



(51) International Patent Classification:

F01N 3/035 (2006.01) B01J 37/02 (2006.01)

(21) International Application Number:

PCT/CN2022/113358

(22) International Filing Date:

18 August 2022 (18.08.2022)

(25) Filing Language:

English

(26) Publication Language:

English

(30) Priority Data:

PCT/CN2021/113509

19 August 2021 (19.08.2021) CN

(71) Applicant: **BASF CORPORATION** [US/US]; 100 Park Avenue, 07932 Florham Park (US).

(71) Applicant (for KN only): **BASF (CHINA) COMPANY LIMITED** [CN/CN]; No. 300, Jiang Xin Sha Road, Pudong District, Shanghai 200137 (CN).

(72) Inventors: **LI, Yuting**; 199 Luqiao Road, Shanghai 201206 (CN). **JIANG, Juncong**; 25/F, Tower A, Gateway Plaza, Beijing 100027 (CN). **QI, Yunfei**; 199 Luqiao Road, Shanghai 201206 (CN). **DENG, Chenghao**; 199 Luqiao Road, Shanghai 201206 (CN). **LIU, Jiancheng**; 199 Luqiao Road, Shanghai 201206 (CN). **SIANI, Attilio**; Seligmannallee 1, 30173 Hannover (DE). **YIN, Xiaomin**; No.239 Luqiao Road, Shanghai 201206 (CN).

(74) Agent: **ZHONGZI LAW OFFICE**; 7F, New Era Building, 26 Pinganli Xidajie, Xicheng, District, Beijing 100034 (CN).

(81) Designated States (unless otherwise indicated, for every kind of national protection available):

AE, AG, AL, AM, AO, AT, AU, AZ, BA, BB, BG, BH, BN, BR, BW, BY, BZ, CA, CH, CL, CN, CO, CR, CU, CV, CZ, DE, DJ, DK, DM, DO, DZ, EC, EE, EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID, IL, IN, IQ, IR, IS, IT, JM, JO, JP, KE, KG, KH, KN, KP, KR, KW, KZ, LA, LC, LK, LR, LS, LU, LY, MA, MD, ME, MG, MK, MN, MW, MX, MY, MZ, NA, NG, NI, NO, NZ, OM, PA, PE, PG, PH, PL, PT, QA, RO, RS, RU, RW, SA, SC, SD, SE, SG, SK, SL, ST, SV, SY, TH, TJ, TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, WS, ZA, ZM, ZW.

(84) Designated States (unless otherwise indicated, for every kind of regional protection available):

ARIPO (BW, GH, GM, KE, LR, LS, MW, MZ, NA, RW, SD, SL, ST, SZ, TZ, UG, ZM, ZW), Eurasian (AM, AZ, BY, KG, KZ, RU, TJ, TM), European (AL, AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI, FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MK, MT, NL, NO, PL, PT, RO, RS, SE, SI, SK, SM, TR), OAPI (BF, BJ, CF, CG, CI, CM, GA, GN, GQ, GW, KM, ML, MR, NE, SN, TD, TG).

Published:

— with international search report (Art. 21(3))

(54) Title: A COATING SYSTEM FOR COATING A SUBSTRATE AND A PROCESS OF COATING THE SUBSTRATE WITH THE SAME

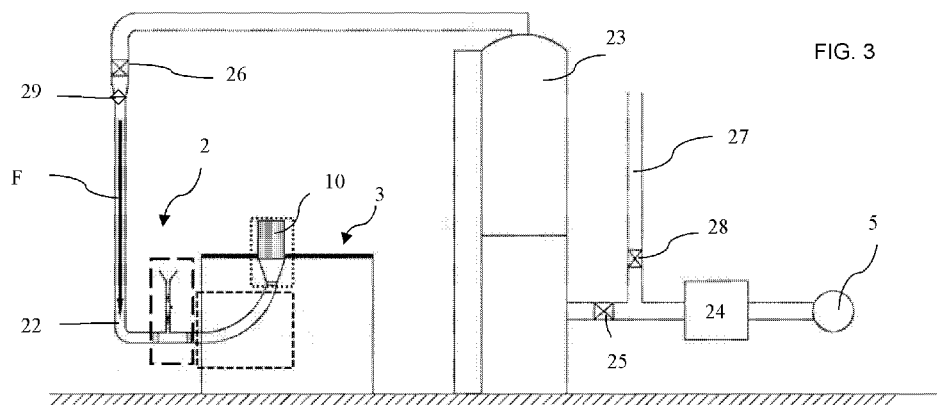


FIG. 3

(57) Abstract: A coating system for coating a substrate (10), comprising: a dosing unit (1) for pre-weighing and dosing a solid material to be conveyed; a conveying unit (2) for conveying the weighed solid material to the substrate (10) to be coated by a conveying gas flow; a receiving unit (3) for receiving the substrate and located downstream of the conveying unit along a flowing direction (F) of the conveying gas flow; and a control unit (4) for controlling the operation of the dosing unit (1), the conveying unit (2) and the receiving unit (3).



A COATING SYSTEM FOR COATING A SUBSTRATE AND A PROCESS OF COATING THE SUBSTRATE WITH THE SAME

Technology Field

- 5 The invention relates to a coating system for coating a substrate, in particular a substrate for a wall-flow filter and a process of coating the substrate with the coating system.

Background

- 10 Certain internal combustion engines, for example lean-burn engines, diesel engines, natural gas engines, power plants, incinerators, and gasoline engines, tend to produce an exhaust gas with a considerable amount of soot and other particulate matter. Usually, particulate matter emissions can be remedied by passing the PM-containing exhaust gas through a wall-flow filter.

- 15 Diesel wall-flow filter have proven to be efficient at removing carbon soot from the exhaust gas of the diesel engines. The most widely used diesel particulate filter is the wall-flow filter which filters the diesel exhaust gas by capturing the soot on the porous walls of the filter body. The wall-flow filter is designed to provide for nearly complete filtration of soot without significantly hindering the exhaust flow.

- 20 There is a need to provide an improved coating system and coating process to obtain a filter, e.g., a wall-flow filter having excellent filtration efficiency and low backpressure.

