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

(19) World Intellectual Property Organization
International Bureau

(43) International Publication Date
16 December 2004 (16.12.2004)

PCT

(10) International Publication Number
WO 2004/109240 A2

(51) International Patent Classification[7]: G01F 1/76

(21) International Application Number:
PCT/IB2004/050847

(22) International Filing Date: 7 June 2004 (07.06.2004)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
2003/3444 6 June 2003 (06.06.2003) ZA

(71) Applicant *(for all designated States except US)*: **ANGLO AMERICAN PLATINUM CORPORATION LIMITED** [ZA/ZA]; 55 Marshall Street, 2001 Johannesburg (ZA).

(72) Inventors; and

(75) Inventors/Applicants *(for US only)*: **VAN SCHALKWYK, Theo Cornelius** [ZA/ZA]; 1 Moorhen Avenue, 15 Blue Crane Estate, 0299 Rustenburg (ZA). **LEIGHTON, Roger Gordon** [ZA/ZA]; 16 Springbok Street, Rant-En-Dal, 1739 Krugersdorp (ZA). **TURNER, Stuart** [ZA/ZA]; 20 P.A. Du Plessis Street, Norkem Park, 1618 Kempton Park (ZA). **BELL, Michael Sean** [ZA/ZA]; 2 Jupiter Drive, Dowerglen, 1609 Edenvale (ZA).

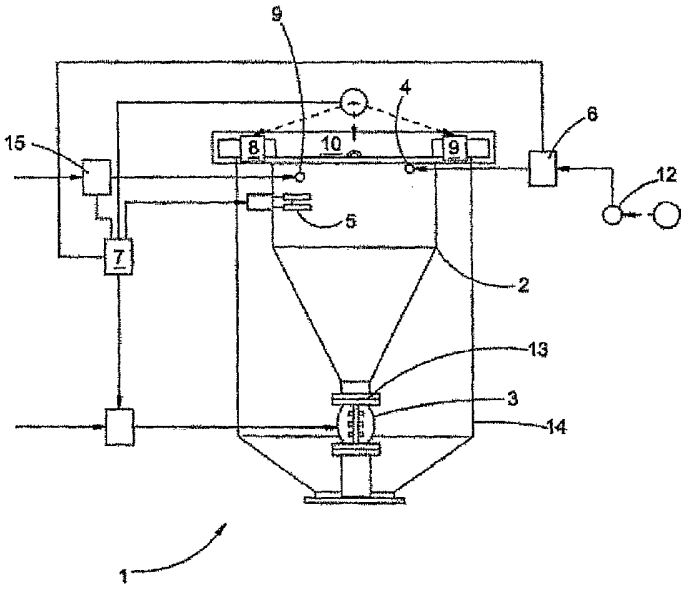
(74) Agent: **D M KISCH INC**; P O Box 781218, 2146 SANDTON (ZA).

(81) Designated States *(unless otherwise indicated, for every kind of national protection available)*: AE, AG, AL, AM, AT, AU, AZ, BA, BB, BG, BR, BW, BY, BZ, CA, CH, CN, CO, CR, CU, CZ, DE, DK, DM, DZ, EC, EE, EG, 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, MZ, NA, NI, NO, NZ, OM, PG, PH, PL, PT, RO, RU, SC, SD, SE, SG, SK, SL, SY, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, YU, ZA, ZM, ZW.

(84) Designated States *(unless otherwise indicated, for every kind of regional protection available)*: ARIPO (BW, GH, GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),

[Continued on next page]

(54) Title: MASS FLOW METERING SYSTEMS



(57) Abstract: A mass flow metering system 1 according to the invention comprises a metered vessel 2 for receiving a flow of froth via a conduit 11. The metered vessel 2 is suspended from mass measuring means In the form of load cells 8, 9 and 10 within a second outer vessel 14. The metered vessel 2 has discharge opening 13 for discharging the froth from the vessel, and a discharge control valve 3 associated with the opening for controlling the discharge of froth from the metered vessel. The metered vessel 2 has a level sensor 5, located in the metered vessel at a predetermined level and associated with the valve 3 for opening the valve when the predetermined froth level is reached. In use, the system operates periodically and in cycles, which alternates between a measuring cycle and a cleaning cycle. There is further provided a method of measuring the mass flow of continuous flowing slurry in line.

WO 2004/109240 A2

European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HU, IE, IT, LU, MC, NL, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:

— *without international search report and to be republished upon receipt of that 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.

