(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) **EP 3 424 600 B1**

(12) **EUROPEAN PATENT SPECIFICATION**

(45) Date of publication and mention of the grant of the patent:
14.08.2024 Bulletin 2024/33

(21) Application number: **17891394.3**

(22) Date of filing: **22.02.2017**

(51) International Patent Classification (IPC):
B03C 1/32 *(2006.01)* ***B03C 1/14*** *(2006.01)*
B03C 1/30 *(2006.01)* ***B03C 1/01*** *(2006.01)*
B03D 1/02 *(2006.01)* ***B03D 1/14*** *(2006.01)*
B03D 1/24 *(2006.01)*

(52) Cooperative Patent Classification (CPC):
B03C 1/14; B03C 1/01; B03C 1/30; B03D 1/023; B03D 1/1462; B03D 1/24; B03C 2201/18; B03C 2201/26

(86) International application number:
PCT/CN2017/074332

(87) International publication number:
WO 2018/129789 (19.07.2018 Gazette 2018/29)

(54) **WHOLE-PROCESS CONTINUOUS GAS-ASSISTED MAGNETIC SEPARATION SYSTEM**

SYSTEM ZUR KONTINUIERLICHEN GASUNTERSTÜTZTEN MAGNETISCHEN GESAMTPROZESSTRENNUNG

SYSTÈME DE SÉPARATION MAGNÉTIQUE CONTINU ASSISTÉ PAR GAZ POUR PROCÉDÉ ENTIER

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO PL PT RO RS SE SI SK SM TR

(30) Priority: **11.01.2017 CN 201710024548**

(43) Date of publication of application:
09.01.2019 Bulletin 2019/02

(73) Proprietor: **Institute of Process Engineering, Chinese Academy of Sciences**
Beijing 100190 (CN)

(72) Inventors:
- **YANG, Liangrong**
  Beijing 100190 (CN)
- **DONG, Tingting**
  Beijing 100190 (CN)
- **XING, Huifang**
  Beijing 100190 (CN)
- **YU, Jiemiao**
  Beijing 100190 (CN)
- **RONG, Meng**
  Beijing 100190 (CN)
- **LIU, Huizhou**
  Beijing 100190 (CN)

(74) Representative: **Prinz & Partner mbB**
Patent- und Rechtsanwälte
Rundfunkplatz 2
80335 München (DE)

(56) References cited:
EP-A1- 2 676 733
WO-A1-99/32229
CN-A- 101 164 700
CN-A- 101 164 700
CN-A- 102 500 460
CN-A- 105 301 265
CN-U- 204 017 444
JP-A- 2005 074 371

EP 3 424 600 B1

Description

Technical field

[0001] The present disclosure relates to the technical field of magnetic separation processing equipment, in particular to a whole process continuous gas-assisted magnetic separation system according to the preamble of claim 1.

Background

[0002] The magnetic carrier separation technology is a novel separation technology that includes the steps of adsorbing target components by affinity ligands, hydrophobic groups, ion exchange groups and the like coupled to the surface of magnetic carriers, separating out the magnetic carriers loaded with the targets by use of a suitable magnetic separation device, and washing and eluting the magnetic carriers to directly and quickly separate the targets. Magnetic carrier separation technology has been developed since the 1970s and has achieved great development. Since this technology has the advantages of quick and simple separation, high selectivity, rapid separation and capability of being used directly to the separation of complex systems, etc., it has been proposed and widely studied for application to the fields such as immunoassay, cell labeling and separation, nucleic acid isolation, protein purification, wastewater treatment, natural product separation, and the like.

[0003] For instance, CN 101 164 700 A discloses a combined adsorption tank and extraction column comprising an inlet for raw material liquid, an inlet port for air at the bottom of a tower, and a distribution plate for mixing the liquid and injected magnetic microspheres by means of the air. In the upper area of the adsorption tower and below the liquid level of the raw material liquid, a magnet group is arranged, the magnet group being adapted to separate the magnetic microspheres together with certain particles of the raw material liquid.

[0004] Moreover, a flotation apparatus for at least one mineral included in a slurry is disclosed in WO 99/32229 A1. The apparatus comprises a flotation cell receiving the slurry and subjecting the slurry to a flotation process, and magnetic means applying a magnetic field to the mineral.

[0005] However, when the technology is used in the separation field, it is a huge challenge to appropriately increase the processing scale due to the separation object is a dilute solution or even a very dilute solution for most of the time. The existing magnetic separation devices either have too small processing scale to meet the requirements, or have insufficient space magnetic field intensity and gradient within the devices after enlargement, resulting in weak magnetic particles and ultrafine magnetic particles flowing in the space, especially the nanometer magnetic particles, which cannot be quickly and efficiently captured due to the too weak magnetic force. How to effectively process a large amount of dilute solution containing magnetic particles is a prominent problem in the application of the magnetic carrier separation technology.

