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(54) Title: METHOD AND DEVICE FOR IN-LINE FAT STANDARDIZATION OF A DAIRY PRODUCT

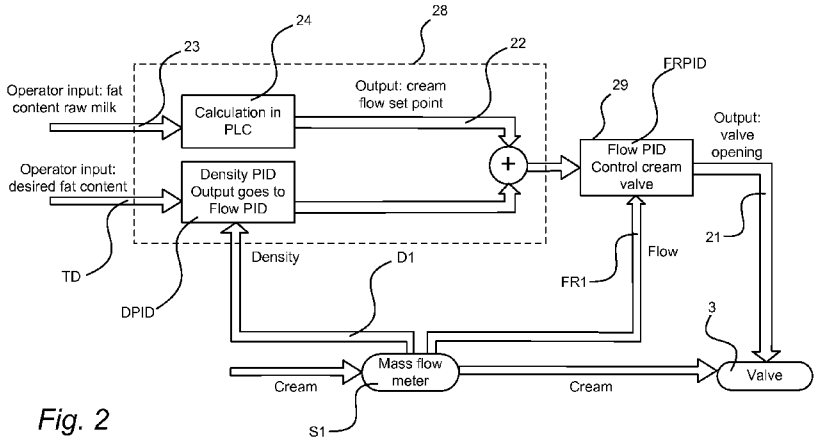

Fig. 2

(57) Abstract: The invention relates to method for in-line fat standardization of a dairy product from a separator. The separator comprises an inlet for a dairy product, a first outlet for a first processed dairy product, a second outlet for a second dairy product. The first processed dairy product has a higher fat concentration than the second processed dairy product. The method comprises the steps of detecting a fat content of said first processed dairy product or said second processed dairy product, and controlling a fat content of said first processed dairy product, using a valve connected to said first outlet, based on said detected density. The device also relates to a device for in-line fat standardization of a dairy product.

METHOD AND DEVICE FOR IN-LINE FAT STANDARDIZATION OF A DAIRY PRODUCT

Technical field

The invention relates to a method and a device for in-line fat standardization of a dairy product from a separator.

Background art

Standardization means that the dairy processes the incoming whole milk, the fat content of which may vary, to make market milk with a specified constant fat content - standardized milk. If the specified constant fat content is higher than that of the incoming whole milk, the process will involve removing some of the skim milk, and the dairy will have a skim milk surplus. Normally, however, standardization proceeds to a lower fat content than that of the incoming whole milk. The process therefore leaves a surplus of fat, which can be used for example to make butter. The same type of standardization applies also for e.g. whey standardization, cream concentration, milk separation at high temperatures, where the milk is melted, or at lower temperatures, where the milk fat is solid or partly solid, or milk with ingredient addition.

The process of standardization can be arranged in three different ways: prestandardization, poststandardization, or direct standardization in line. The first step in all three methods is to separate whole milk into cream and skim milk.

Prestandardization means that the milk is standardized before being pasteurized. To adjust the fat content upward, separated cream is mixed with raw whole milk in tanks in proportions calculated to give the required fat content. To standardize to a lower fat content, the raw whole milk is diluted with separated skim milk. After analysis and adjustment, the standardized milk is pasteurized.

In poststandardization, pasteurized whole milk is mixed in tanks with either cream or skim milk, according to whether the fat content is to be adjusted upward or downward, in the same way as in the case of prestandardization. However, as poststandardization involves mixing already

pasteurized products, some risk of reinfection is involved. Both methods, moreover, require the use of large, bulky tanks, and the work of analysis and adjustment is labour-intensive.

The third method, direct standardization, has therefore been an attractive alternative for industrial needs. In this method, the fat content is adjusted to the desired level by immediate remixing of a calculated proportion of the cream flow from the separator to the skim milk line.

Direct standardization begins with separation of cold or preheated whole milk into cream and skim milk of constant fat content. A regulated amount of cream is then remixed with the skim milk in an in-line system immediately after the separator to obtain standardized milk of the required fat content.

