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(54) Title: WOUND FILTER MODULE

(57) Abstract: A filter module comprising a body of wound layers of a sheet material, the body having an inlet and an outlet and a winding axis, the sheet material having a plurality of openings formed therein, the openings forming two types of channels within the wound layers of sheet material of the body, a first type of channels being open at one end at the inlet and closed at the other end located adjacent to the outlet, a second type of channels being open at one end at the outlet and closed at the other end located adjacent to the inlet, the channels of the first type being separated from the channels of the second type by portions of sheet material, and a process for manufacturing a filter module.
Wound Filter Module

Description

The invention relates to a filter module comprising a body of wound layers of a sheet material, the body having an inlet and an outlet and a winding axis, the sheet material having a plurality of openings formed therein, the openings forming two types of channels within the wound layers of sheet material of the body, a first type of channels being open at one end at the inlet and closed at the other end located adjacent to the outlet, a second type of channels being open at one end at the outlet and closed at the other end located adjacent to the inlet, the channels of the first type being separated from the channels of the second type by portions of sheet material.

Such a filter module is described in US 7 934 604 B2. A filter module is proposed, comprising a body of wound layers of a sheet material, said body having an inner and an outer peripheral surface, a winding axis and a passage extending along the winding axis of said body and in fluid communication with said inner peripheral surface. The sheet material has a plurality of openings formed therein, said openings forming at least two types of channels within the wound layers of sheet material of said body, said channels extending in a direction from the inner peripheral surface to the outer peripheral surface. A first type of channel formed in said body is open at one end at the outer peripheral surface of the body and closed at the other end located adjacent to the inner peripheral surface. A second type of channel is open at one end at the inner peripheral surface of the body and in fluid communication with said passage and closed at the other end located adjacent to the outer peripheral surface. The different types of channels are separated from one another by portions of sheet material such that fluid to be filtered and entering one type of channels may reach the other type of channel and exit the filter module only by migrating through a portion of said body formed by the sheet material separating these different types of channels. One type of channel is communicating with a fluid inlet of said filter module, another type of channels is communicating with an outlet of said filter module.
In filtration technology, filter modules as described above are developed, which provide for a compact body representing a high filtration capacity per volume. It is a drawback of the filter module described above that a passage extending along the winding axis of the body is necessary to provide a fluid communication with the one type of the channels, which are open to the inner peripheral surface. The passage volume thus cannot be used for filtration capacity.

It is an objective of the present invention to provide a filter module with a body of wound layers of a sheet material, with a body that is similarly compact or more compact, in particular with a decreased volume of the passage extending along the winding axis.

The objective is accomplished by a filter module according to claim 1. The depending claims recite favourable embodiments.

The filter module according to the invention comprises a body of wound layers of a sheet material, the body having an inlet plane and an outlet plane and a winding axis extending from the inlet plane to the outlet plane. The body of wound layers of a sheet material will generally have a cylindrical or hollow cylindrical form with a top and bottom plane, which define the inlet plane and the outlet plane according to the invention.

Further, according to the invention, the sheet material has a plurality of openings formed therein, the openings forming two types of channels within the wound layers of sheet material of the body, wherein the channels extend in a direction parallel to the winding axis between the inlet plane and the outlet plane. It is an advantage of the invention that the channels generally run in parallel to the winding axis, because unlike the state of the art filter elements with channels running in radial direction, the filter element body according to the invention does not need a hollow passage along the winding axis. Instead, almost the full volume of the generally cylindrical body is available for filtering purposes and thus increases the filtering performance. Of course, the filter module according to the invention may as well have an axial passage, which may be necessary due to production conditions. For example, the body of wound layers
of sheet material is produced by coiling the sheet material onto a spindle or winding form.

Further, according to the invention, a first type of channels is open at one end at the inlet plane of the body and closed at the other end located adjacent to the outlet plane of the body, and a second type of channels is open at one end at the outlet plane of the body and closed at the other end located adjacent to the inlet plane of the body. The channels of the first type are separated from the channels of the second type by portions of sheet material, such that fluid to be filtered and entering the first type of channels or inlet channels may reach the second type of channels or outlet channels and exit the filter module only by migrating through a portion of the body formed by the sheet material separating the different types of channels.