Summary

[0006] The object of the present disclosure is to provide a whole process continuous gas-assisted magnetic separation system to solve the problem that weak magnetic particles and ultrafine magnetic particles, especially nanometer magnetic particles, within the space cannot be quickly and efficiently captured due to the insufficient magnetic field intensity and gradient after the enlargement of the device in the related technics.

[0007] To achieve this object, the present disclosure adopts the following technical solutions:

A whole process continuous gas-assisted magnetic separation system according to claim 1.

[0008] Further, the whole process continuous gas-assisted magnetic separation system comprises a plurality of extraction columns, and the plurality of extraction columns are connected in series through mixed liquid inlets and raffinate outlets;

wherein, the mixed liquid inlet of the extraction column at the head end is connected with the mixed liquid outlet, and the raffinate outlet of the extraction column at the tail end is connected with the raffinate storage tank.

[0009] Further, the whole process continuous gas-assisted magnetic separation system comprises a plurality of extraction columns, and the mixed liquid inlet of each extraction column is connected with the mixed liquid outlet, and the raffinate outlet of each extraction column is connected with the raffinate storage tank.

[0010] Further, the whole process continuous gas-assisted magnetic separation system comprises a plurality of desorbers, and the a plurality of desorbers are connected in series through magnetic particle inlets and product outlets;

wherein, the magnetic particle inlet of the desorber at the head end is connected with the mixture storage tank, and the product outlet of the desorber at the tail end is connected with the product storage tank.

[0011] Further, the whole process continuous gas-assisted magnetic separation system comprises a plurality of desorbers, and the magnetic particle inlet of each desorbers is connected with the mixture storage tank, and the product outlet of each desorbers is connected with the product storage tank.

[0012] Further, the feed liquid inlet, the magnetic particle inlet and the stirring device are arranged on the tank cover of the adsorption tank, and the tank cover of the adsorption tank is connected with a lifting assembly.

[0013] Further, the whole process continuous gas-assisted magnetic separation system comprises a control device which includes a controller, the controller is connected with the stirring device, the magnetic roller, the lifting assembly and the peristaltic pump, and the con-

troller is provided with a control button.

[0014] Further, the magnetic roller comprises a magnetic arc region, and the arc of the magnetic arc region is 240°.

[0015] According to the present disclosure, a whole process continuous gas-assisted magnetic separation system is provided, when in use, extraction is performed in a adsorption tank to complete the adsorption of targets with magnetic particles, afterwards, they enter an extraction column where the magnetic particles are captured by rising bubbles and enriched to the liquid level to form a magnetic particle solution enrichment region where the magnetic particles are separated from the raffinate by a magnetic roller, then the magnetic particles enter a desorber that is provided with a desorption liquid for separating the targets from the magnetic particles. Similarly, the magnetic particles are captured by rising bubbles and enriched to the liquid level to form a magnetic particle solution enrichment region where the magnetic particles are separated from the desorption liquid by a magnetic roller, afterwards, the magnetic particles are continuously sent to the adsorption tank for recycling.

[0016] The whole process continuous gas-assisted magnetic separation system combines an air flotation separation technology with a magnetic carrier separation technology, and still has a higher magnetic separation effect after an increase in the scale of the device; meanwhile, since the adsorption tank, the extraction column and the desorber arranged in series are used for continuous magnetic separation of the adsorption, washing and desorption processes of the targets, respectively, and in combination with a continuous implementation of these three processes themselves, a whole process continuous separation of the target isolates can be achieved ultimately. At the same time, the system can not only achieve a whole process continuity of the target isolates, but also enable a whole process continuity and a direct recycling utilizability of the magnetic particle carriers.

Brief Description of the Drawings

[0017]

Figure 1 is a schematic flow diagram of a whole process continuous gas-assisted magnetic separation system provided by the present disclosure;

Figure 2 is a main view at the magnetic roller of a whole process continuous gas-assisted magnetic separation system provided by the present disclosure.

[0018] In the Figures:

1. adsorption tank; 2. extraction column; 3. desorber; 4. feed liquid inlet; 5. magnetic particle inlet; 6. stirring device; 7. air flotation column; 8. magnetic roller; 9. scraper; 10. mixture storage tank; 11. magnetic particle storage tank; 12. raffinate storage tank; 13. product storage tank; 14. peristaltic pump; 15. gas flowmeter; 16. magnetic arc region; 17. washing liquor storage tank.

Detailed Description

[0019] The technical solution of the present disclosure will be further described below by way of specific embodiments in combination with accompanying drawings.