- 25 Lately, even stricter regulations like Euro 6d and China 6b were imposed, and the conventional catalytic filter technology was not able to simultaneously meet the customer's emission targets for particulate matter & backpressure targets for exhaust system without further improvement. This created an urgent need for developing the next generation catalytic filter (or FWC) and at the same time a new coating system to be able to produce this next generation product in large scale.

30

Summary of the Invention

- 35 An object of the present invention is to provide an improved coating system for more efficiently preparing a filter having excellent filtration efficiency and low backpressure.

- Another object of the present invention is to provide an improved coating process for more efficiently preparing a filter having excellent filtration efficiency and low backpressure.

- 40 So, one aspect of the present invention relates to a coating system for coating a substrate, comprising: a dosing unit for pre-weighing and dosing a solid material to be conveyed; a conveying unit for conveying the weighed solid material to the substrate to be coated by a conveying gas flow; a receiving unit for receiving the substrate and located downstream of the conveying unit along a flowing direction of the conveying gas flow; a control unit for controlling the operation of the dosing unit, the conveying unit and the receiving unit.

- 45 In an embodiment, the dosing unit may comprise an automatic material dosing device

having a material container with a dispensing port and a dispensing mechanism arranged in the material container; a material transfer container; and a weighing device; wherein the dispensing mechanism is used for dispensing the solid material into the material transfer container through the dispensing port, and the weighing device is used for weighing the solid material in the material transfer container.

In an embodiment, the dispensing mechanism and the weighing device may be respectively in communication with the control unit, and the control unit receives a weight measurement value of the solid material dispensing into the material transfer container from the weighing device, and compares the weight measurement value with the set weight of the solid material to be conveyed, and the control unit will control the dispensing mechanism to stop dispensing the solid material, if the weight measurement value is in the range of the set weight $\pm 5\%$.

In an embodiment, the conveying unit may comprise a conveying pipe having an inlet end and an outlet end, wherein a first check valve and a second check valve are provided between the inlet end and the outlet end; a fan for generating a conveying gas flow flowing from the outlet end of the conveying pipe to the receiving unit; and a connecting pipeline fluidly communicating the fan with the outlet end of the conveying pipe and the receiving unit.

Preferably, the conveying pipe may be vertically arranged, and its inlet end is of funnel-shaped, and the conveying unit may further comprise a gas buffer box arranged between the fan and the conveying pipe; a cooler arranged between the fan and the gas buffer box; a first control valve provided between the cooler and the gas buffer tank; a second control valve provided between the gas buffer box and the conveying pipe; and a branch pipe provided between the cooler and the first control valve, which fluidly communicating the connecting pipeline with the external environment, and a third control valve is disposed in the branch pipe.

In an embodiment, the receiving unit may comprise a holding mechanism for fixedly holding the substrate, the holding mechanism is airtightly connected to the fan by means of the connecting pipeline.

Preferably, the holding mechanism is an inflatable flexible holder which can be adjusted to hold the substrates of different sizes.

In an embodiment, the connecting pipeline may comprise a first pipe section connected to the fan and the outlet end of the conveying pipe and having a first cross section, and a second tapered pipe section connected to the receiving unit, the minimum cross section of the second tapered pipe section is equal to the first cross section, and the maximum cross section of the second tapered pipe section is defined as a second cross section which is greater than or equal to the cross section of the substrate.

In an embodiment, the diameter of the first cross-section may be in the range of 0.3D-0.75D, preferably 0.4D-0.6D. The maximum diameter of the second cross-section

may be in the range of $1D-1.2D$, preferably $1.02D-1.1D$. The height of the second tapered pipe section may be in the range of $0.3D-0.9D$, preferably $0.4D-0.8D$, wherein D means the diameter of the circular cross-section of the substrate or the minor axis of the elliptical cross-section of the substrate in case the substrate is an elliptical cylinder.

5

A person skilled in the art can understand that a circular cylinder has a circular cross-section and an elliptical cylinder has an elliptical cross-section.

10

In an embodiment, in case D of the substrate is in the range of 95mm-155mm, the diameter of the first cross-section may be in the range of 60mm-100mm, for example 60mm or 100mm, the maximum diameter of the second cross-section may be in the range of 96 to 160mm, for example 98 or 155mm, and the height of the second tapered pipe section may be in the range of 60mm-130mm.

15

In another embodiment, the connecting pipeline may comprise a first pipe section connected to the fan and the outlet end of the conveying pipe and having a first cross section, a second tapered pipe section connected to the receiving unit, and a third pipe section connecting the first pipe section and the second tapered pipe section, the third pipe section is connected to the first pipe section by a tapered connecting portion thereof, the maximum cross section of the second tapered pipe section is defined as a second cross section, the second cross section is greater than or equal to the cross section of the substrate, and the cross section of the third pipe section is defined as a third cross section, wherein the third cross section is greater than the first cross section and equal to the minimum cross section of the second tapered pipe section.

20

In an embodiment, the substrate may be a filter substrate, in particular a wall-flow filter substrate having an inlet side and an outlet side, and the substrate is arranged in the inflatable flexible holder with its inlet side facing the conveying unit.

25

Preferably, the coating system according to the present invention may further comprise an automatic transfer mechanism for transferring the substrate to be coated to the receiving unit and removing the coated substrate from the receiving unit.

30

The present invention also relates to a process of coating a substrate with the above coating system, the process may comprise the steps of: providing the substrate; fixedly holding the substrate in a receiving unit; pre-weighing a solid material to be coated on the substrate by a dosing unit; mixing the weighed solid material with the conveying gas flow and convey them to the receiving unit by the conveying unit to coat the substrate; and removing the coated substrate from the receiving unit.

35

In the above process, the substrate may be a substrate for a wall-flow filter.

40

The coating system according to the present invention is able to simultaneously meet the customer's emission targets for particulate matter & backpressure targets for exhaust system without further improvement. The product (catalytic filter) obtained by this new

45

coating system has a higher trapping efficiency for particulate matter, and at the same time the coating system is able to produce this product in large scale.