According to a preferred embodiment, the sheet material is composed of at least two types of sheet layers, all types of sheet layers having a first edge forming the inlet plane of the body and having a second edge forming the outlet plane of the body, a first type of sheet layer being formed by a flat filter sheet with notches cut out of the flat filter sheet alternatingly from the first edge and from the second edge to obtain the plurality of openings, and a second type of sheet layer being formed by an uncut flat filter sheet. The flat filter sheets of the first and second type of sheet layer preferably have similar filtering performances. The notches preferably extend straightly and perpendicularly from the first and second edges, though any angular or curved extension would be possible, as well, as long as the notches cut from the first edge are separated from the notches cut from the second edge, in order to provide separated openings in the body of wound layers of sheet material. The term notches does not imply any limitation with regard to the form of the cut out portions, which will generally have a long and thin form. Instead of using the term notches, the cuts are equivalently described as slits. The notches or slits are cut according to any suitable cutting technique, like for example, stamping. Preferably, however, the notches are cut out by means of waterjet cutting.

A length of the cut out notches or slits from the first edge towards the second edge, or vice versa, and thus the length of the openings from the inlet plane or the outlet plane to
the respective dead ends, is preferably longer than half the distance between the inlet plane and the outlet plane. Hence, the notches or slits cut from the first edge overlap with the notches or slits cut from the second edge. In particular, the notches are as long as possible, with regard to production conditions. The respective dead ends of the resulting openings are then located close to the inlet or outlet plane, respectively. According to a preferred embodiment, a flat filter sheet of the first type of sheet layer results, which comprises a meandering form, alternatingly extending between the first edge and the second edge.

After the body of wound layers of a sheet material has been made by winding the sheet material around a winding axis, preferably, each opening of the plurality of openings comprises four delimiting walls, comprising a first pair of opposite walls and a second pair of opposite walls. The first pair of opposite walls is formed by the first type of sheet layer, in particular by cutting edges of the cut out notch of the respective flat filter sheet. The second pair of opposite walls is formed by the second type of sheet layer, wherein, however, the two opposite walls are formed by different layers of either the same flat filter sheet or two flat filter sheet, depending on the number of flat filter sheet of the second type used to compose the sheet material for winding the body.

The minimum number of sheet layers used to compose the sheet material for winding the body, would be two, one each of the first and the second type of sheet layer. After winding the sheet material, the body comprises of alternating first and second type sheet layers. According to a further preferred embodiment, however, the sheet material is composed of three sheet layers, one sheet layer of the first type of sheet layers being sandwiched between two sheet layers of the second type of sheet layers. The body thus comprises a sequence of layers, beginning with one second type sheet layer, one first type sheet layer, two second type sheet layers, wherein the sequence of one first type sheet layer and two second type sheet layers is continued, finally ending with one single second type sheet layer succeeding the last first type sheet layer.

Generally, the flat filter sheet of both types of sheet layer are equally thick. According to an alternative embodiment, however, the flat filter sheet of the first type of sheet layer is
thicker than the flat filter sheets of the second type of sheet layers, particularly about
twice as thick. This embodiment may advantageously applied, for example, if only the
minimum number of two sheet layers is used to compose the sheet material for winding
the body.

Generally, the openings forming the first type of channels may have similar dimensions,
with regard to e.g. length and width, as the openings forming the second type of
channels. According to yet a further preferred embodiment, however, the openings
forming the first type of channels are bigger than the openings forming the second type
of channels, the openings forming the first type of channels particularly being wider in a
direction perpendicular to the winding axis. The width of the channels is defined by the
width of the notches cut out of the flat filter sheet of the first type of sheet layer. A height
of the channels in a direction parallel to the winding axis depends on the thickness of the
flat filter sheet of the first type of sheet layer and will thus be identical for both the
openings forming the first type of channels and the openings forming the second type of
channels. A width difference or ratio between the openings forming the first type of
channels and the openings forming the second type of channels is preferably set in
dependence of filtering parameters in order to optimize the filtering performance.