[0020] As shown in Figure 1 and Figure 2, a whole process continuous gas-assisted magnetic separation system is provided by this example, the system comprises an adsorption tank 1, the adsorption tank 1 is connected with an extraction column 2, and the extraction column 2 is connected with a desorber 3;

a feed liquid inlet 4 and a magnetic particle inlet 5 are arranged at the top of the adsorption tank 1, a mixed liquid outlet is arranged at the bottom of the adsorption tank 1, and a stirring device 6 is arranged inside the adsorption tank 1;

the extraction column 2 comprises a hollow air flotation column 7, a mixed liquid inlet and a raffinate outlet are arranged on the air flotation column 7, the mixed liquid inlet is connected with the mixed liquid outlet, and a magnetic roller 8 is arranged at the top of the air flotation column 7, a scraper 9 is arranged on one side of the magnetic roller 8, a mixture storage tank 10 is arranged at the end of the scraper 9, and a gas inlet is arranged at the bottom of the air flotation column 7;

the desorber 3 comprises a hollow air flotation column 7, a magnetic particle inlet and a product outlet are arranged on the air flotation column 7, and the magnetic particle inlet is connected with the mixture storage tank 10, a magnetic roller 8 is arranged at the top of the air flotation column 7, a scraper 9 is arranged on one side of the magnetic roller 8, a magnetic particle storage tank 11 is arranged at the end of the scraper 9, the magnetic particle storage tank 11 is connected with the adsorption tank, and a gas inlet is arranged at the bottom of the air flotation column 7;

the air flotation columns 7 of the extraction column 2 and the desorber 3 are connected with a washing device, and the washing port of the washing device is arranged opposite to the scraper 9.

[0021] The adsorption tank 1 in the system has a larger capacity, that is, it can be used to prepare a sufficient amount of adsorbed raw material liquid at one time for subsequent continuous use, and also provides high-capacity storage to easily realize the closed-loop circulation. A glass-made manhole and liquid level observation hole are arranged on the adsorption tank 1 so as to observe the materials and the liquid level in the adsorption

tank 1.

[0022] The washing device comprises a washing liquor storage tank 17 which is connected with the washing port, wherein the extraction column 2 and the desorber 3 use the same washing liquor storage tank 17, or the extraction column 2 and the desorber 3 are separately provided with a washing liquor storage tank 17.

[0023] In the whole process continuous gas-assisted magnetic separation system, a plurality of extraction columns 2 and a plurality of desorbers 3 can be employed respectively, specifically a plurality of extraction columns 2 are included, and the plurality of extraction columns 2 are connected in series through mixed liquid inlets and raffinate outlets;

wherein, the mixed liquid inlet of the extraction column 2 at the head end is connected with the mixed liquid outlet, and the raffinate outlet of the extraction column 2 at the tail end is connected with the raffinate storage tank 12.

[0024] Alternatively, the whole process continuous gas-assisted magnetic separation system comprises a plurality of extraction columns 2, the mixed liquid inlet of each extraction column 2 is connected with the mixed liquid outlet, and the raffinate outlet of each extraction column 2 is connected with the raffinate storage tank 12.

[0025] The above two forms are the plurality of extraction columns 2 being connected in series and in parallel, respectively, wherein, when the extraction columns 2 are connected in series, they can be used for multi-stage magnetic separation, so that the magnetic particles in the raffinate can be separated more sufficiently; while when they are connected in parallel, a plurality of extraction columns 2 can be used at the same time, resulting in higher magnetic separation efficiency.

[0026] Similarly, the desorbers 3 can also be connected in series or in parallel, that is, a plurality of desorbers 3 can be included, and the plurality of desorbers 3 are connected in series through magnetic particle inlets and product outlets;

wherein, the magnetic particle inlet of the desorber 3 at the head end is connected with the mixture storage tank 10, and the product outlet of the desorber 3 at the tail end is connected with the product storage tank 13.

[0027] Alternatively, the whole process continuous gas-assisted magnetic separation system comprises a plurality of desorbers 3, the magnetic particle inlet of each desorber 3 is connected with the mixture storage tank 10, and the product outlet of each desorber 3 is connected with the product storage tank 13.

[0028] The desorbers 3 connected in series are more sufficient for the recovery of the magnetic particles and reduce the circulation loss of the magnetic particles; while the desorbers 3 connected in parallel can improve the recovery efficiency of the magnetic particles.

[0029] The feed liquid inlet 4, the magnetic particle inlet 5 and the stirring device 6 are arranged on the tank cover of the adsorption tank 1, and the tank cover of the adsorption tank 1 is connected with a lifting assembly.

[0030] The adsorption tank 1 can be lifted and lowered by arranging a lifting assembly, which facilitates the maintenance and overhaul of the interior of the device in the later period, wherein, the lifting assembly is a telescopic cylinder, a hydraulic cylinder, and an electric hoist, etc.

[0031] Peristaltic pumps 14 are arranged between the adsorption tank 1 and the extraction column 2, between the extraction column 2 and the desorber 3 and between the washing device and the scraper 9, wherein, the flow rate of the peristaltic pump 14 is adjusted in a range of 3 to 6800 mL/min.

[0032] This example further comprises a control device which includes a controller, the controller is connected with the stirring device 6, the magnetic roller 8, the lifting assembly and the peristaltic pump 14, and the controller is provided with a control button. The control device is arranged in the lower part of the system, which is easy to operate. The control device is provided with corresponding control buttons, which facilitates the unified manipulation of the operator.

[0033] This example further comprises a gas supply line which is connected with the gas inlets of the extraction column 2 and the desorber 3, respectively, and gas flowmeters 15 are arranged at the gas inlets of the extraction column 2 and the desorber 3.