Description of the Drawing

- 5 FIG. 1 shows a schematic block diagram of one embodiment of a coating system according to the present invention
- FIG.2 shows a schematic structural diagram of the dosing unit according to the present invention.
- FIG. 3 is a schematic structural diagram shows the conveying unit and the receiving unit
- 10 connected with each other.
- FIG.4 is a schematic structural diagram shows the conveying pipe and the connecting pipeline connected to each other.
- FIG.5 is a schematic structural diagram shows an embodiment of a connecting section for connecting the conveying pipe to the receiving unit according to the present invention.
- 15 FIG.6 is a schematic structural diagram shows another embodiment of a connecting section for connecting the conveying pipe to the receiving unit according to the present invention.
- FIG.7 is a schematic structural diagram shows an embodiment of the substrate for wall-flow filter according to the present invention.

20

Detailed Description of the Embodiments

The undefined article "a", "an", "the" means one or more of the species designated by the term following said article.

- 25 In the context of the present disclosure, any specific values mentioned for a feature (comprising the specific values mentioned in a range as the end point) can be recombined to form a new range.

- In the context of the present disclosure, each aspect so defined may be combined with
- 30 any other aspect or aspects unless clearly indicated to the contrary. In particular, any feature indicated as being preferred or advantageous may be combined with any other feature or features indicated as being preferred or advantageous.

- FIG. 1 shows a schematic block diagram of one embodiment of a coating system for
- 35 coating a substrate 10 according to the present invention. The coating system mainly comprises a dosing unit 1, a conveying unit 2, a receiving unit 3, and a control unit 4 for controlling the operation of the dosing unit 1, the conveying unit 2 and the receiving unit 3. The dosing unit 1 is used for pre-weighing and dosing a solid material to be conveyed, and the conveying unit 2 is used for conveying the weighed solid material to the substrate
- 40 10 to be coated by a conveying gas flow. In addition, the receiving unit 3 is used for receiving the substrate and located downstream of the conveying unit along a flowing direction F of the conveying gas flow. In this invention, the substrate may be a substrate for particulate filters, in particular a wall-flow filter. However, one skilled in the art should be understood that the substrate may also be other types of substrates that need to be
- 45 coated.

In a preferred embodiment, as shown in FIG. 2, the dosing unit 1 may comprise an automatic material dosing device 11, a material transfer container 15 and a weighing device 16. It can be seen from the figure that the automatic material dosing device 11 is configured to include a material container 13 with a dispensing port (or a dispensing tube) 12 and a dispensing mechanism 14 arranged in the material container. The solid materials to be conveyed are contained in the material container, and the dispensing mechanism 14 is used for dispensing the solid material into the material transfer container 15 such as a cup through the dispensing port 12, and the solid material in the material transfer container is weighed by the weighing device. In an example, the dispensing mechanism 14 may be, for example, a threaded screw mechanism for pushing solid materials into the dispensing pipe which is arranged obliquely.

In the above dosing unit 1, the dispensing mechanism 14 and the weighing device 16 are respectively in communication with the control unit 4, and the control unit 4 receives a weight measurement value $W1$ of the solid material dispensing into the material transfer container from the weighing device 16, and compares the weight measurement value $W1$ with the set weight W of the solid material to be conveyed, and the control unit 4 will control the dispensing mechanism 14 to stop dispensing the solid material, if the weight measurement value $W1$ is in the range of the set weight $W \pm 5\%$.

In actual operation, the weight measurement value $W1$ of the solid material is the weight measurement value Wt of the weighing device 16 subtract the weight Wc of the material transfer container 15. Since it is difficult to avoid adhering some solid materials to the wall of the material transfer container 15, after feeding the solid materials in the material transfer container 15 into the conveying unit 2, it is necessary to put the empty material transfer container 15 on the weighing device 16 for re-weighing, and the measured value is Wr , then $Wt-Wr$ is the actual material weight G feeding into the conveying unit 2. If the actual material weight G is within the specified range, for example, in the range of the set weight $W \pm 5\%$, the dosing unit 1 will continue to weigh the solid material for the next substrate, otherwise, the weighing device 16 will send a signal to the control unit to mark the substrate coated in this time as a "reject product".

In an embodiment according to the present invention, as shown in FIG.3, the conveying unit 2 may comprise a fan 5, a conveying pipe 21 and a connecting pipeline 22 fluidly communicating the fan 5 with the outlet end 21b of the conveying pipe and the receiving unit 3.

Referring to FIG. 4 particularly, the conveying pipe 21, having an inlet end 21a and an outlet end 21b, is vertically arranged and its inlet end 21a is preferably of funnel shaped. A first check valve (i.e., one-way valve) $V1$ and a second check valve $V2$ may be provided between the inlet end and the outlet end in the conveying pipe 21, and the first check valve $V1$ and the second check valve $V2$ are respectively in communication with the control unit 4, and the opening and closing of these valves are controlled by the control unit 4. For example, the first check valve $V1$ at the upper part of the conveying pipe 21

can be opened firstly, and the solid materials may be fed into the conveying pipe 2 from the material transfer container 15, then the first check valve V1 is closed, and finally the second check valve V2 is opened. Under the action of gravity, the solid materials will be conveyed into the conveying pipeline 22 and conveyed to the receiving unit 3 by the conveying air flow from the fan 5. The main purpose of providing two check valves is to prevent the solid materials from being blown out by the conveying air flow from the fan 5 in the reverse direction when the solid materials are fed into the conveying pipe 21, resulting in the loss of the solid materials.

Referring to FIG.3 again, in order to maintain the stability of the conveying air flow, the conveying unit 2 further comprises a gas buffer box 23 arranged between the fan 5 and the conveying pipe 21. To prevent the fan from overheating, a cooler 24 is provided between the fan 5 and the gas buffer tank 2. In addition, a first control valve 25 is provided between the cooler 24 and the gas buffer box 23, and a second control valve 26 is provided between the gas buffer box 23 and the conveying pipe 21 for controlling the speed of the conveying gas flow. Moreover, a branch pipe 27 which can fluidly communicate the connecting pipe 22 with the external environment may be further arranged between the first control valve 25 and the cooler 24, and a third control valve 28 is arranged in the branch pipe 27, and the third control valve 28 may be fully or partially opened when the coating system works, so as to control the flow rate of the conveying air flow in the conveying unit 2. In order to control the stability of the coating process, a flow sensor 29 may also be provided downstream of the second control valve 26 in the connecting pipe 22 to monitor the flow rate of the conveying air stream.