The filter module body certainly has an outer peripheral surface, and preferably, the
filter module body also has an inner peripheral surface, which is, for example, necessary
due to production conditions, as explained before. A resulting passage in fluid
communication with said inner peripheral surface extends along the winding axis of the
body, and is preferably sealed by at least one first gasket, particularly at an end of the
passage, more particularly at the end located at the inlet plane.

According to yet a further preferred embodiment, at least one second gasket is provided
surrounding the outer peripheral surface of the body, preferably at an end of the outer
peripheral surface, in particular at the end located at the outlet plane. The second gasket
surrounding the outer peripheral surface of the body is advantageously suitable to seal
the filter module against a filter housing. With the filter module installed inside a filter
housing, the body, the first gasket and the second gasket expediently separate a fluid
inlet side from a fluid outlet side, the first type of channels being inlet channels communicating with the fluid inlet of the filter module and the second type of channels being outlet channels communicating with the fluid outlet of the filter module.

The invention also refers to a process for manufacturing of a filter module as described in here before, which therefor is also suitable to accomplish the above stated objective of the invention.

According to the process for manufacturing, the sheet material is wound around a winding axis, preferably onto a support element, to form a body of a multiplicity of consecutive layers, the body having an inlet plane and an outlet plane, the winding axis extending from the inlet plane to the outlet plane. A plurality of openings is formed in the sheet material to provide two types of channels extending within the wound layers of sheet material of the body in a direction parallel to the winding axis between the inlet plane and the outlet plane. A first type of channels is made open at one end at the inlet plane of the body and closed at the other end located adjacent to the outlet plane of the body. A second type of channels is made open at one end at the outlet plane of the body and closed at the other end located adjacent to the inlet plane of the body, the channels of the first type being formed separately from the channels of the second type by portions of sheet material.

Preferably, at least two types of sheet layers are composed to form the sheet material, all types of sheet layers having a first edge forming the inlet plane of the body and having a second edge forming the outlet plane of the body, wherein a first type of sheet layer is provided by cutting notches into a flat filter sheet alternatingly from the first edge and from the second edge, and wherein a second type of sheet layer is provided as an uncut flat filter sheet. Particularly, the notches are cut out by waterjet cutting.

Furthermore preferably, three sheet layers are composed to form the sheet material, wherein one sheet layer of the first type of sheet layers is sandwiched between two sheet layers of the second type of sheet layers.
The invention will now be exemplified with reference to an embodiment shown on the attached drawing sheets. The description refers both to the filter module and to the process for manufacturing. The general inventive idea, however, is not limited by the referenced exemplary embodiment.

In the drawings

Figure 1 shows a schematic view of an embodiment of the filter module according to the invention, with the body of wound layers of a sheet material partly unwound;

Figure 2 shows a schematic sectional view of the embodiment of Figure 1 to illustrate a fluid flow through the filter element;

Figure 3 shows a schematic sectional view of the embodiment of Figure 1 installed into a standard filter housing.

In Figure 1, a schematic view of an embodiment of the filter module 1 according to the invention, with a body 2 of wound layers of a sheet material 7, 8, which is depicted in a partly unwound state to illustrate a layer structure of the body 2. The body 2 has a generally cylindrical form, which is achieved by winding up the layers of sheet material 7, 8 around a winding axis 21, which also represents a longitudinal axis of the cylindrical body 2 in the depicted embodiment. To obtain the filter module 1, the layers of sheet material 7, 8 are tightly wound, preferably onto a winding form 15 to provide an adequate compactness at an inner peripheral of the body 2.