[0034] The extraction column 2 and the desorber 3 perform a unified gas supply operation through the gas supply line, wherein a corresponding gas flowmeter 15 is arranged at the gas inlet, and the measurement range of the gas flowmeter 15 is set at 6 to 60 L/h.

[0035] The magnetic roller 8 comprises a magnetic arc region 16, and the arc of the magnetic arc region 16 is 240°. The surface of the magnetic arc region 16 of the magnetic roller 8 is made to have a relatively uniform capturing force on the magnetic particles. In the design of the magnetic circuit system, a certain amount of small-size rubidium ferroboron rare earth permanent magnets are arranged in an annular shape at a certain distance along the surface of a sleeve, so that a uniform magnetic field intensity on the surface of the sleeve can be generated.

[0036] The mixture storage tank 10, the magnetic particle storage tank 11, the raffinate storage tank 12, the product storage tank 13, and the washing liquor storage tank 17 used in the whole process continuous gas-assisted magnetic separation system are all made of stainless steel, the shape of which is generally set to be a cuboid shape. At the same time, multiple spare storage tanks can be provided to configure and store the washing clear liquid and the desorption liquid.

[0037] Specifically, when in use, the magnetic carriers (i.e., magnetic particles) and the solution containing the target isolates are mixed in the adsorption tank 1 and fully stirred by the stirring device 6 to accelerate the extraction process of the targets by the magnetic particles and promote the full suspension of the magnetic particles, then the mixture is pumped into the extraction column 2 (taking two extraction columns 2 as an example, only one of them can be used, or they can be used si-

multaneously or alternately or in series), and the magnetic particles are fully captured by the magnetic roller 8 with the aid of the air flotation column 7. The magnetic particles on the magnetic roller 8 are washed off by the washing liquor pumped from the washing liquor storage tank 17 and collected into the mixture storage tank 10, and the raffinate is collected into the raffinate storage tank 12, the suspension inside the mixture storage tank 10 is pumped into the desorber 3, and desorption liquid is contained in the desorber 3, the targets desorb from the magnetic particles and enter the product storage tank 13, the desorbed magnetic particles are captured by the magnetic roller 8 and washed off by the washing liquor, and then enter the magnetic particle storage tank 11, the magnetic particles can be returned to the adsorption tank for recycling, and form a continuous closed-loop circulation.

Claims

1. A whole process continuous gas-assisted magnetic separation system, wherein it comprises an adsorption tank (1), the adsorption tank (1) is connected with an extraction column (2), and the extraction column (2) is connected with a desorber (3);

   the extraction column (2) comprises a hollow air flotation column (7), a mixed liquid inlet and a raffinate outlet are arranged on the air flotation column (7), the mixed liquid inlet is connected with a mixed liquid outlet, and a gas inlet is arranged at the bottom of the air flotation column (7);
   the desorber (3) comprises a hollow air flotation column (7), a magnetic particle inlet and a product outlet are arranged on the air flotation column (7), and the magnetic particle inlet is connected with a mixture storage tank (10), a magnetic roller (8) is arranged at the top of the air flotation column (7), a scraper (9) is arranged on one side of the magnetic roller (8), a magnetic particle storage tank (11) is arranged at the end of the scraper (9), the magnetic particle storage tank (11) is connected with the adsorption tank (1), and a gas inlet is arranged at the bottom of the air flotation column (7);
   characterized in that
   a feed liquid inlet (4) and a magnetic particle inlet (5) are arranged at the top of the adsorption tank (1), a mixed liquid outlet is arranged at the bottom of the adsorption tank (1), and a stirring device (6) is arranged inside the adsorption tank (1),
   wherein in the hollow air flotation column (7) of the extraction column (2), a magnetic roller (8) is arranged at the top of the air flotation column (7), a scraper (9) is arranged on one side of the magnetic roller (8), a mixture storage tank (10) is arranged at the end of the scraper (9),
   wherein the air flotation columns (7) of the extraction column (2) and the desorber (3) are connected with a washing device, and the washing port of the washing device is arranged opposite to the scraper (9),
   wherein peristaltic pumps (14) are arranged between the adsorption tank (1) and the extraction column (2), between the extraction column (2) and the desorber (3) and between the washing device and the scraper (9), wherein the flow rate of the peristaltic pump (14) is adjusted in a range of 3 to 6800 mL/min,
   wherein a gas supply line is connected with the gas inlets of the extraction column (2) and the desorber (3), respectively,
   wherein gas flowmeters (15) are arranged at the gas inlets of the extraction column (2) and the desorber (3), wherein the measurement range of the gas flowmeter (15) is set at 6 to 60 L/h; and
   wherein the magnetic rollers (8) of the extraction column (2) and the desorber (3) comprise a magnetic arc region (16), and the arc of the magnetic arc region (16) is 240°, and a certain amount of small-size rubidium ferroboron rare earth permanent magnets are arranged in an annular shape at a certain distance along the surface of the magnetic rollers (8).