MASS FLOW METERING SYSTEM

TECHICAL FIELD

This invention relates to a mass flow metering system for measuring the mass flow of fluids and to a method of measuring such the mass flow. Particularly but not exclusively, the invention relates to a system and a method for periodically measuring the mass flow of continuously flowing slurries, such as mineral laden froth.

BACKGROUND ART

The use of flow meters and samplers in chemical and metallurgical processes is well known, with the difficulty of representative and accurate samples and measurements being exacerbated by heterogeneous, dynamic and non-steady state flows, such as in slurries.

The above difficulty is particularly prevalent in unstable slurries such as froth, where the physical characteristics of the liquid medium are materially influenced by the characteristics of the froth bubbles.

The volumetric flow of froth, such as that produced in a flotation process, can be determined to some degree of accuracy by methods known in the art. However, as a result of the significant influence of aspects such as the physical characteristics and mineralogy of the solids constituent in the slurry as well as the bubble characteristics of the froth, on the mineral loading of the froth over time, volumetric flow often provides inaccurate calculations of the mass flow of the froth. It also is problematic to sample froth representatively and repetitively, particularly due to the continuously varying density of the froth. The difficulty with and inaccuracy of sampling and measuring the weight of a froth sample is often inversely proportionate to the size of the sampler used, making the measuring of the mass of bulk froth over time impractical.

An additional difficulty of measuring the mass flow of froth repeatedly is that the solid particles tend to deposit on the walls of the sampler, causing fouling and contamination of the sampler and subsequent samples.

Bulk mass flow meters are known in the art. EP O 657022 discloses a mass flow meter suitable for measuring the mass flow of milk. An outer conduit, which is suspended within a housing by a force transducer system, in the form of a load cell, is disclosed. The mass of the conduit is continuously recorded and the density of its content is calculated. From the density and volume flow, the mass flow can be calculated. This type of mass flow meter is effective in measuring the mass flow of liquids of varying density such as milk, but does not overcome the difficulties associated with heterogeneous and multi-phase fluids such as slurries, particularly froth.

Methods of measuring bulk mass flows are also known in the art. US4726896 discloses a method of measuring the mass flow of a slurry. A micro motion meter is used to measure the flow rate and density. However, this method does not overcome the difficulties associated with bulk froth flow from multiple flotation cells on a commercial scale such as in a large metallurgical operation.

It is therefore an object of this invention to provide a mass flow metering system, suitable for measuring the mass flow of froth produced in a large-scale metallurgical operation, and to provide a method for measuring the mass flow of froth that will overcome at least some of the above difficulties.

DISCLOSURE OF THE INVENTION

According to a first aspect of the invention there is provided an in-line mass flow metering system comprising:

a volumetrically metered vessel, configured and dimensioned to receive a metered volume of at least a substantial fraction of a continuous slurry flow;

time measuring means for measuring the time for filling the metered volume with slurry;

mass measuring means for measuring the mass of the metered volume of slurry in the metered vessel;

a discharge valve, to discharge slurry from the metered vessel; and

valve control means for controlling the discharge of slurry from the metered vessel.

The system may include a metered fluid addition facility to facilitate the dispersion of froth in the metered vessel. Preferably, the mass flow meter also includes a rinse fluid facility to facilitate the rinsing of the metered vessel after slurry discharge.

The metered vessel may be provided with an overflow to facilitate continuous slurry flow in the event of electric or mechanical failure of the valve.

The overflow is preferably provided by a second, outer vessel, configured and dimensioned to receive the metered vessel operationally therein.

The metered vessel may be suspended on load cells to provide the mass measuring means for measuring the mass of the metered volume of slurry within the metered vessel.

The metered vessel may be provided with a level sensor, located at a pre-determined level within the metered vessel in accordance with the pre-determined metered volume and to ensure a repeatably, volumetrically constant mass measurement.

The system may be provided with processing means for calculating the mass flow on a semi-continuous basis to provide real time information on the mass

flow of the slurry. The processing means may include a Process Logic Controller ("PLC") or other dedicated electronic device.

The fluid may comprise water, and the water may contain a reagent, such as a surfactant, for accelerating the rate at which the bubbles of the froth are dispersed so as to form stable slurry.

The level sensor may be in communication with the PLC for opening and closing the valve. The level sensor may be a vibrating fork-type sensor.

The valve control means may be in communication with the valve as well as the load cells and the level sensor. The valve control means may be provided by the PLC.

The time measuring means may be in communication with the level sensor and the valve.

The load cells preferably are of the bending beam-type load cells.

The valve is preferably a dart or pinch valve.