The cylindrical body 2 comprises two parallel planes, one of which serves as an inlet plane 3 and the other one as an outlet plane 4, the winding axis 21 being aligned rectangularly to both planes 3, 4. The sheet material 7, 8 has a plurality of openings 5, 6 formed therein, which are divided into two types of channels within the wound layers of
sheet material 7, 8 of the body 2. The channels or openings 5, 6 extend in a direction parallel to the winding axis 21 between the inlet plane 3 and the outlet plane 4, a first type of channels 5 being open at one end at the inlet plane 3 of the body 2 and closed at the other end located adjacent to the outlet plane 4 of the body 2, a second type of channels 6 being open at one end at the outlet plane 4 of the body 2 and closed at the other end located adjacent to the inlet plane 3 of the body 2. The channels of the first type 5 are separated from the channels of the second type 6 by portions of sheet material 7, 8, such that fluid to be filtered and entering the filter module 1 via the first type of channels 5 may reach the second type of channel 6 and exit the filter module 1 only by migrating through a portion of said body formed by the sheet material 7, 8 separating the different types of channels 5, 6.

Figure 1 further illustrates an aspect of a production process to obtain the filter module 1 according to the invention, wherein the sheet material is composed of at least two types of sheet layers 7, 8, both types of sheet layers 7, 8 having a first edge 10 forming the inlet plane 3 of the body 2 and having a second edge 11 forming the outlet plane 4 of the body 2, a first type of sheet layer 7 being formed by a flat filter sheet with notches 9 or slits 9 cut out of the flat filter sheet 7 alternatingly from the first edge 10 and from the second edge 11 to obtain the plurality of openings 5, 6. The notches 9 cut from the first edge 10 form the first type of channels 5 and the notches 9 cut from the second edge 11 form the second type of channels 6. A second type of sheet layer 8 is formed by an uncut flat filter sheet. The sheet material is, however, composed of three sheet layers, i.e. one sheet layer of the first type of sheet layer 7 being sandwiched between two sheet layers of the second type of sheet layers 8. The flat filter sheet of the first type of sheet layer 7 is preferably thicker than the flat filter sheets of the second type of sheet layers 8, particularly about twice as thick. A preferred way of affecting the inlet filter area and the outlet filter area of the filter module 1, respectively, is to choose a width of the notches 9 cut from the first edge 10 different from a width of the notches 9 cut from the second edge 11, which results in different width of the two types of channels 5, 6, in a direction perpendicular to the winding axis 21. The height of the openings 5, 6 in radial direction of the cylindrical body 2 cannot be chosen differently. A further possible way of affecting the inlet filter area and the outlet filter area of the filter module 1, respectively, is to
choose a length of the notches 9 cut from the first edge 10 different from a length of the notches 9 cut from the second edge 11, which results in different lengths of the two types of channels 5, 6, in a direction parallel to the winding axis 21.

In Figure 2, a schematic sectional view of the embodiment of Figure 1 is shown to illustrate a fluid flow through the filter element. The body 2 of wound layers of the sheet material is sealed by a sealing arrangement 24, which forms a fluid inlet 19 and a fluid outlet 20. The sealing arrangement 24 comprises a first gasket 16 and a second gasket 17, the positions of which may, according to a third variant, be chosen to affect the inlet filter area and the outlet filter area. The body 2 has an inner peripheral surface 14 and an outer peripheral surface 12 and a passage 18 in fluid communication with said inner peripheral surface 15 extending along the winding axis 21 of the body 2, formed by the winding form 15, a perforated plastic roll, for example. At least one first gasket 16 is necessary for sealing the passage 18, in order to separate the fluid inlet 19 from the fluid outlet 20. In the depicted embodiment, the first gasket 16 is provided at an end of the passage 18, in particular at the end located at the inlet plane 3. Therefor the inner peripheral surface 14 is part of the outlet filter area. If the first gasket 16 was provided at the end of the passage 18, which is located at the outlet plane 4, the inner peripheral surface 14 would be part of the inlet filter area. At least one second gasket 17 is provided surrounding the outer peripheral surface 12 of the body 2 and, in the depicted example, seals the body 2 against the sealing arrangement 24, thus also separating the volume inside the sealing arrangement 24 into an inlet side and an outlet side. The second gasket 17 is provided at an end of the outer peripheral surface 12, in particular at the end located at the outlet plane 4. The outer peripheral surface 12 thus is part of the inlet filter area.