2. The whole process continuous gas-assisted magnetic separation system according to claim 1, wherein it comprises a plurality of extraction columns (2), and the plurality of the extraction columns (2) are connected in series through mixed liquid inlets and raffinate outlets;
   wherein, the mixed liquid inlet of the extraction column (2) at the head end is connected with the mixed liquid outlet, and the raffinate outlet of the extraction column (2) at the tail end is connected with a raffinate storage tank (12).

3. The whole process continuous gas-assisted magnetic separation system according to claim 1, wherein it comprises a plurality of extraction columns (2), and the mixed liquid inlet of each extraction column (2) is connected with the mixed liquid outlet, and the raffinate outlet of each extraction column (2) is connected with a raffinate storage tank (12).

4. The whole process continuous gas-assisted magnetic separation system according to any of claims 1 to 3, wherein it comprises a plurality of desorbers (3), and the plurality of the desorbers (3) are connected in series through magnetic particle inlets and product outlets;
   wherein, the magnetic particle inlet of the desorber (3) at the head end is connected with the mixture

storage tank (10), and the product outlet of the desorber (3) at the tail end is connected with the product storage tank (13).

5. The whole process continuous gas-assisted magnetic separation system according to claims 1-3, wherein it comprises a plurality of desorbers (3), and the magnetic particle inlet of each desorber (3) is connected with the mixture storage tank (10), and the product outlet of each desorber (3) is connected with the product storage tank (13).

6. The whole process continuous gas-assisted magnetic separation system according to any of claims 1 to 5, wherein the feed liquid inlet (4), the magnetic particle inlet (5) and the stirring device (6) are arranged on the tank cover of the adsorption tank (1), and the tank cover of the adsorption tank (1) is connected with a lifting assembly.

7. The whole process continuous gas-assisted magnetic separation system according to claim 1, wherein it further comprises a control device which includes a controller, the controller is connected with the stirring device (6), the magnetic rollers (8) of the extraction column (2) and the desorber (3), the lifting assembly and the peristaltic pump (14), and the controller is provided with a control button.

Patentansprüche

1. System zur kontinuierlichen gasunterstützten Gesamtprozessmagnetabscheidung, wobei es einen Adsorptionsbehälter (1) umfasst, der Adsorptionsbehälter (1) mit einer Extraktionssäule (2) verbunden ist und die Extraktionssäule (2) mit einem Desorber (3) verbunden ist,

die Extraktionssäule (2) eine hohle Luftflotationssäule (7) umfasst, ein Mischflüssigkeitseinlass und ein Raffinatauslass an der Luftflotationssäule (7) angeordnet sind, der Mischflüssigkeitseinlass mit einem Mischflüssigkeitsauslass verbunden ist und ein Gaseinlass am Boden der Luftflotationssäule (7) angeordnet ist,
der Desorber (3) eine hohle Luftflotationssäule (7) umfasst, an der Luftflotationssäule (7) ein Magnetpartikeleinlass und ein Produktauslass angeordnet sind und der Magnetpartikeleinlass mit einem Mischungsspeicherbehälter (10) verbunden ist, eine Magnetrolle (8) oben an der Luftflotationssäule (7) angeordnet ist, an einer Seite der Magnetrolle (8) ein Abstreifer (9) angeordnet ist, ein Magnetpartikelspeicherbehälter (11) am Ende des Abstreifers (9) angeordnet ist, der Magnetpartikelspeicherbehälter (11) mit dem Adsorptionsbehälter (1) verbunden ist und ein Gaseinlass am Boden der Luftflotationssäule (7) angeordnet ist,
dadurch gekennzeichnet, dass
ein Zufuhrflüssigkeitseinlass (4) und ein Magnetpartikeleinlass (5) an der Oberseite des Adsorptionsbehälters (1) angeordnet sind, ein Mischflüssigkeitsauslass am Boden des Adsorptionsbehälters (1) angeordnet ist und eine Rührvorrichtung (6) im Inneren des Adsorptionsbehälters (1) angeordnet ist,
wobei bei der hohlen Luftflotationssäule (7) der Extraktionssäule (2) eine Magnetrolle (8) oben an der Luftflotationssäule (7) angeordnet ist, an einer Seite der Magnetrolle (8) ein Abstreifer (9) angeordnet ist, am Ende des Abstreifers (9) ein Mischungsspeicherbehälter (10) angeordnet ist,
wobei die Luftflotationssäulen (7) der Extraktionssäule (2) bzw. des Desorbers (3) mit einer Waschvorrichtung verbunden sind und der Waschanschluss der Waschvorrichtung entgegengesetzt zum Abstreifer (9) angeordnet ist,
wobei zwischen dem Adsorptionsbehälter (1) und der Extraktionssäule (2), zwischen der Extraktionssäule (2) und dem Desorber (3) und zwischen der Waschvorrichtung und dem Abstreifer (9) Peristaltikpumpen (14) angeordnet sind, wobei die Durchflussmenge der Peristaltikpumpe (14) in einem Bereich von 3 bis 6800 ml/min eingestellt ist,
wobei eine Gaszuführungsleitung mit den Gaseinlässen der Extraktionssäule (2) bzw. des Desorbers (3) verbunden ist,
wobei an den Gaseinlässen der Extraktionssäule (2) bzw. des Desorbers (3) Gasdurchflussmesser (15) angeordnet sind, wobei der Messbereich des Gasdurchflussmessers (15) auf 6 bis 60 l/h eingestellt ist und
wobei die Magnetrollen (8) der Extraktionssäule (2) bzw. des Desorbers (3) einen Magnetbogenbereich (16) umfassen und der Bogen des Magnetbogenbereichs (16) 240° beträgt, und eine bestimmte Menge an kleinen Rubidium-Ferrobor-Seltenerdpermanentmagneten in einer Ringform in einem bestimmten Abstand entlang der Oberfläche der Magnetrollen (8) angeordnet sind.