To obtain the necessary degree of precision in the process, it is necessary to be able to control all variable parameters such as fluctuations in the fat content of the incoming milk; fluctuations in throughput; fluctuations in preheating temperature.

Most of these variables are interdependent; any deviation in one step of the process therefore often results in deviations in all stages. Unless such deviations can be quickly corrected, precision of standardization will suffer and the fat content of the standardized milk will deviate from the specified value.

Performing direct standardization in a way that can handle many types of dairy products requires a rather complicated control system with online analysis of the cream flow and the skim milk flow. Such a control system includes a number of valves, connections, sensors and control equipment. One such automated direct standardization system is the Tetra Alfast sold by the Tetra Pak that can handle a variety of dairy products that has to be standardized, milk being the most common.

However, when a dairy only needs to standardize simple dairy products as milk a Tetra Alfast or similar complex machine that can control the fat content and also contents of other substances to a very exact level for many different dairy products may be unnecessary expensive. There is thus a need for a simplified automated direct standardization method for simple

standardization that does not require more complex automation as e.g. Tetra Alfast.

Summary of the invention

It is an object of the present invention to improve the current state of the art, to solve the above problems, and to provide an improvement of in-line fat standardization of a dairy product from a separator.

According to a first aspect of the invention, these and other objects are achieved in full, or at least in part, by a method for in-line fat standardization of a dairy product from a separator. The separator comprises an inlet for a dairy product, a first outlet for a first processed dairy product, a second outlet for a second dairy product. The first processed dairy product has a higher fat concentration than the second processed dairy product. The method comprises the steps of detecting a fat content of said first processed dairy product or said second processed dairy product, and controlling a fat content of said first processed dairy product, using a valve connected to said first outlet, based on said detected density. The method is advantageous in that it provides a simple yet reliable fat content control system using an absolute minimum of components. The step of controlling the fat content of said first processed dairy product may be further based on a known fat content of said dairy product and a known flow rate of said dairy product into said separator.

The fat content of said dairy product and said flow rate of said dairy product into said separator may be measured upstream an inlet to said separator. This way all necessary input relating to the dairy product will be available when the dairy product enters into the separator.

The valve may be controlled to a flow rate according to the following mass balance equation: FR1 = FRR * (FC1 - FCR) / (FC1 – FC2), wherein FR1 is the flow rate of said first processed dairy product; FRR is the flow rate of said dairy product; FC1 is the fat content of said first processed dairy product; FCR is the fat content of said dairy product; FC1 is the fat content of said first processed dairy product; and FC2 is the fat content of second processed dairy product. This is a preferred embodiment of the present invention and a reliable solution for providing the necessary input to the

regulating valve or a control unit controlling the regulating valve. Additionally, the flow rate of said second processed dairy product may be calculated as: FR2 = FRR - FR1, wherein FR2 is the flow rate of said second processed dairy product.

According to a second aspect of the invention, these and other objects are achieved in full, or at least in part, by a device for in-line fat standardization of a dairy product. The device comprises: a separator for separating a dairy product of a known fat content at a known flow rate into a first processed dairy product and a second processed dairy product. The separator has a first outlet for said first processed dairy product and a second outlet for said second dairy product, wherein said first processed dairy product has a higher fat concentration than the second processed dairy product. The device further comprises a first fat sensor for detecting a fat content of said first processed dairy product at said first outlet or of said second processed dairy product at said second outlet, and a valve connected to said first outlet, said valve being adapted to control a flow of said first processed dairy product out of said first outlet based on said detected fat content. The device is advantageous in that it provides a simply yet reliable fat content control system using an absolute minimum of components. If, for example, the fat content of said first processed dairy product, measured by the first fat sensor is considered too high, the flow of said first processed dairy product out of said first outlet may be regulated using the regulating valve. By limiting the flow of said first processed dairy product through the first outlet, the pressure is increased and thereby the fat content decreased.