According to a second aspect of the invention there is provided a method of measuring the mass flow of a continuous flowing slurry in-line, the method including the steps of:

periodically filling a metered volume with at least a substantial fraction of a continuous slurry flow;

measuring the time for filling each metered volume with the slurry;

measuring the mass of each metered volume of slurry; and

discharging each metered volume of slurry into the slurry flow.

The method may include the step of adding a metered volume of fluid to the slurry sample during filling to facilitate the dispersion of froth in the metered vessel.

The method further may include the step of adding rinse fluid for rinsing the metered vessel after slurry discharge.

BRIEF DESCRIPTION OF THE DRAWING

The invention is described below by way of example only and with reference to the accompanying drawing, which shows the mass flow meter.

BEST METHOD OF CARRYING OUT THE INVENTION

With reference to Figure 1, a mass flow meter is generally indicated by reference numeral 1.

The mass flow metering system 1 comprises a metered vessel 2 for receiving a flow of froth via a conduit 11. The metered vessel 2 is suspended from mass measuring means in the form of load cells 8, 9 and 10 within a second outer vessel 14. The metered vessel 2 has discharge opening 13 for discharging the froth from the vessel, and a discharge control valve 3 associated with the opening for controlling the discharge of froth from the metered vessel.

The metered vessel 2 has a level sensor 5, located in the metered vessel at a predetermined level and associated with the valve 3 for opening the valve when the predetermined froth level is reached.

In use, the system operates periodically and in cycles, which alternates between a measuring cycle and a cleaning cycle.

The cycles are as follows:

<u>The Measuring Cycle</u>

Pinch valve 3 of container 2 is closed. Froth from a flotation process in a minerals beneficiation operation is delivered through conduit 11, into container

2. Spray water valve 6 is opened and spray water is concurrently sprayed into container 2, through a spray nozzle 4, thereby to reduce the froth to a liquid mixture.

A flow meter 12 measures the flow of spray water to container 2. The liquid mixture accumulates within container 2, until the level in the container reaches the level at which a fork type level sensor 5 is located. The level sensor 5 is located at a predetermined level in the container, such that the volume defined up to the sensor is known. Level sensor 5, load cells 8, 9 and 10 are in communication with PLC 7.

When the fluid level in container 2 reaches sensor 5, the weight of the liquid in the container, the time consumed to fill container and the volume of spray water added is recorded by the PLC. The PLC now calculates the mass flow of froth by means of a mass balance calculation.

The Cleaning Cycle

After recordal of the data, pinch valve 3 is open and liquid is dispensed from container 2. Spray water valve 6 is closed and cleaning water valve 15 is open. The mass flow meter is operated on the cleaning cycle for 20 minutes, after which time it is reverted back to the measuring cycle.

Opening and closing of the valves is affected by means of solenoid actuators. Spray water nozzle 4 and cleaning water nozzle 9 is in fluid communication with a source of water under 4 Bar pressure. Pinch valve 3 is in fluid communication with a source of air under a pressure of 4 Bar, for pressure closing of the valve.

A constant flow of froth is received into container 2, via conduit 11, both when the mass flow meter is in both the measuring and cleaning cycle. This allows for uninterrupted operation of the floatation process and for continuous measurement of the mass flow of froth. The mass flow meter continuously alternates between the measuring and the cleaning cycle.

It will be appreciated that many variations in detail are possible without departing from the scope and/or spirit of the inventions as defined in the consistory clauses herein before.

CLAIMS:

1. An in-line mass flow metering system comprising
a volumetrically metered vessel, configured and dimensioned to receive a metered volume of at least a substantial fraction of a continuous slurry flow;
time measuring means for measuring the time for filling the metered volume with slurry;
mass measuring means for measuring the mass of the metered volume of slurry in the metered vessel;
a discharge valve, to discharge slurry from the metered vessel; and
valve control means for controlling the discharge of slurry from the metered vessel.

2. A mass flow metering system according to claim 1 including a metered fluid addition facility to facilitate the dispersion of fluid in the metered vessel.

3. A mass flow metering system according to claim 2, wherein the fluid dispersed is froth.

4. A mass flow metering system according to claim 1, 2 or 3, wherein the mass flow meter also includes a rinse fluid facility to facilitate the rinsing of the metered vessel after slurry discharge.

5. A mass flow metering system according to any of claims 1 to 4, wherein the metered vessel is provided with an overflow to facilitate continuous slurry flow in the event of electric or mechanical failure of the valve.

6. A mass flow metering system according to any of claims 1 to 5, wherein the overflow is preferably provided by a second outer vessel, configured and dimensioned to receive the metered vessel operationally therein.