2. System zur kontinuierlichen gasunterstützten Gesamtprozessmagnetabscheidung nach Anspruch 1, wobei es mehrere Extraktionssäulen (2) umfasst und die mehreren Extraktionssäulen (2) über Mischflüssigkeitseinlässe und Raffinatauslässe in Reihe geschaltet sind,
wobei der Mischflüssigkeitseinlass der Extraktionssäule (2) am Kopfende mit dem Mischflüssigkeitsauslass verbunden ist und der Raffinatauslass der Extraktionssäule (2) am hinteren Ende mit einem

Raffinatspeicherbehälter (12) verbunden ist.

3. System zur kontinuierlichen gasunterstützten Gesamtprozessmagnetabscheidung nach Anspruch 1, wobei es mehrere Extraktionssäulen (2) umfasst und der Mischflüssigkeitseinlass jeder Extraktionssäule (2) mit dem Mischflüssigkeitsauslass verbunden ist und der Raffinatauslass jeder Extraktionssäule (2) mit einem Raffinatspeicherbehälter (12) verbunden ist.

4. System zur kontinuierlichen gasunterstützten Gesamtprozessmagnetabscheidung nach einem der Ansprüche 1 bis 3, wobei es mehrere Desorber (3) umfasst und die mehreren Desorber (3) über Magnetpartikeleinlässe und Produktauslässe in Reihe geschaltet sind,
wobei der Magnetpartikeleinlass des Desorbers (3) am Kopfende mit dem Mischungsspeicherbehälter (10) verbunden ist und der Produktauslass des Desorbers (3) am hinteren Ende mit dem Produktspeicherbehälter (13) verbunden ist.

5. System zur kontinuierlichen gasunterstützten Gesamtprozessmagnetabscheidung nach den Ansprüchen 1 - 3, wobei es mehrere Desorber (3) umfasst und der Magnetpartikeleinlass jedes Desorbers (3) mit dem Mischungsspeicherbehälter (10) verbunden ist und der Produktauslass jedes Desorbers (3) mit dem Produktspeicherbehälter (13) verbunden ist.

6. System zur kontinuierlichen gasunterstützten Gesamtprozessmagnetabscheidung nach einem der Ansprüche 1 bis 5, wobei der Zufuhrflüssigkeitseinlass (4), der Magnetpartikeleinlass (5) und die Rührvorrichtung (6) am Behälterdeckel des Adsorptionsbehälters (1) angeordnet sind und der Behälterdeckel des Adsorptionsbehälters (1) mit einer Hebeanordnung verbunden ist.

7. System zur kontinuierlichen gasunterstützten Gesamtprozessmagnetabscheidung nach Anspruch 1, wobei es ferner eine Steuervorrichtung umfasst, die eine Steuerung aufweist, wobei die Steuerung mit der Rührvorrichtung (6), den Magnetrollen (8) der Extraktionssäule (2) bzw. des Desorbers (3), der Hebeanordnung und der Peristaltikpumpe (14) verbunden ist und die Steuerung mit einem Bedienknopf versehen ist.