According to an embodiment of the present invention, as shown in FIG.5, the receiving unit 3 may comprise a holding mechanism 31 for fixedly holding the substrate 10 to be coated, and the holding mechanism may be airtightly connected to the fan 5 by means of a connecting pipe 22. Advantageously, the holding mechanism 31 is an inflatable flexible holder which can be adjusted to accommodate substrates 10 of different sizes. For example, the inflatable flexible holder may be in the form of a swimming ring or a tire.

In the present invention, referring to FIG. 7, the substrate 10 is, for example, a wall-flow filtered substrate, and has an inlet side 10a and an outlet side 10b, wherein the substrate 10 is arranged in the inflatable flexible holder with its inlet side 10a facing the conveying unit 2, in other words, with its inlet side 10a facing the connecting pipe 22. The substrate shown in this figure has a circular cross section, and the diameter (D) of the cross-section of the substrate with relatively small size may be in the range of 95 mm-155 mm, while the diameter (D) of the cross-section of the substrate with relatively large size may be in the range of 160 mm-350 mm, for example.

In an embodiment not shown, the cross-section of the substrate may be elliptical, in which case, the minor axis (D) of the elliptical cross-section of the substrate with relatively small size may be in the range of 95 mm-155 mm, while the minor axis (D) of the cross-section of the substrate with relatively large size may be in the range of 160 mm-350 mm.

Referring to FIG. 5 again, which is a schematic structural diagram shows an embodiment of a connecting section of the connecting pipeline 22 for connecting the conveying pipe 21 to the receiving unit 3 according to the present invention.

5 As can be seen in FIG.3 and FIG.5, the connecting pipeline 22 comprises a first pipe section 22a connected to the fan 5 and the outlet end 21b of the conveying pipe and having a first cross section, and a second tapered pipe section 22b connected to the receiving unit 3, the minimum cross section of the second tapered pipe section is equal to the first cross section, and the maximum cross section of the second tapered pipe section
10 is defined as a second cross section which is greater than or equal to the cross section of the substrate 10.

The configuration of said connecting section of the connecting pipeline, shown in FIG. 5, is especially suitable for substrates with small size, for example, the diameter/minor axis
15 (D) of the cross section of the substrate 10 is in the range of 95 mm-155mm. In this case, the diameter of the first cross section may be in the range of 0.3D-0.75D, preferably 0.4D-0.6D, for example 60 mm - 100 mm, the maximum diameter of the second cross section may be in the range of 1D-1.2D, preferably 1.02D-1.1D, for example 95-155 mm, and the height of the second tapered pipe section 22b may be in the range of 0.3D-0.9D,
20 preferably 0.4D-0.8D, for example 60 mm-130 mm.

FIG.6 is a schematic structural diagram shows another embodiment of a connecting section of the connecting pipeline 22 for connecting the conveying pipe 21 to the receiving unit 3 according to the present invention. The configuration of said connecting section of
25 the connecting pipeline, shown in FIG. 6, is especially suitable for substrates with larger size, for example, the diameter/minor axis (D) of the cross section of the substrate is in the range of 160mm-350mm.

In this embodiment, the connecting pipeline 22 comprises a first pipe section 22a
30 connected to the fan 5 and the outlet end 21b of the conveying pipe 21 and having a first cross section, a second tapered pipe section 22b connected to the receiving unit 3, and a third pipe section 22c connecting the first pipe section 22a with the second tapered pipe section 22b, the third pipe section is connected to the first pipe section 22b by a tapered connecting portion 22d thereof, the maximum cross section of the second tapered pipe section is defined as a second cross section, the second cross section is greater than or
35 equal to the cross section of the substrate 10, and the cross section of the third pipe section is defined as a third cross section, wherein the third cross section is greater than the first cross section and equal to the minimum cross section of the second tapered pipe section. For example, in one example, the diameter of the first cross section may be
40 0.17D-0.375 D, the diameter of the third cross section may be 0.28D-0.625 D, and the diameter of the second cross section may be greater than or equal to D. Specifically, the diameter of the first cross section may be 60mm, the diameter of the third cross section may be 100mm, and the diameter of the second cross section may be 350 mm.

45 Further referring to FIG.5, the coating system according to the present invention may

further comprise an automatic transfer mechanism 6 for transferring the substrate 10 to be coated to the receiving unit and removing the coated substrate from the receiving unit. Herein, the automatic transfer mechanism 6 may be a robot.

5 The present invention also relates to a process of coating a substrate 10 with the above-mentioned coating system to obtain a product such a wall-flow filter, the process comprises the steps of: providing the substrate 10; fixedly holding the substrate in a receiving unit 3; pre-weighing a solid material to be coated on the substrate by a dosing unit 1; mixing the weighed solid material with the conveying gas flow and convey them to
10 the receiving unit 3 by the conveying unit 2 to coat the substrate; and removing the coated substrate from the receiving unit 3.

In the step of providing the substrate 10, a scanning device (not shown in the figure) can be provided to scan the provided substrate to judge whether the batch of the substrate is
15 correct. If it is correct, the substrate will be fixed and held in the receiving unit 3, otherwise, the substrate will be judged as a reject substrate.

In the step of pre-weighing a solid material to be coated on the substrate by a dosing unit 1, the weight G of the solid materials, which are actually fed into the conveying unit 2, can also be measured by the weighing device 16 and sent to the control unit for comparing
20 with the set weight W . If G is within the range of the set weight $W \pm 5\%$, the metering unit will continue to weigh the solid materials for the next substrate, otherwise it will send a signal to the control unit to mark the coated substrate as a rejected product.

25 In the step of mixing the weighed solid material with the conveying gas flow and convey them to the receiving unit 3 to coat the substrate by the conveying unit 2, the flow rate of the conveying gas flow can be controlled by the first control valve, the second control valve and the third control valve.