The first fat sensor may be a mass flow meter providing both mass flow and volume flow or a density meter combined with a volume flow meter. The device may further comprise a dairy product flow meter measuring the flow rate of said dairy product entering said separator, and or a second fat sensor for detecting the fat content of said dairy product entering said separator. The detected measurements from these sensors may be used to perform calculations for the control of the valve by means of a control unit. By using a control unit, the entire control system may be automated. Thus, with the

exception of a potential manual input of some standard values for the product to be processed, no manual contribution will be necessary.

When the method and device described above are used for standardizing milk, the dairy product is whole milk, the first dairy product is cream and the second dairy product is skim milk. The device for in-line fat standardization of a dairy product may, however, also be used for standardization of whey, cream concentration, milk separation at high temperatures where the milk is melted or at lower temperatures where the milk fat is solid or partly solid or milk with ingredient addition.

Generally, all terms used in the claims are to be interpreted according to their ordinary meaning in the technical field, unless explicitly defined otherwise herein. All references to "a/an/the [element, device, component, means, step, etc.]" are to be interpreted openly as referring to at least one instance of said element, device, component, means, step, etc., unless explicitly stated otherwise.

Brief description of the drawings

The above objects, as well as additional objects, features and advantages of the present invention, will be more fully appreciated by reference to the following illustrative and non-limiting detailed description of preferred embodiments of the present invention, when taken in conjunction with the accompanying drawings, wherein:

Fig. 1 is a schematic drawing of a device for in-line fat standardization of a dairy product according the invention.

Fig. 2 is a block diagram showing a cascade control loop for controlling the flow rate of a first dairy product and thereby the fat content of said first dairy product.

Detailed description of preferred embodiments of the invention

Fig. 1 shows a device 1 for in-line fat standardization of a dairy product comprising a separator 2, having an inflow of a dairy product with a flow rate FRR. The separator 2 separates the dairy product, e.g. whole milk, into a first processed dairy product flowing out through a first conduit 4 with a flow rate

FR1, and a second processed dairy product flowing out through a second conduit 5 with a flow rate FR2. A valve 3 is placed on the first conduit 4, being able to throttle the flow FR1 of the first processed dairy product. A first fat sensor S1 is also arranged on the first conduit 4 able to measure fat content of the first processed dairy product flowing in the first conduit 4. The first fat sensor S1 may e.g. be a mass flow meter able to measure mass flow and volume flow or a density meter. The valve is controlled by a control unit 6 dependent on the value measured by first fat sensor S1 and a control algorithm. The control algorithm is based on a mass balance equation according to:

FR1 = FRR * (FC1 - FCR) / (FC1 – FC2), wherein

FR1 is the flow rate of said first processed dairy product; FRR is the flow rate of said dairy product; FC1 is the fat content of said first processed dairy product; FCR is the fat content of said dairy product; FC1 is the fat content of said first processed dairy product; and FC2 is the fat content of second processed dairy product.

The fat content of the dairy product is either known for the batch that is processed from previous analysis of the dairy product and manually entered into the control unit or measured by a second fat sensor (not shown). The fat content of the second dairy product FC2 can be calculated by the fat content of the dairy product FCR and the fat content of the first processed dairy product FC1. The in-flow into the separator 2 FRR is either known from other equipment in the dairy or measured by a flow meter (not shown). The flow rate of said second processed dairy product FR2 can be calculated by the flow rate of said dairy product FRR, also referred to as the raw dairy product, and the flow rate of said first processed dairy product FR1.

Fig. 2 shows a cascade control loop. The fat content of the first dairy product FC1 is measured by the fat sensor S1 and calculated (if needed) into a density D1 provided to a density PID regulator. A target value for the density TD of the first dairy product is also provided to the density PID regulator DPID.

The fat content of the dairy product is input to a calculation unit which will calculate an initial value for the flow rate of the first dairy product.

The output signal from the density PID regulator (DPID) is provided to a flow rate PID regulator (FRPID) together with the initial value 22 for the flow rate of the first dairy product FR1. The initial value 22 is calculated 24 from the input value 23 of the flow rate of the dairy product FRR. The flow rate PID regulator (FRPID) calculates the deviation in fat content in the first dairy product compared to the target value for the density TD and provides an output signal 21 that controls the valve 3 and thereby the flow rate of the first dairy product FR1.