Revendications

1. Système de séparation magnétique continu assisté par gaz pour un processus complet, comprenant un réservoir d'absorption (1), le réservoir d'absorption (1) étant relié à une colonne d'extraction (2), et la colonne d'extraction (2) étant reliée à un désorbeur (3) ;
la colonne d'extraction (2) comprenant une colonne de flottation à air creuse (7), une entrée de liquide mixte et une sortie de produit raffiné étant agencées sur la colonne de flottation à air (7), l'entrée de liquide mixte étant reliée à une sortie de liquide mixte, et une entrée de gaz étant agencée au fond de la colonne de flottation à air (7) ;
le désorbeur (3) comprenant une colonne de flottation à air creuse (7), une entrée de particules magnétiques et une sortie de produit étant agencées sur la colonne de flottation à air (7), et l'entrée de particules magnétiques étant reliée à un réservoir de stockage de mélange (10), un rouleau magnétique (8) étant agencé en haut de la colonne de flottation à air (7), une racle (9) étant agencée d'un côté du rouleau magnétique (8), un réservoir de stockage de particules magnétiques (11) étant agencé à l'extrémité de la racle (9), le réservoir de stockage de particules magnétiques (11) étant relié au réservoir d'absorption (1), et une entrée de gaz étant agencée au fond de la colonne de flottation à air (7) ;
caractérisé en ce que
une entrée de liquide d'amenée (4) et une entrée de particules magnétiques (5) sont agencées en haut du réservoir d'absorption (1), une sortie de liquide mixte est agencée au fond du réservoir d'absorption (1), et un dispositif d'agitation (6) est agencé à l'intérieur du réservoir d'absorption (1),
un rouleau magnétique (8), dans la colonne de flottation à air creuse (7) de la colonne d'extraction (2), étant agencé en haut de la colonne de flottation à air (7), une racle (9) étant agencée d'un côté du rouleau magnétique (8), un réservoir de stockage de mélange (10) étant agencé à l'extrémité de la racle (9),
les colonnes de flottation à air (7) de la colonne d'extraction (2) et du désorbeur (3) étant reliées à un dispositif de lavage, et le raccordement de lavage du dispositif de lavage étant agencé à l'opposé de la racle (9),
des pompes péristaltiques (14) étant agencées entre le réservoir d'absorption (1) et la colonne d'extraction (2), entre la colonne d'extraction (2) et le désorbeur (3), et entre le dispositif de lavage et la racle (9), le débit de la pompe péristaltique (14) étant réglé dans une plage de 3 à 6800 mL/min,
une conduite d'amenée de gaz étant reliée aux entrées de gaz de la colonne d'extraction (2) et du désorbeur (3), respectivement,
des débitmètres de gaz (15) étant agencés au niveau des entrées de gaz de la colonne d'extraction (2) et du désorbeur (3), la plage de me-

sure du débitmètre de gaz (15) étant réglée à 6 à 60 Uh ; et
les rouleaux magnétiques (8) de la colonne d'extraction (2) et du désorbeur (3) comprenant une zone d'arc magnétique (16) et l'arc de la zone d'arc magnétique (16) étant égal à 240°, et une quantité déterminée de petits aimants permanents en rubidium-ferrobore-terre rare étant agencée en une forme annulaire à une distance déterminée le long de la surface des rouleaux magnétiques (8).

2. Système de séparation magnétique continu assisté par gaz pour un processus complet selon la revendication 1, comprenant une pluralité de colonnes d'extraction (2), et les plusieurs colonnes d'extraction (2) étant reliées en série par des entrées de liquide mixtes et des sorties de produit raffiné ;
l'entrée de liquide mixte de la colonne d'extraction (2) à l'extrémité supérieure étant reliée à la sortie de liquide mixte, et la sortie de produit raffiné de la colonne d'extraction (2) à l'extrémité arrière étant reliée à un réservoir de stockage de produit raffiné (12).

3. Système de séparation magnétique continu assisté par gaz pour un processus complet selon la revendication 1, comprenant une pluralité de colonnes d'extraction (2), et l'entrée de liquide mixte de chaque colonne d'extraction (2) étant reliée à la sorte de liquide mixte, et la sortie de produit raffiné de chaque colonne d'extraction (2) étant reliée à un réservoir de stockage de produit raffiné (12).

4. Système de séparation magnétique continu assisté par gaz pour un processus complet selon l'une des revendications 1 à 3, comprenant une pluralité de désorbeurs (3), et les plusieurs désorbeurs (3) étant reliés en série par des entrées de particules magnétiques et des sorties de produit ;
l'entrée de particules magnétiques du désorbeur (3) à l'extrémité supérieure étant reliée à un réservoir de stockage de mélange (10), et la sortie de produit du désorbeur (3) à l'extrémité arrière étant reliée au réservoir de stockage de produit (13).

5. Système de séparation magnétique continu assisté par gaz pour un processus complet selon l'une des revendications 1 à 3, comprenant une pluralité de désorbeurs (3), et l'entrée de particules magnétiques de chaque désorbeur (3) étant reliée au réservoir de stockage de mélange (10), et la sortie de produit de chaque désorbeur (3) étant reliée au réservoir de stockage de produit (13).

6. Système de séparation magnétique continu assisté par gaz pour un processus complet selon l'une des revendications 1 à 5, l'entrée de liquide d'amenée (4), l'entrée de particules magnétiques (5) et le dispositif d'agitation (6) étant agencés sur le couvercle de réservoir du réservoir d'absorption (1), et le couvercle de réservoir du réservoir d'absorption (1) étant relié à un ensemble de soulèvement.

7. Système de séparation magnétique continu assisté par gaz pour un processus complet selon la revendication 1, comprenant en outre un dispositif de commande qui comporte une commande, la commande étant reliée au dispositif d'agitation (6), aux rouleaux magnétiques (8) de la colonne d'extraction (2) et du désorbeur (3), à l'ensemble de soulèvement et à la pompe péristaltique (14), et la commande étant pourvu d'un bouton de commande.