The person skilled in the art will recognize that the meandering form of the body 2 shown in the schematic sectional view of Figure 2 does not correspond to the meandering form of the first type of sheet layer 7 with the cut out notches 9 as shown in figure 1. The section through the body 2 shows openings forming the first type of channel 6 and openings forming the second type of channel 7. The wound layers of the sheet material 7, 8, forming the body 2, however, cannot be distinguished into the
different types of sheet layers, here. The arrows without reference numerals shown in
Figure 2 shall illustrate the fluid flow from the fluid inlet 19 into the openings forming the first type of channel 5 or to the outer peripheral surface 12 or directly through the inlet plane 3, further through the flat filter sheet material 7, 8, then into the openings forming the second type of channel 6 or into the passage 18 or directly through the outlet plane 4, and finally to the fluid outlet 20.

The person skilled in the art is aware that the sealing arrangement 24 may be adapted in any order to an application environment, in which the filter element 1 shall be used. One such application is illustrated with reference to Figure 3.

In Figure 3, a schematic view of the embodiment of the filter module 1 according to the invention is shown, which is installed into a standard filter housing 22, depicted in a partly sectional view. The filter housing 22 comprises an intake 27 over which a fluid to be filtered is conveyed into an interior space of the filter housing, where the filter element 1 is installed. The passage 18 (visible in Figure 2) of the filter element 1 is sealed at the end, which is located in the inlet plane 3 by the first gasket 16. A tensioning screw 26 engages the first gasket 16 to retain the filter module 1 securely inside the filter housing 22.

The fluid to be filtered is conveyed through the intake 27 into the filter housing 22 and may enter into the body 2 of wound layers of sheet material, which is held together by straps 23, via the inlet plane 3 with the respective openings and also via the outer peripheral surface 12. The outlet plane 4 of the filter element 1 is sealed by the second gasket 17 against the interior space of the filter housing 22. The second gasket 17 is formed to provide a fluid outlet 20 connecting the outlet plane 4 and the passage 18 to a drain 28 of the filter housing 22, through which the filtered fluid is further conveyed after filtration. The second gasket 17 further supports the body 2 and is mounted on a flat gasket 25 around the drain outlet 28 on a bottom plate 29 of the filter housing 22, which forms a counter bearing for the tensioning screw 26. Instead of one filter module 1 according to the invention, also multiple filter modules 1 may be installed in filter housings of respective dimensions.
Reference numerals

1 Filter module
2 Body of wound layers of a sheet material
3 Inlet plane
4 Outlet plane
5 First type of channel, opening
6 Second type of channel, opening
7 First type of sheet layer, flat filter sheet
8 Second type of sheet layer, flat filter sheet
9 Notches, slits
10 First edge
11 Second edge
12 Outer peripheral surface
14 Inner peripheral surface
15 Winding form, spindle
16 First gasket
17 Second gasket
18 Passage
19 Fluid inlet
20 Fluid outlet
21 Winding axis
22 Filter housing
23 Strap
24 Sealing arrangement
25 Flat gasket
26 Tensioning screw
27 Intake
28 Drain
Bottom plate
Claims

1. A filter module comprising a body of wound layers of a sheet material, the body having an inlet plane and an outlet plane and a winding axis extending from the inlet plane to the outlet plane, the sheet material having a plurality of openings formed therein, the openings forming two types of channels within the wound layers of sheet material of the body, the channels extending in a direction parallel to the winding axis between the inlet plane and the outlet plane, a first type of channels being open at one end at the inlet plane of the body and closed at the other end located adjacent to the outlet plane of the body, a second type of channels being open at one end at the outlet plane of the body and closed at the other end located adjacent to the inlet plane of the body, the channels of the first type being separated from the channels of the second type by portions of sheet material.

2. The filter module according to claim 1, wherein the sheet material is composed of at least two types of sheet layers, all types of sheet layers having a first edge forming the inlet plane of the body and having a second edge forming the outlet plane of the body, a first type of sheet layer being formed by a flat filter sheet with notches cut out of the flat filter sheet alternatingly from the first edge and from the second edge to obtain the plurality of openings, and a second type of sheet layer being formed by an uncut flat filter sheet.

