

(12) INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
22 February 2001 (22.02.2001)

PCT

(10) International Publication Number
WO 01/12307 A1

(51) International Patent Classification⁷: **B01F 3/04**,
5/10, C02F 11/06 [FI/FI]; Rauhanpuisto 6, FIN-28120 Pori (FI). **ÖINONEN**,
Yrjö [FI/FI]; Pyynkuja 6, FIN-67800 Kokkola (FI).

(21) International Application Number: PCT/FI00/00681

(22) International Filing Date: 10 August 2000 (10.08.2000)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
19991719 12 August 1999 (12.08.1999) FI

(71) Applicant (for all designated States except US): **OUTOKUMPU OYJ** [FI/FI]; Riihitontuntie 7, FIN-02200 Espoo (FI).

(72) Inventors; and

(75) Inventors/Applicants (for US only): **TAKALA, Heikki**

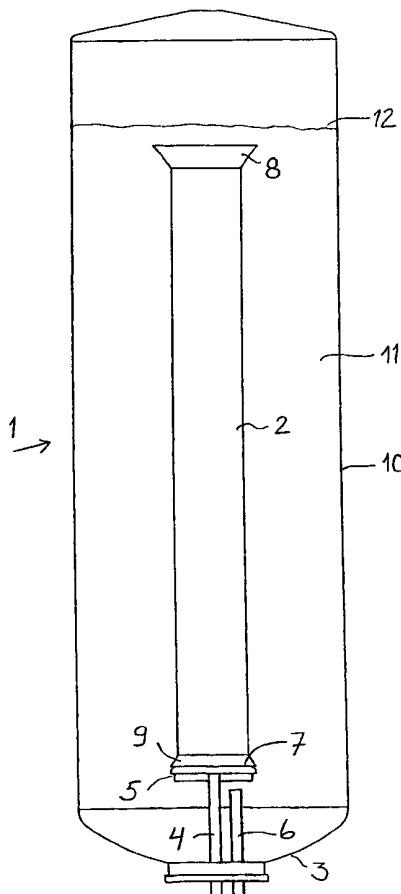
(74) Agent: **OUTOKUMPU OYJ**; Intellectual Property Management, P.O. Box 27, FIN-02201 Espoo (FI).

(81) Designated States (national): AE, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BY, CA, CH, CN, CR, CU, CZ, DE, DK, DM, EE, ES, FI, GB, GD, GE, GH, GM, HR, HU, ID, IL, IN, IS, JP, KE, KG, KP, KR, KZ, LC, LK, LR, LS, LT, LU, LV, MA, MD, MG, MK, MN, MW, MX, NO, NZ, PL, PT, RO, RU, SD, SE, SG, SI, SK, SL, TJ, TM, TR, TT, TZ, UA, UG, US, UZ, VN, YU, ZA, ZW.

(84) Designated States (regional): Eurasian patent (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM), European patent (AT, BE, CH, CY, DE, DK, ES, FI, FR, GB, GR, IE, IT, LU, MC, NL, PT, SE).

[Continued on next page]

(54) Title: METHOD FOR THE LEACHING OF SOLID MATTER FROM SLUDGE



(57) Abstract: The invention relates to a method for the leaching of solid matter from a sludge with the aid of a gas containing oxygen, whereby the solid matter of the sludge is recirculated in a tall reactor equipped with a central pipe in the centre of the reactor and a double-action mixer located in the vicinity of the lower edge of the central pipe. A flow is formed with the aid of the mixer which sucks the sludge from the central pipe downward, and a gas to be conducted into the sludge in the bottom part of the reactor is dispersed in the form of small bubbles into the sludge outside the central pipe and the flow direction of the sludge is turned upwards in the outer casing of the reactor.

WO 01/12307 A1



Published:

— *With international search report.*

For two-letter codes and other abbreviations, refer to the "Guidance Notes on Codes and Abbreviations" appearing at the beginning of each regular issue of the PCT Gazette.

METHOD FOR THE LEACHING OF SOLID MATTER FROM SLUDGE

The present invention relates to a method for the leaching of solid matter from a sludge with the aid of a gas containing oxygen, whereby the solid matter of the sludge is recirculated in a tall reactor equipped with a central pipe in the centre of the reactor and a double-action mixer located in the vicinity of the lower edge of the central pipe. A flow is formed with the aid of the mixer which sucks the sludge from the central pipe downward, and a gas to be conducted into the sludge in the bottom part of the reactor is dispersed 5 in the form of small bubbles into the sludge outside the central pipe and the flow direction of the sludge is turned upwards in the outer casing of the reactor.