7. A mass flow metering system according to any of claims 1 to 6, wherein the metered vessel is suspended on load cells to provide the mass measuring means for measuring the mass of the metered volume of slurry within the metered vessel.

8. A mass flow metering system according to any of claims 1 to 7, wherein the metered vessel is provided with a level sensor.

9. A mass flow metering system according to claim 8, wherein the level sensor is located at a pre-determined level within the metered vessel in accordance with the pre-determined metered volume to ensure a repeatably, volumetrically constant mass measurement.

10. A mass flow metering system according to any of claims 1 to 9, wherein the system is provided with processing means for calculating the mass flow.

11. A mass flow metering system according to claim 10, wherein the processing means calculates the mass flow on a semi-continuous basis to provide real time information on the mass flow of the slurry.

12. A mass flow metering system according to claim 10 or 11, wherein the processing means includes a Process Logic Controller.

13. A mass flow metering system according to claim 2, wherein the fluid comprises water.

14. A mass flow metering system according to claim 13, wherein the water contains a reagent.

15. A mass flow metering system according to claim 14, wherein the reagent is a surfactant, for accelerating the rate at which the bubbles of the froth are dispersed so as to form stable slurry.

16. A mass flow metering system according to claim 12, wherein the level sensor is in communication with the PLC for opening and closing the valve.

17. A mass flow metering system according to any of claims 8 to 16, wherein the level sensor is a vibrating fork-type sensor.

18. A mass flow metering system according to any of claims 8 to 17, wherein the valve control means is in communication with the valve, the load cells and the level sensor.

19. A mass flow metering system according to any of claims 12 to 18, wherein the valve control means is provided by the PLC.

20. A mass flow metering system according to any of claims 8 to 19, wherein the time measuring means may be in communication with the level sensor and the valve.

21. A mass flow metering system according to any of claims 7 to 20, wherein the load cells are of the bending beam-type load cells.

22. A mass flow metering system according to any of claims 1 to 21, wherein the valve is a pinch valve.

23. A mass flow metering system according to any of claims 1 to 21, wherein the valve is a dart valve.

24. A method of measuring the mass flow of continuous flowing slurry in-line, the method including the steps of

periodically filling a metered volume with at least a substantial fraction of a continuous slurry flow;

measuring the time for filling each metered volume with the slurry;

measuring the mass of each metered volume of slurry; and

discharging each metered volume of slurry into the slurry flow.

25. A method of measuring the mass flow of continuous flowing slurry in-line according to claim 23, further including the step of adding a metered volume of fluid to the slurry sample during filling to facilitate the dispersion of froth in the metered vessel.

26. A method of measuring the mass flow of continuous flowing slurry in-line according to claim 23 or 24, further including the step of adding rinse fluid for rinsing the metered vessel after slurry discharge.

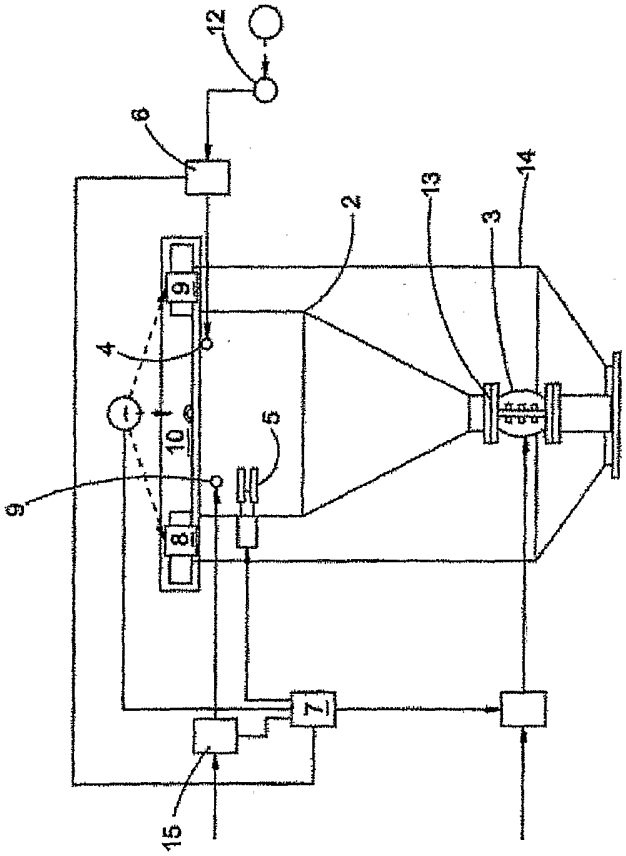


FIGURE 1