30 In order to make the obtained products with the qualified product characteristics and appearance, the conveying gas flow with different flow rates can be provided for substrates with different sizes. For example, for the substrate with a cross-sectional diameter or minor axis below 100mm, the flow rate of the conveying air flow can be selected as $600 \pm 40 \text{ m}^3/\text{h}$; for the substrate with a cross-sectional diameter or minor axis in
35 the range of 100mm-160mm, the flow rate of the conveying air flow can be selected to be in the range of $300 \text{ m}^3/\text{h} - 800 \text{ m}^3/\text{h}$. Meanwhile, for the substrates with larger size, the flow rate of the conveying air flow can be selected to be in the range of $500 \text{ m}^3/\text{h} - 1000 \text{ m}^3/\text{h}$. In addition, during coating, it is necessary to use a conveying gas flow with a suitable flow rate to purge the substrate to be coated for a certain period of time, such as
40 20 seconds. If the flow rate is not suitable and the purging time is not enough, the obtained product may be unqualified.

After the step of removing the coated substrate from the receiving unit 3, it is possible to judge whether the obtained product is qualified by a backpressure test. For example, if the
45 backpressure of the desired product is P and the measured backpressure $P_t = P (1 \pm 5\%)$,

the product can be judged as a qualified product, otherwise it can be judged as a unqualified product (reject product).

5 Various modifications and variations conceivable by those skilled in the art can be made to the embodiments disclosed above without departing from the scope or spirit of the present disclosure. According to the disclosure, other embodiments will be obvious to those skilled in the art. This description and its disclosed examples are to be considered illustrative only, and the protection scope of the present disclosure is to be specified by the appended claims and their equivalents.

Claims

1. A coating system for coating a substrate (10), comprising:
a dosing unit (1) for pre-weighing and dosing a solid material to be conveyed;
5 a conveying unit (2) for conveying the weighed solid material to the substrate (10) to be coated by a conveying gas flow;
a receiving unit (3) for receiving the substrate and located downstream of the conveying unit along a flowing direction (F) of the conveying gas flow;
a control unit (4) for controlling the operation of the dosing unit (1), the conveying unit
10 (2) and the receiving unit (3).
2. The coating system according to claim 1, wherein the dosing unit (1) comprises:
an automatic material dosing device (11) comprising a material container (13) with a dispensing port (12) and a dispensing mechanism (14) arranged in the material container;
a material transfer container (15); and
15 a weighing device (16);
wherein the dispensing mechanism (14) is used for dispensing the solid material into the material transfer container (15) through the dispensing port (12), and the weighing device is used for weighing the solid material in the material transfer container.
3. The coating system according to claim 2, wherein,
20 the dispensing mechanism (14) and the weighing device (16) are respectively in communication with the control unit (4), and the control unit (4) receives a weight measurement value of the solid material dispensing into the material transfer container from the weighing device (16), and compares the weight measurement value with the set weight of the solid material to be conveyed, and the control unit (4) will control the
25 dispensing mechanism (14) to stop dispensing the solid material, if the weight measurement value is equal to the set weight.
4. The coating system according to any of claims 1 to 3, wherein, the conveying unit (2) comprises:
a conveying pipe (21) having an inlet end (21a) and an outlet end (21b), wherein a
30 first check valve (V1) and a second check valve (V2) are provided between the inlet end and the outlet end;
a fan (5) for generating a conveying gas flow flowing from the outlet end (21b) of the conveying pipe to the receiving unit (3); and
a connecting pipeline (22) fluidly communicating the fan (5) with the outlet end (21b)
35 of the conveying pipe and the receiving unit (3).
5. The coating system according to claim 4, wherein the conveying pipe is vertically arranged and its inlet end (21a) is of funnel-shaped, and
the conveying unit (2) further comprises:
a gas buffer box (23) arranged between the fan (5) and the conveying pipe (21);
40 a cooler (24) arranged between the fan (5) and the gas buffer box (23);
a first control valve (25) provided between the cooler and the gas buffer tank;
a second control valve (26) provided between the gas buffer box (23) and the conveying pipe (21); and
a branch pipe (27) provided between the cooler (24) and the first control valve (25),
45 which fluidly communicating the connecting pipeline (22) with the external environment,

and a third control valve (28) is disposed in the branch pipe (27).

6. The coating system according to claim 4 or 5, wherein the receiving unit (3) comprises:

5 a holding mechanism (31) for fixedly holding the substrate (10), the holding mechanism is airtightly connected to the fan (5) by means of the connecting pipeline (22).

7. The coating system according to claim 6, wherein the holding mechanism (31) is an inflatable flexible holder which can be adjusted to hold the substrates of different sizes.

10 8. The coating system according to claim 7, wherein the connecting pipeline (22) comprises a first pipe section (22a) connected to the fan (5) and the outlet end (21b) of the conveying pipe and having a first cross section, and a second tapered pipe section (22b) connected to the receiving unit (3), the minimum cross section of the second tapered pipe section is equal to the first cross section, and the maximum cross section of the second tapered pipe section is defined as a second cross section which is greater than or equal to the cross section of the substrate (10).

15 9. The coating system according to claim 8, wherein the diameter of the first cross section is in the range of $0.3D-0.75D$, preferably $0.4D-0.6D$; the maximum diameter of the second cross section is in the range of $1D-1.2D$, preferably $1.02D-1.1D$, and the height of the second tapered pipe section 22b is in the range of $0.3D-0.9D$, preferably $0.4D-0.8D$, wherein D means the diameter of the circular cross-section of the substrate or the minor axis of the elliptical cross-section of the substrate in case the substrate is an elliptic cylinder.

20 10. The coating system according to claim 7, wherein the connecting pipeline (22) comprises a first pipe section (22a) connected to the fan (5) and the outlet end (21b) of the conveying pipe and having a first cross section, a second tapered pipe section (22b) connected to the receiving unit (3), and a third pipe section (22c) connecting the first pipe section (22a) with the second tapered pipe section (22b), the third pipe section is connected to the first pipe section (22b) by a tapered connecting portion (22d) thereof, the maximum cross section of the second tapered pipe section is defined as a second cross section, the second cross section is greater than or equal to the cross section of the substrate (10), and the cross section of the third pipe section is defined as a third cross section, wherein the third cross section is greater than the first cross section and equal to the minimum cross section of the second tapered pipe section.

30 11. The coating system according to any of claims 6 to 10, wherein the substrate (10) is a substrate for a wall-flow filter and has an inlet side (10a) and an outlet side (10b), and the substrate (10) is arranged in the inflatable flexible holder with its inlet side (10a) facing the conveying unit (2).

12. The coating system according to claim 1, further comprising:

an automatic transfer mechanism (6) for transferring the substrate (10) to be coated to the receiving unit and removing the coated substrate from the receiving unit.