In leaching of a sludge containing solid matter, such as for example metal 15 concentrate, it is important that the participatory oxygen in the leaching, being introduced in the form of oxygen or gas containing oxygen, must firstly dissolve into the solid-containing sludge, in order that the oxygen can participate in the leaching reactions of the solid matter. A tall reactor is used 20 for the improvement of the dissolution of the oxygen, whereupon, as compared to normal atmospheric reactors, great hydrostatic pressure forms at the bottom of the reactor (1.5 - 3.0 atm, i.e. 0.15 - 0.30 MPa), due to which the oxygen dissolves well in the reaction solution and thereby catalyses the dissolution of the solid matter.

25 In the prior art it is known for example US Pat. No. 4,648,973, wherein the equipment concerns a reactor with a height many times greater than its diameter, inside which is located a concentric pipe. The sludge is fed into the upper part of the central pipe, as is the oxygen. For recirculation of the sludge, the central pipe is equipped with a mixer suspended from the top 30 downwards, which pumps the sludge down the central pipe and the sludge then passes up through the space between the reactor and the internal pipe.

The ratio between the diameters of the central pipe and outer pipe is between 0.4 and 0.85.

Now, the developed invention relates to a method for leaching of solid matter from a sludge, such as metal concentrate with the aid of oxygen-containing gas whereby the sludge is recirculated in a tall reactor. The height of the reactor is many times greater than its diameter and the reactor is equipped with a concentric central pipe extending to the bottom part, a mixer being located in the vicinity of the lower part of the central pipe and a feeding member for gas containing oxygen. The shaft of the mixer extends upwards from the bottom of the reactor. A sludge flow turning downwards is achieved with the aid of the mixer. The gas containing oxygen to be fed underneath the mixer is dispersed into the sludge in the form of small bubbles and at the same time the flow direction of the sludge is turned in the bottom part of the reactor to ascend upwards. Reactions between the solid matter-containing sludge and the oxygen-containing gas happen mainly either in the bottom part of the reactor or in a casing part between the reactor walls and the central pipe. The essential features of the present invention are laid out in the enclosed claims.

20

As mentioned above, it is essential to the method that the mixer is located in the immediate vicinity of the lower edge of the central pipe, whereby the cross-section area of the discharge orifice remaining between the central pipe and the mixer is less than half the cross-section area of the central pipe, preferably at most one third of the cross-section area of the pipe. Thus the flow rate, from the central pipe, of the downward-flowing sludge increases at least twofold in comparison to the flow rate taking place in the central pipe. The nearer the mixer is located to the lower edge of the pipe, the better the suction building up to the central pipe. In practice the limit is set by the tolerances, which result from the wearing of the shaft and from the flexibility and dimensioning of the other parts. At the aforementioned

cross-sectional area ratio, such a flow rate is achieved that the downward-directed solution flow is faster than the ascending rate of the gas bubbles, and the upward flow rate of the solution in the annular casing of the reactor is greater than the settling rate of the particles of the solid matter.

5

The mixer used in the method according to the invention is of double-action, it is formed of two parts having an essentially horizontal plate between them. Curved blades are fixed above the horizontal plate which suck sludge downward in the central pipe. The blades fixed underneath the horizontal 10 plate form a straight-bladed turbine mixer. As the gas containing oxygen is fed underneath the mixer installed in the bottom part of the reactor, the lower part of the mixer disperses the feed gas into very small bubbles, thus assisting the dissolution of the gas into the sludge. As the gas is fed into the sludge at the bottom part of the reactor, the gas bubbles moving with the 15 sludge flow have as long a residence and reaction time in the sludge as possible, before they reach the surface or descend with the flow to be recirculated through the central pipe or are discharged through outlet means in the upper part of the reactor.

20 The equipment for carrying out the method according to the invention is explained in more detail with the aid of the enclosed figures, wherein figure 1 shows a vertical section of the reactor, in figure 2 a vertical section of the reactor is shown at the point of the central pipe and mixer, and

25 figure 3 shows a three-dimensional picture of the reactor mixer.

