticlockwise directions to simultaneously revolve the toothed paddle in clockwise or anticlockwise directions.
4. An apparatus as claimed in claim 1, wherein the transmission mechanism is selected from the group consisting of a belt drive, rope drive and a gear drive.
5. An apparatus as claimed in claim 1, wherein the shaft-bearing-prime mover is positioned at an angle with respect to the axis of the reactor of either 0° or 90°.

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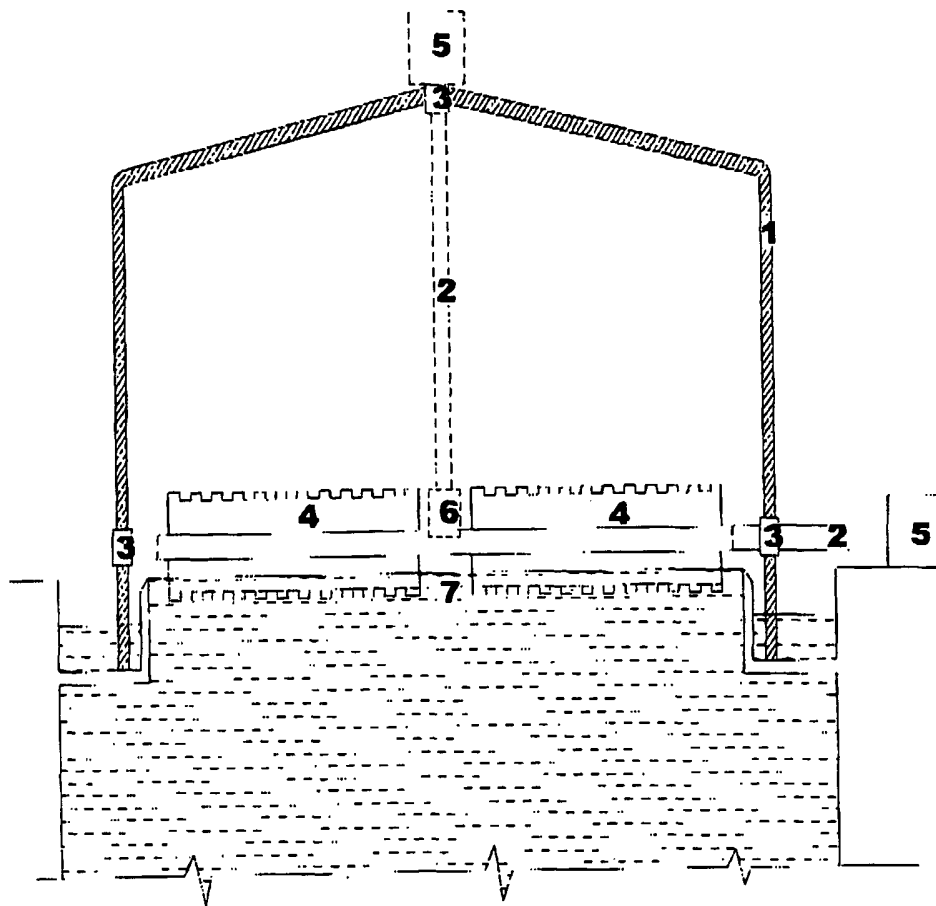


FIG 1

INTERNATIONAL SEARCH REPORT

International Application No

/IN2004/000414

A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 B01D21/06 B01D21/24

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)
IPC 7 B01D

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category *	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	DE 200 13 464 U1 (HANS HUBER AG MASCHINEN- UND ANLAGENBAU) 19 October 2000 (2000-10-19) the whole document	1
A	WO 00/43320 A (THE LENOX INSTITUTE OF WATER TECHNOLOGY, INC) 27 July 2000 (2000-07-27) figures	1-5

☐ Further documents are listed in the continuation of box C.

☒ Patent family members are listed in annex.

* Special categories of cited documents :

- *A* document defining the general state of the art which is not considered to be of particular relevance
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Patent document cited in search report		Publication date	Patent family member(s)	Publication date
DE 20013464	U1	19-10-2000	NONE	
WO 0043320	A	27-07-2000	AU 3212000 A	07-08-2000