40 13. A process of coating a substrate (10) with the coating system according to any of claims 1 to 12, comprising:

providing the substrate (10);

fixedly holding the substrate in a receiving unit (3);

pre-weighing a solid material to be coated on the substrate by a dosing unit (1);

45 mixing the weighed solid material with the conveying gas flow and convey them to the

receiving unit (3) by the conveying unit (2) to coat the substrate; and
removing the coated substrate from the receiving unit (3).

14. the process according to claim 13, wherein the substrate (10) is a substrate for a wall-flow filter.

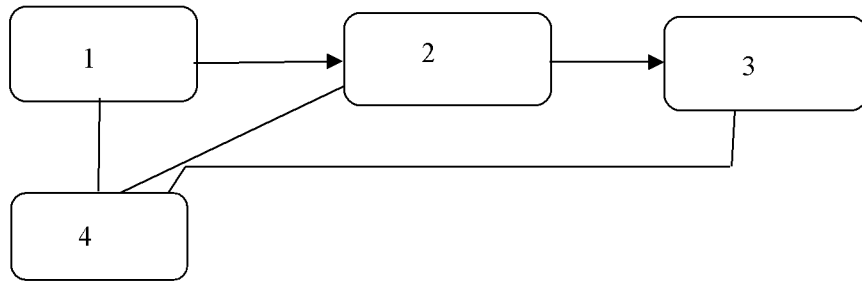


FIG. 1

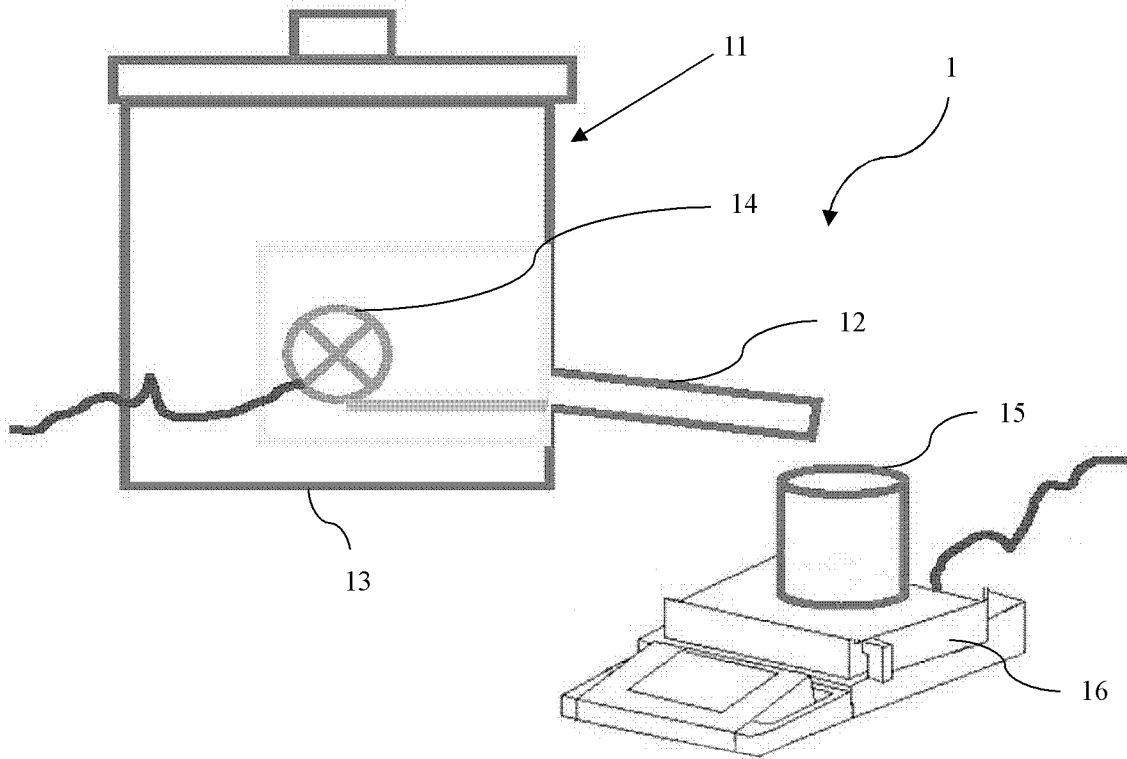


FIG. 2

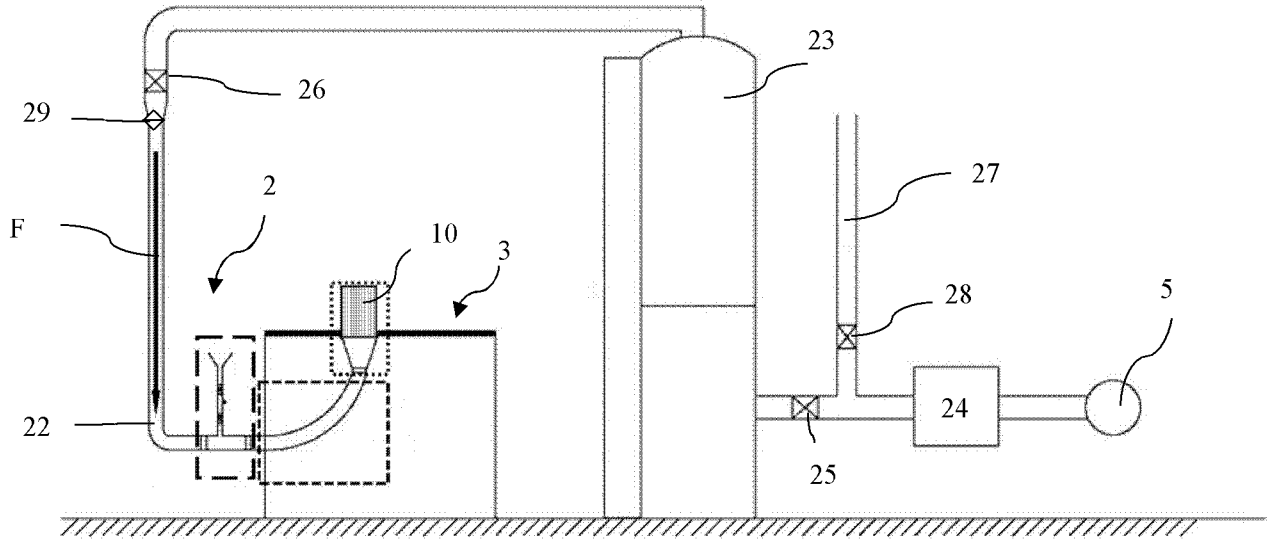


FIG. 3

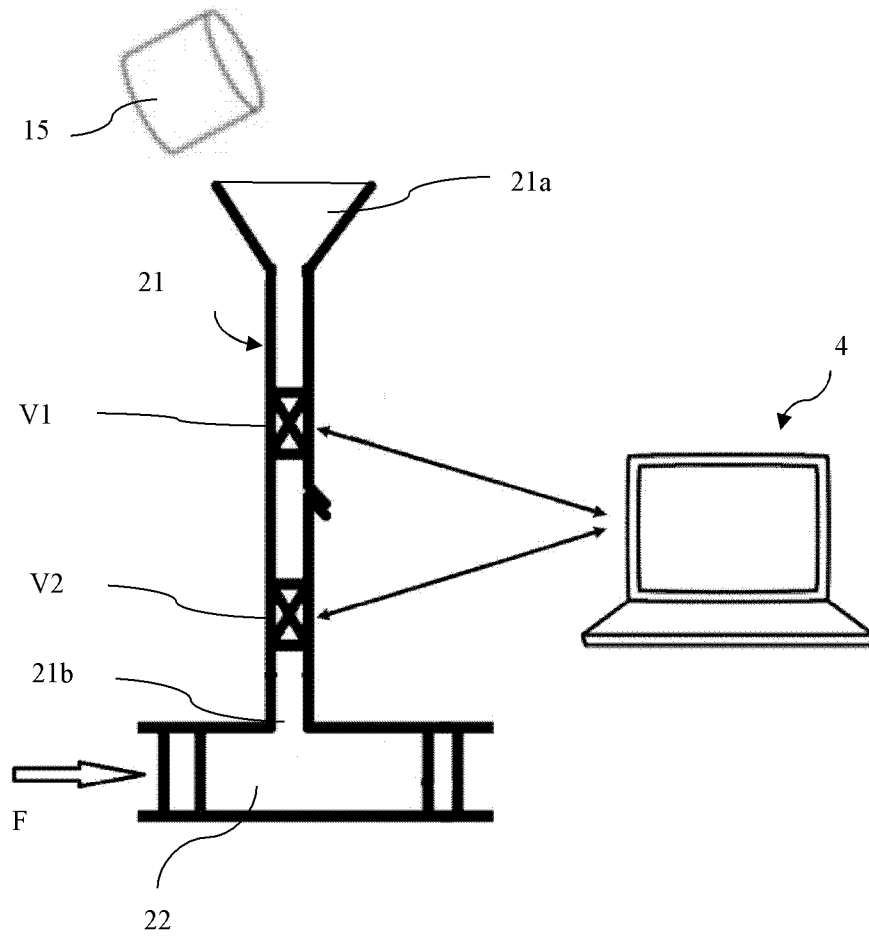


FIG. 4

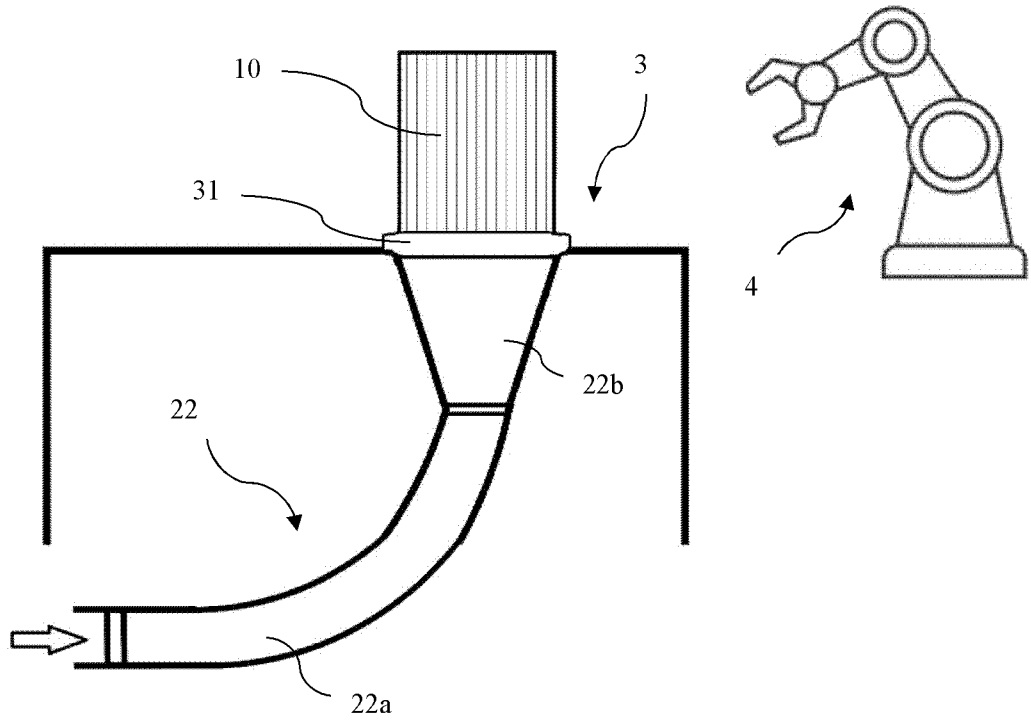


FIG. 5

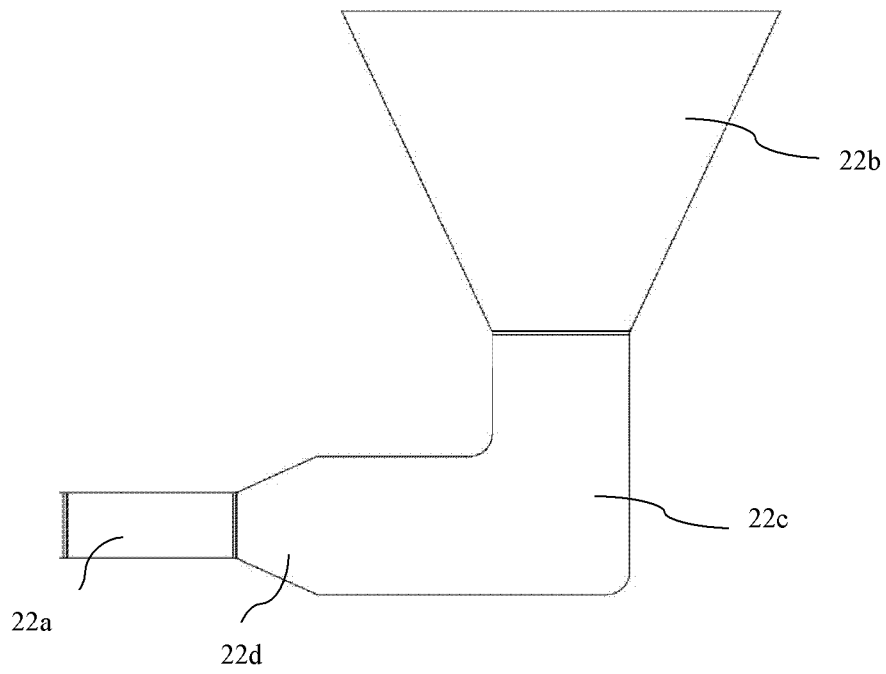


FIG. 6



FIG.7

INTERNATIONAL SEARCH REPORT

International application No.

PCT/CN2022/113358

A. CLASSIFICATION OF SUBJECT MATTER		
F01N 3/035(2006.01)i; B01J 37/02(2006.01)i		
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) F01N; B01J; 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 practicable, search terms used) CNTXT;WPABSC;ENTXTC;WPABS;ENTXT;DWPI;CNKI;ISI web of science;BASF, filter, coat+, convey, transfer, hold+, secure+, gravymeter, mass meter, pipe, tube		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 2011229635 A1 (NGK. INSULATORS LTD.) 22 September 2011 (2011-09-22) paragraphs [0070], [0072], [0075], [0078], [0092]-[0093], figures 1-7	1-14
A	CN 101970088 A (BASF CORP.) 09 February 2011 (2011-02-09) the whole document	1-14
A	CN 112105440 A (UMICORE AG. & CO. KG.) 18 December 2020 (2020-12-18) the whole document	1-14