For the leaching of sludge containing solid matter, figure 1 shows a tubular reactor 1, equipped with a concentric central pipe 2, which extends to the bottom part of the reactor. The distance of the central pipe from the reactor 30 bottom is at range between 0.2 - 1.0 times the reactor diameter preferably between 0.3 - 0.5. The surface area ratio between the central pipe and the

casing of the reactor surrounding it is below 0.1. Upward from a reactor bottom 3 is a mixer 5 supported by its shaft 4, and a feed member 6 for gas containing oxygen. As the inlet of the mixer shaft is in the lower part of the reactor, the shaft can be made to be as short and as sturdy as is possible.

5

The mixer is concentric with the pipe 2 and is located in very close proximity to a lower edge 7 of the central pipe. As seen in the figure, the central pipe 2 can be equipped at the upper and lower ends with conical extensions 8 and 9. According to the figure the mixer can also be placed partly inside the 10 central pipe. The annular space between reactor walls 10 and central pipe 2 can be designated as a casing 11. When necessary the lower part of the central pipe can be equipped with baffles (not illustrated). The sludge feed to the reactor can be fed in a conventional manner for example to the central pipe and the solution can be removed for example as overflow or the sludge 15 can be preferable fed and discharged via its own means under a sludge surface 12. The inlet and outlet means are not illustrated in more detail in the figure.

As can be seen from figures 2 and 3, the mixer 5 comprises the mixer shaft 20 4, to which is fixed a horizontal plate 13, below which are attached straight lower blades 14 and above which are attached curved upper blades 15. The horizontal plate of the mixer impedes the flow of sludge from above the mixer to below it and vice versa. The horizontal plate can be circular or angular. Both the lower blades 14 and upper blades 15 are fixed to the 25 horizontal plate 13 of the mixer in an essentially vertical manner. The lower blades are nearly rectangular and their task is to disperse the oxygen gas fed underneath the mixer as well as possible into the sludge and to bring about a vertically rotating flow at the bottom of the reactor, thereby preventing the solid matter contained in the sludge from settling to the 30 bottom of the reactor. A well-mixed area, of a height about the same as the diameter of the reactor, thus forms at the bottom part of the reactor.

The lower parts of the upper blades are preferably of rectangular form, but the upper part smoothly tapered. The curved upper blades bring about the downward flow in the central pipe and the lower blades the upward return

5 flow to the casing 11 of the reactor, in other words between walls 10 and central pipe 2. In figure 2 it can also be seen that in this case the mixer is installed at such a height that upper blades 15 partly extend into the inside of the central pipe.

10 The benefits gained from the method according to the present invention can be listed among the following facts: An efficient mixing is performed to the sludge only in the lower part of the reactor where the oxygen-containing gas is also fed, and so both the mixing energy which promotes dissolution of the solid matter of the sludge and the energy which is needed for recirculation

15 are brought to the sludge at the same time and then the total energy needed is lower than conventionally. In the method, there is formed firstly a downward sucking flow to the central pipe and secondly a flow which turns the sludge flow from the bottom part of the reactor upwards and at the same time mixes the oxygen-containing gas to the sludge and prevents the

20 particles of the solid matter to settle.