The control unit 6 executes the cascade control loop, and the cascade control loop comprises a primary controller 28 and a secondary controller 29. The primary controller 28 uses a value representing a density of the first processed dairy product (the cream) as control input, and the second controller 29 uses a value representing a flow rate of the first processed dairy product as control input. The primary controller 28 applies its control to the measured density against a desired density. The desired density corresponds to a desired fat content, and conversions between fat content and density is done according to known techniques and principles. Control in respect of a “fat content” may thus be understood as control in respect of a “density”, and vice versa. The primary controller then provides a varying setpoint, i.e. a flow set point, to the secondary controller 29, which in turn controls the process (valve 3) directly.

Even though specific wording has been used in some parts this should not be understood as a restriction of the general concept, but as examples. For instance, the wording “raw dairy product” should be understood as any product fed into the separator and not necessarily an unprocessed milk product. The features of the method for in-line fat standardization of a dairy product may be implemented for the device for in-line fat standardization of a dairy product, and vice versa.

CLAIMS

1. Method for in-line fat standardization of a dairy product from a separator, said separator comprising an inlet for a dairy product, a first outlet for a first processed dairy product, a second outlet for a second dairy product, said first processed dairy product having a higher fat concentration than the second processed dairy product, said method comprising the steps of:

detecting a fat content of said first processed dairy product or said second processed dairy product, and

controlling a fat content of said first processed dairy product, using a valve connected to said first outlet, based on said detected fat content.

2. Method according to claim 1, wherein said step of controlling the fat content of said first processed dairy product is further based on a known fat content of said dairy product and a known flow rate of said dairy product into said separator.

3. Method according to claim 2, wherein said fat content of said dairy product and said flow rate of said dairy product into said separator are measured upstream an inlet to said separator.

4. Method according to any one of the preceding claims, wherein the detected fat content is determined based on a density of the first processed dairy product.

5. Method according to any one of the preceding claims, wherein said step of controlling the fat content of said first processed dairy product is done using a cascade control loop.

6. Method according to claim 5, wherein the cascade control loop comprises a primary controller (28) and a secondary controller (29),

the primary controller (28) using a value representing a density of the first processed dairy product as control input,

the second controller (29) using a value representing a flow rate of the first processed dairy product as control input.

7. Method according to any one of the preceding claims, wherein said said valve is controlled to a flow rate according to the following equation:
FR1 = FRR * (FC1 - FCR) / (FC1 – FC2), wherein
FR1 is the flow rate of said first processed dairy product;
FRR is the flow rate of said dairy product;
FC1 is the fat content of said first processed dairy product;
FCR is the fat content of said dairy product;
FC1 is the fat content of said first processed dairy product; and
FC2 is the fat content of second processed dairy product.

8. Method according to claim 7, wherein the flow rate of said second processed dairy product is calculated as:
FR2 = FRR - FR1, wherein FR2 is the flow rate of said second processed dairy product.

9. Device for in-line fat standardization of a dairy product, comprising:
a separator for separating a dairy product into a first processed dairy product and a second processed dairy product, said separator having a first outlet for said first processed dairy product and a second outlet for said second dairy product, said first processed dairy product has a higher fat concentration than the second processed dairy product
a first fat sensor for detecting a fat content of said first processed dairy product at said first outlet or of said second processed dairy product at said second outlet,
a valve connected to said first outlet, said valve being adapted to control a flow of said first processed dairy product out of said first outlet based on said detected fat content.

10. Device according to claim 9, wherein said first fat sensor is a mass

flow meter providing both mass flow and volume flow or a density meter combined with a volume flow meter.

11. Device according to any one of claims 9-10, further comprising a dairy product flow meter measuring the flow rate of said dairy product entering said separator.

12. Device according to any one of claims 9-11, further comprising a second fat sensor for detecting the fat content of said dairy product entering said separator.

13. Device according to any one of claims 9-12, further comprising a control unit performing calculations for the control of said valve.