A	CN 101600858 A (BASF Catalysts LLC.) 09 December 2009 (2009-12-09) the whole document	1-14
A	US 6478874 B1 (ENGELHARD CORP.) 12 November 2002 (2002-11-12) the whole document	1-14
A	US 6599570 B1 (JOHNSON MATTHEY PLC.) 29 July 2003 (2003-07-29) the whole document	1-14
<input type="checkbox"/> Further documents are listed in the continuation of Box C. <input checked="" type="checkbox"/> 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 "E" earlier application or patent but published on or after the international filing date "L" 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) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "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 "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 "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 "&" document member of the same patent family		
Date of the actual completion of the international search 16 September 2022		Date of mailing of the international search report 10 October 2022
Name and mailing address of the ISA/CN National Intellectual Property Administration, PRC 6, Xitucheng Rd., Jimen Bridge, Haidian District, Beijing 100088, China Facsimile No. (86-10)62019451		Authorized officer LI,Zhipeng Telephone No. 86-(10)-53962801

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2022/113358

Patent document cited in search report			Publication date (day/month/year)	Patent family member(s)			Publication date (day/month/year)
US	2011229635	A1	22 September 2011	CN	102188858	A	21 September 2011
				JP	2011212671	A	27 October 2011
				MX	357753	B	23 July 2018
				EP	2371452	A1	05 October 2011
				US	2013260029	A1	03 October 2013
				MX	2011002876	A	29 September 2011
				US	8495968	B2	30 July 2013
CN	101970088	A	09 February 2011	JP	2017121624	A	13 July 2017
				EP	2240259	A1	20 October 2010
				US	2009155134	A1	18 June 2009