CLAIMS

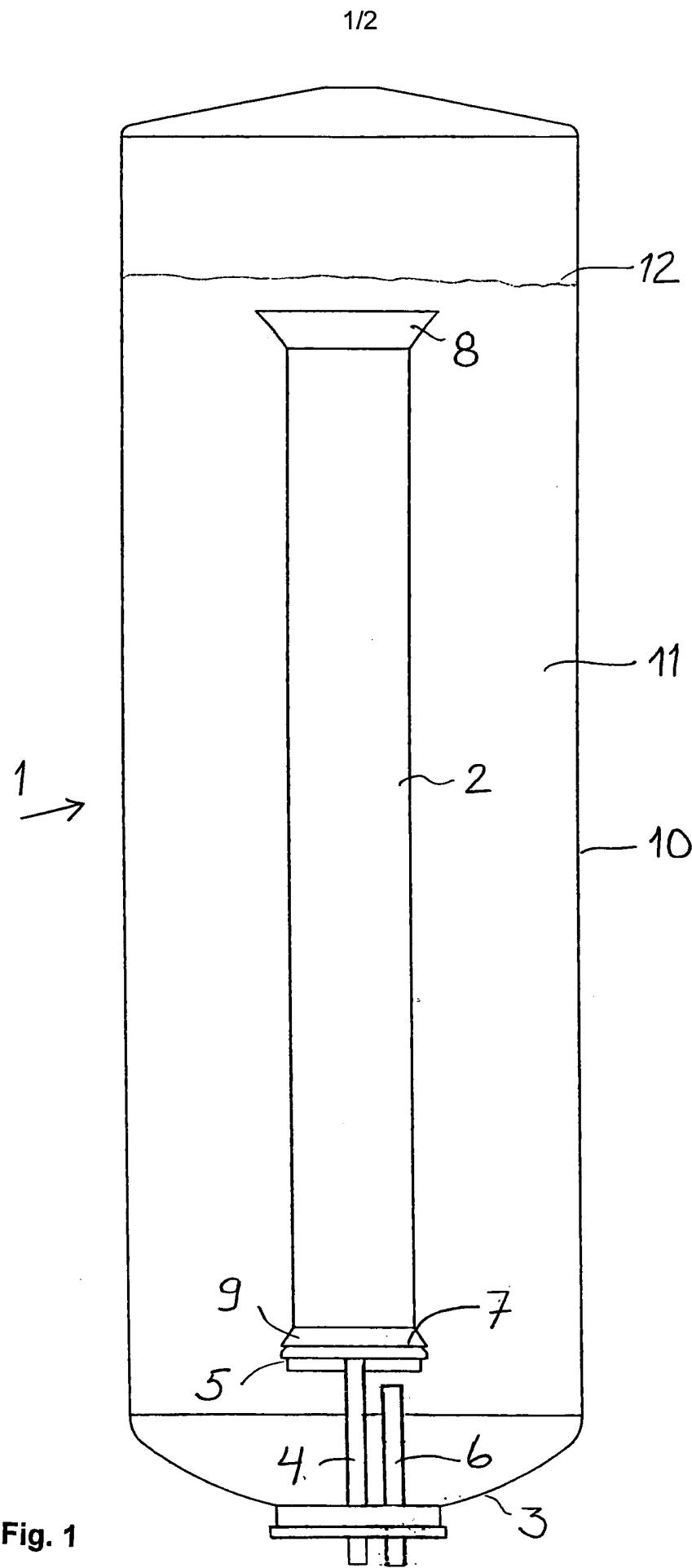
1. A method for leaching of solid matter from a sludge aided by a gas containing oxygen, whereby the leaching takes place in a tubular reactor, 5 with a height many times greater than its diameter and which is equipped with a concentric central pipe and a mixer, **characterized** in that a downward directed sludge flow is formed in the central pipe with the aid of the mixer which is located upward from the bottom of the reactor in the immediate vicinity of the lower edge of the central pipe, the the direction of 10 sludge flow is turned outside the central pipe in the bottom part of the reactor to an upward flow at the same time as an oxygen-containing gas is fed into the sludge and is dispersed to small bubbles.
2. A method according to claim 1, **characterized** in that the flow rate of the 15 sludge discharging from the central pipe is increased at least twofold in comparison to the flow rate of the sludge inside the central pipe.
3. A method according to claim 1, **characterized** in that the cross-section area remaining between the mixer and the central pipe is adjusted to be less 20 than half, preferably at most one third of the cross-section area in the central pipe.
4. A method according to claim 1, **characterized** in that the flow rate of the sludge descending in the central pipe is faster than the ascending rate of the 25 gas bubbles dissolved in the the sludge.
5. A method according to claim 1, **characterized** in that the flow rate of the sludge ascending in a casing of the reactor is greater than the settling rate of the particles of the solid matter.

6. A method according to claim 1, **characterized** in that sucking of the sludge downward in the central pipe is performed by the aid of the double-action mixer situated in the immediate vicinity of the central tube whereby upper curved blades of the mixer bring about the downward 5 sucking flow.

7. A method according to claim 1, **characterized** in that dispersing of the oxygen-containing gas in to the sludge and turning of the sludge flow upwards is achieved by the aid of lower, nearly rectangular and straight 10 blades of the mixer.

8. A method according to claim 1, **characterized** in that the lower edge of the central pipe is at a height from the reactor bottom, which is 0.7 - 1.3 times that of the diameter of the reactor, preferably the same as the 15 diameter.