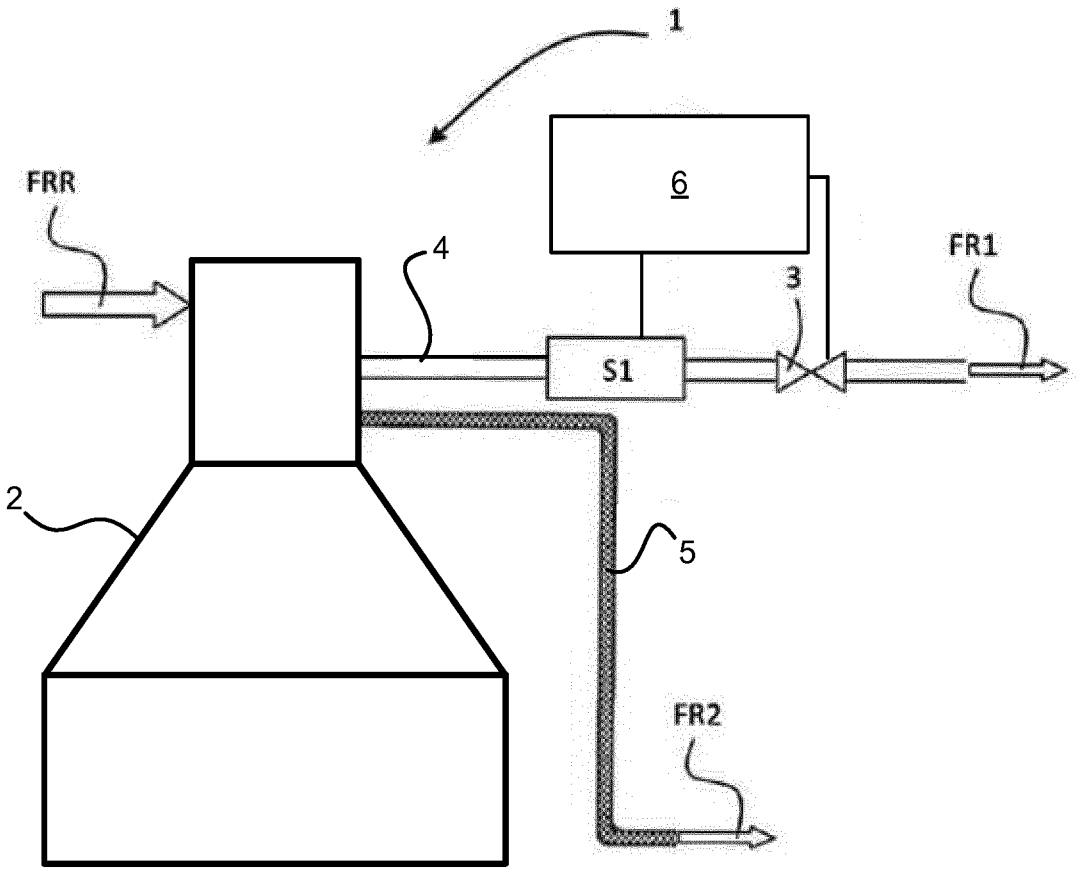

Fig. 1

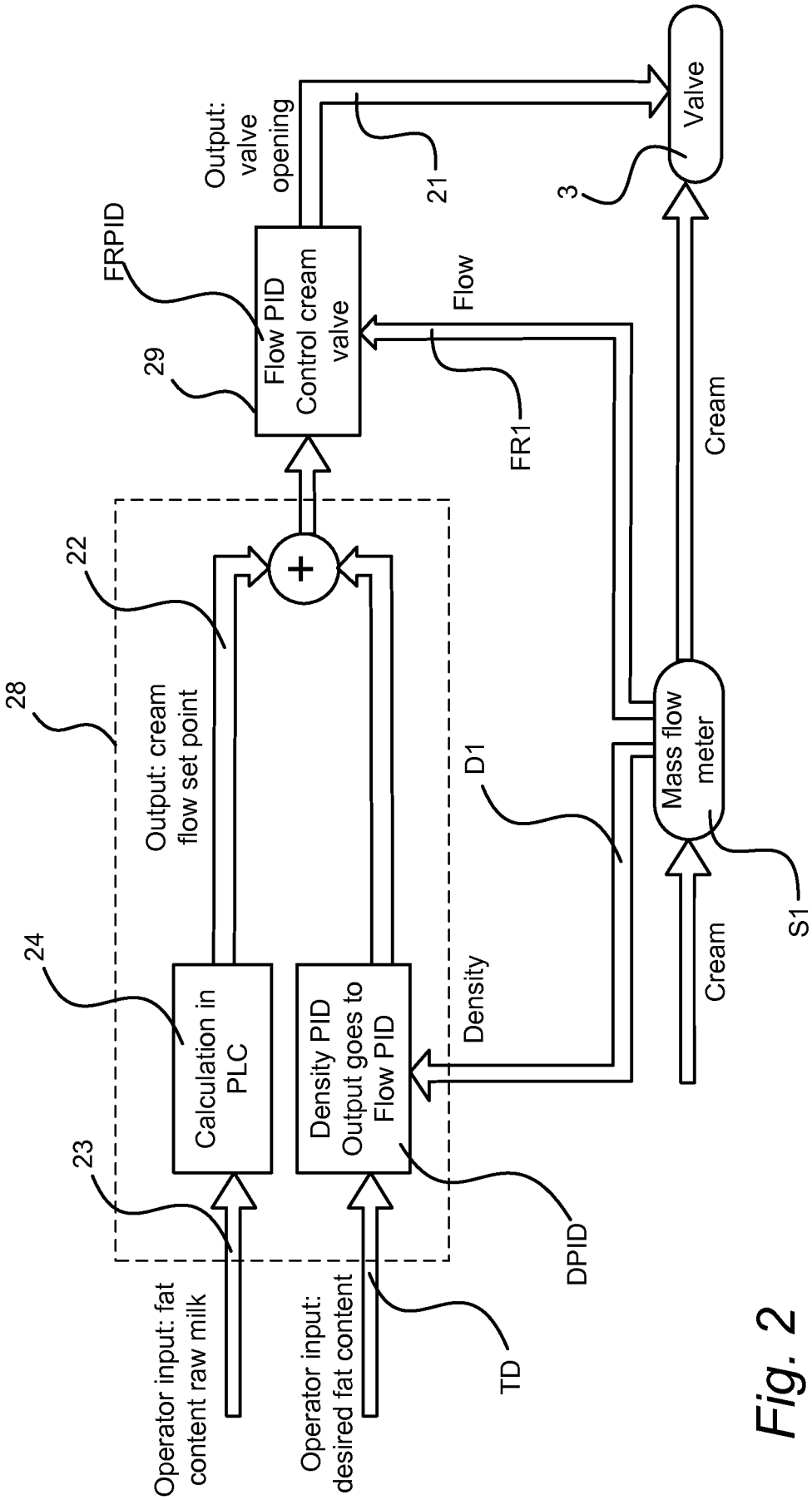
Valve
3
Output: valve opening
21
FRPID
Flow PID Control cream valve
29
Flow
FR1
Cream
22
+
28
Output: cream flow set point
D1
Mass flow meter
S1
24
Calculation in PLC
Density PID Output goes to Flow PID
Density
Cream
23
DPID
Operator input: fat content raw milk
Operator input: desired fat content
TD

Fig. 2

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2016/065662

A. CLASSIFICATION OF SUBJECT MATTER
INV. A23C9/15 A01J11/10 G01N33/06
ADD.

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)
A23C A01J G01N

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)
EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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[X] Further documents are listed in the continuation of Box C.

[X] See patent family annex.

* Special categories of cited documents :

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"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	Date of mailing of the international search report
7 September 2016	10/10/2016

Name and mailing address of the ISA/	Authorized officer
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Form PCT/ISA/210 (second sheet) (April 2005)

C(Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
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INTERNATIONAL SEARCH REPORT

Information on patent family members

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