3. The filter module according to claim 2, wherein the notches are cut out by means of waterjet cutting.

4. The filter module according to any one of the preceding claims 2 or 3, wherein the flat filter sheet of the first type of sheet layer is meandering between the first edge and the second edge.

5. The filter module according to any one of the preceding claims 2 through 4, wherein each opening of the plurality of openings comprises four delimiting walls, a first pair of opposite walls being formed by the first type of sheet layer
and a second pair of opposite walls being formed by the second type of sheet layer.

6. The filter module according to any one of the preceding claims 2 through 5, wherein the flat filter sheets of the first and second type of sheet layer have similar filtering performances.

7. The filter module according to any one of the preceding claims 2 through 6, wherein the sheet material is composed of three sheet layers, one sheet layer of the first type of sheet layer being sandwiched between two sheet layers of the second type of sheet layers.

8. The filter module according to any one of the preceding claims 2 through 6, wherein the flat filter sheet of the first type of sheet layer is thicker than the flat filter sheets of the second type of sheet layers, particularly about twice as thick.

9. The filter module according to any one of the preceding claims, wherein the openings forming the first type of channels are bigger than the openings forming the second type of channels, the openings forming the first type of channels particularly being wider in a direction perpendicular to the winding axis.

10. The filter module according to any one of the preceding claims, wherein the body has an inner and an outer peripheral surface and a passage in fluid communication with said inner peripheral surface extending along the winding axis of said body, at least one first gasket sealing the passage, preferably at an end of the passage, in particular at the end located at the inlet plane.

11. The filter module according to claim 10, wherein at least one second gasket is provided surrounding the outer peripheral surface of the body, preferably at an end of the outer peripheral surface, in particular at the end located at the outlet plane.
12. A process for manufacturing of a filter module according any one of claims 1 through 11, wherein the sheet material is wound around a winding axis onto a support element to form a body of a multiplicity of consecutive layers, the body having an inlet plane and an outlet plane, the winding axis extending from the inlet plane to the outlet plane, wherein a plurality of openings is formed in the sheet material to provide two types of channels extending within the wound layers of sheet material of the body in a direction parallel to the winding axis between the inlet plane and the outlet plane, wherein a first type of channels is made open at one end at the inlet plane of the body and closed at the other end located adjacent to the outlet plane of the body, and wherein a second type of channels is made open at one end at the outlet plane of the body and closed at the other end located adjacent to the inlet plane of the body, the channels of the first type being formed separately from the channels of the second type by portions of sheet material.

13. The process according to claim 12, wherein at least two types of sheet layers are composed to form the sheet material, all types of sheet layers having a first edge forming the inlet plane of the body and having a second edge forming the outlet plane of the body, wherein a first type of sheet layer is provided by cutting notches into a flat filter sheet alternatingly from the first edge and from the second edge, and wherein a second type of sheet layer is provided as an uncut flat filter sheet.

14. The process according to claim 13, wherein the notches are cut out by waterjet cutting.

15. The process according to any one of the preceding claims 12 through 14, wherein three sheet layers are composed to form the sheet material, wherein one sheet layer of the first type of sheet layer is sandwiched between two sheet layers of the second type of sheet layer.
INTERNATIONAL SEARCH REPORT

A. CLASSIFICATION OF SUBJECT MATTER

According to International Patent Classification (IPC) or both national classification and IPC

B01D25/00 B01D25/24

ADD.

According to International Patent Classification...

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Fax: (+31-70) 340-3016

Hilt, Daniel

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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)

EPO-Internal, WPI Data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

<table>
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<td>US 2 519 506 A (RUSSELL JOHN K) 22 August 1950 (1950-08-22) column 11, line 4 - line 27; figures 10, 11</td>
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<td>US 5 316 676 A (DR0RI MÔRDEKI [IL]) 31 May 1994 (1994-05-31) the whole document</td>
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