9. A method according to claim 1, characterized in that the cross-section ratio of the central pipe and its surrounding reactor casing is under 0.1.



2/2

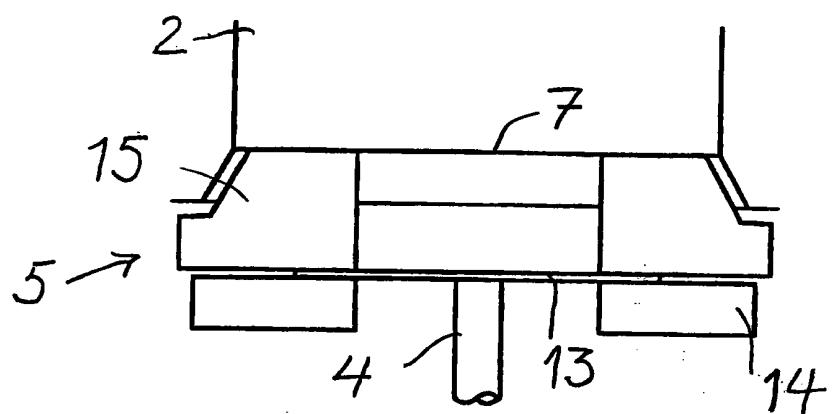


Fig. 2

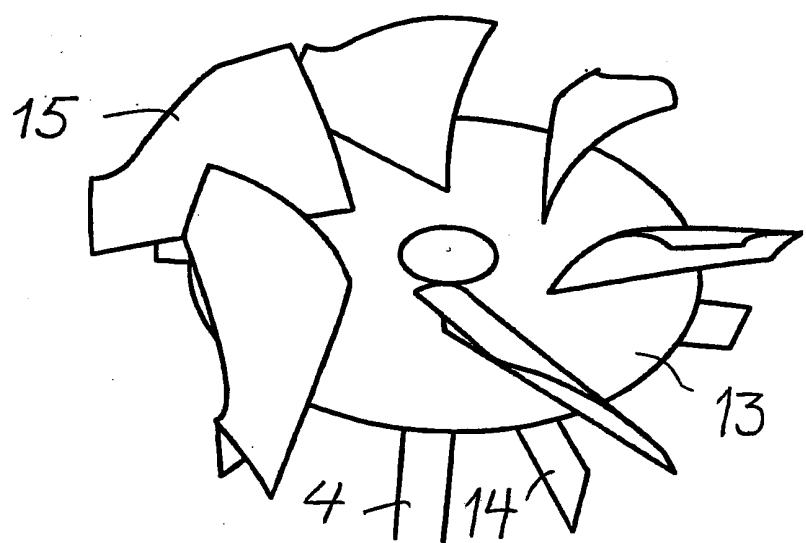


Fig. 3

INTERNATIONAL SEARCH REPORT

International application No.

PCT/FI 00/00681

A. CLASSIFICATION OF SUBJECT MATTER

IPC7: B01F 3/04, B01F 5/10, C02F 11/06

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)

IPC7: B01F, C02F

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

SE,DK,FI,NO classes as above

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

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	US 4832848 A (GERHARD VELEBIL ET AL), 23 May 1989 (23.05.89), column 5, line 40 - column 6, line 14, figure 1 -- -----	1

 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	"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
"E"	earlier application or patent but published on or after the international filing date	"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
"I"	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)	"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
"O"	document referring to an oral disclosure, use, exhibition or other means	"&"	document member of the same patent family
"P"	document published prior to the international filing date but later than the priority date claimed		

Date of the actual completion of the international search

1 November 2000

Date of mailing of the international search report

03-11-2000

Name and mailing address of the ISA/
Swedish Patent Office
Box 5055, S-102 42 STOCKHOLM
Facsimile No. +46 8 666 02 86Authorized officer
Wiva Asplund/ELY
Telephone No. +46 8 782 25 00

INTERNATIONAL SEARCH REPORT

Information on patent family members

03/10/00

International application No.

PCT/FI 00/00681

US	4832848	A	23/05/89	AT	69970	T	15/12/91
				CA	1303260	A	09/06/92
				DE	3626231	A,C	03/03/88
				DE	3774955	A	16/01/92
				DK	401487	A	03/02/88
				EP	0255642	A,B	10/02/88
				SE	0255642	T3	
				ES	2028001	T	01/07/92
				JP	63119839	A	24/05/88