				US	2009155135	A1	18 June 2009
				JP	2015157285	A	03 September 2015
				WO	2009079590	A1	25 June 2009
				MY	152756	A	28 November 2014
				ZA	201005017	B	28 September 2011
				JP	2011506095	A	03 March 2011
				KR	20100106497	A	01 October 2010
				BR	PI0820724	A2	16 June 2015
				CA	2708235	A1	25 June 2009
				CN	112105440	A	18 December 2020
WO	2019215208	A1	14 November 2019				
EP	4043088	A1	17 August 2022				
US	2021236976	A1	05 August 2021				
EP	3595796	A1	22 January 2020				
CN	101600858	A	09 December 2009	ZA	200904519	A	29 September 2010
				CN	101600857	A	09 December 2009
				ZA	200904518	A	29 September 2010
				AR	064113	A1	11 March 2009
				US	2008127638	A1	05 June 2008
				WO	2008070551	A2	12 June 2008
				EP	2102460	A2	23 September 2009
				KR	20090102781	A	30 September 2009
US	6478874	B1	12 November 2002	WO	0110573	A2	15 February 2001
				BR	0013079	A	30 April 2002
				KR	20020048386	A	22 June 2002
				US	2003003232	A1	02 January 2003
				AT	359875	T	15 May 2007
				CN	1368905	A	11 September 2002
				DE	60034461	D1	31 May 2007
				EP	1204489	A2	15 May 2002
				AU	6373400	A	05 March 2001
				TW	512073	B	01 December 2002
				JP	2003506211	A	18 February 2003
				US	6599570	B1	29 July 2003
DK	1064094	T3	03 February 2003				
US	2004001919	A1	01 January 2004				
DE	69903139	D1	31 October 2002				
MY	119840	A	29 July 2005				
JP	2002506720	A	05 March 2002				

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

PCT/CN2022/113358

Patent document cited in search report	Publication date (day/month/year)	Patent family member(s)	Publication date (day/month/year)
		MX PA00009180 A	01 April 2001
		GB 9805815 D0	13 May 1998
		AU 3265299 A	11 October 1999
		EP 1064094 A1	03 January 2001
		WO 9947260 A1	23 September 1999
		CA 2324546 A1	23 September 1999
<hr/>			