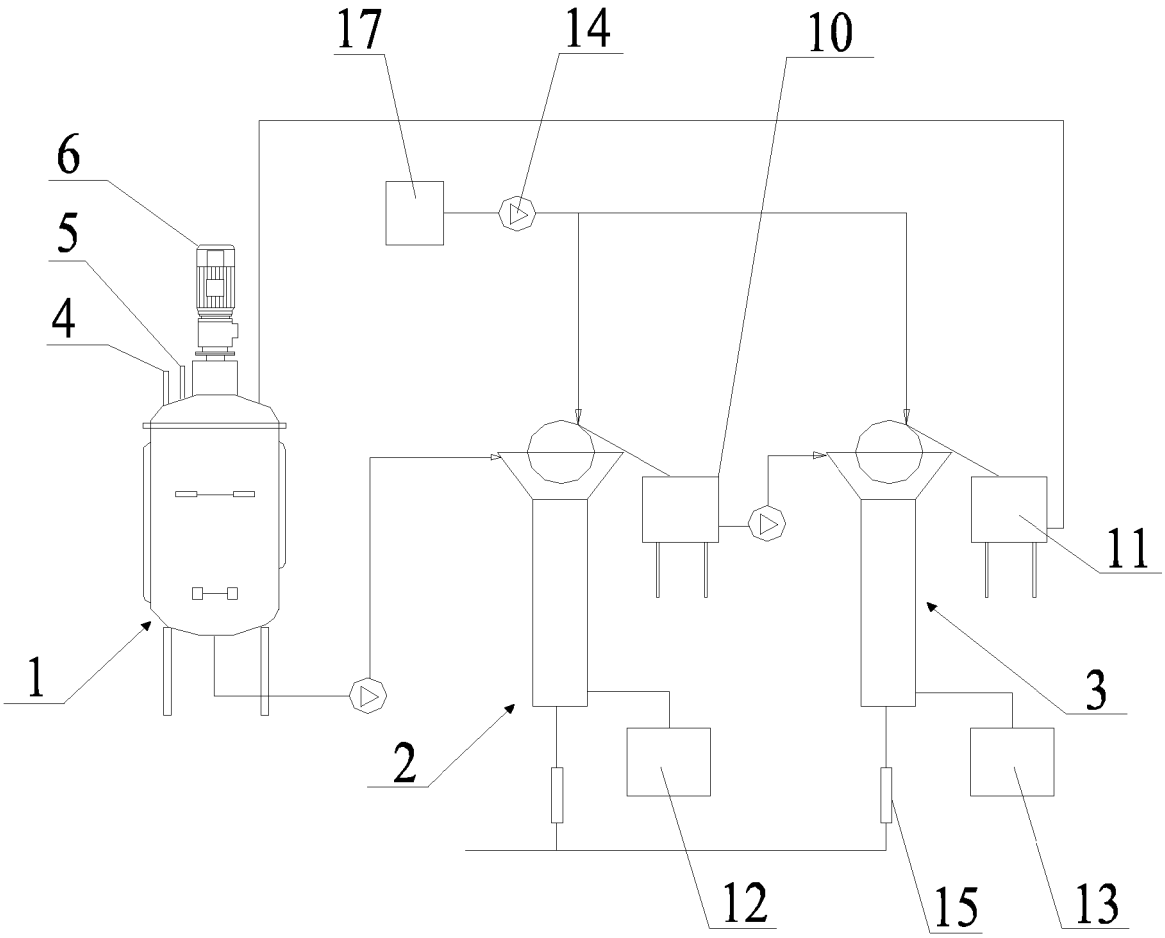

Figure 1

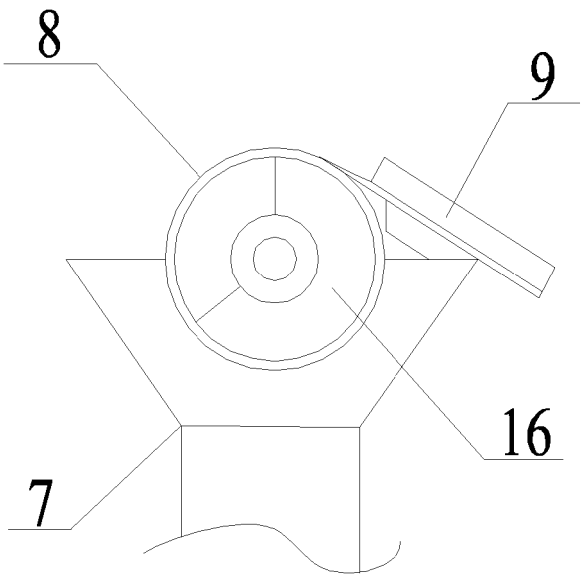

Figure 2

REFERENCES CITED IN THE DESCRIPTION

This list of references cited by the applicant is for the reader's convenience only. It does not form part of the European patent document. Even though great care has been taken in compiling the references, errors or omissions cannot be excluded and the EPO disclaims all liability in this regard.

Patent documents cited in the description

- CN 101164700 A **[0003]**
- WO 9932229 A1 **[0004]**