

CARTRIDGE FILTER

The present invention pertains to a tubular filter for filtering fluids and a method of manufacturing said filter and a method of filtering of fluids.

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BACKGROUND OF THE INVENTION

Traditionally, existing fluid filters that are adapted for filtering particles from fluids, are surface filters in the sense that the filtering occurs at just the outer surface of the element where the fluid first enters the element. With very fine surface filter elements, particles tend to accumulate at the outer surface, thereby loading the filter element and cutting off the flow of fluid through it. As a result, filtering is degraded and the element must be changed more frequently than desired. This has been a particular problem with high viscosity fluids such as oil, engine oil in particular. In order to alleviate this surface build-up problem so called string/yarn wound filters wherein a yarn is wound on a tubular bobbin have been developed. These filters have the advantage, that the fluid is filtered all the way along the thickness of the wound yarn. Examples of such yarn wound filters are known from EP 0489157, US 5,552,065, US 4,761,231, US 5,772,952, FR 2097502 and WO 2007/015643.

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SUMMARY OF THE INVENTION

Embodiments of the present invention seek~~It is an object~~ to provide an alternative yarn wound filter that is particularly advantageous for filtering particles from a petrochemical fluid such as oil.

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~~According to the present invention, the above mentioned and other objects are fulfilled by a first aspect of the invention, there is provided~~ According to the present invention, there is provided pertaining to a filter comprising a tubular core with a plurality of apertures and a hollow interior, said core having an open end for fluid communication with the hollow interior, a length of yarn wound in a series of at least three layers around an outer surface of the core, wherein the first layer closest to the surface of the core comprises at least 5 windings of the yarn, the second layer comprises at least 6 windings of the yarn and the third layer comprises at least 10 windings of the yarn and wherein two consecutive layers have been wound in accordance with different winding patterns.

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Investigations performed by the applicant has shown that this particular way of building up the filter in a layered structure of yarn that wound onto the tubular core in

accordance with winding patterns that are different for two consecutive layers and wherein the layers are built up with the minimum number of windings in the first, second, and third layer as stated above, may be particularly effective for filtering petrochemical fluids, especially oil, for particles having a diameter or average particle size in the range from 0.5 μm to 50 μm , without having using excessive pressure, but merely by letting the fluid flow freely through the filter at a pressure that is usually used in engines, power transmissions, such as hydraulics, gears, valves etc.

The tubular core is preferably cylindrical in its shape, and it is preferably made from plastic or metal. In one embodiment the tubular core with the yarn wound onto it is adapted to be bent into a curved shape along its longitudinal axis. Thus, facilitating a filter that can be bent around a corner, or other structure that is not compatible with a strictly cylindrical shape.

In one embodiment according to the invention each of the three layers have been wound in accordance with a winding pattern that is different from the winding pattern of the other layers. Hereby is achieved a filter wherein each layer mainly filters particles from the fluid up to a certain size. This may allow Thus, allowing a more effective utilization of the total volume of the filter for the filtering purpose.

The first layer comprises preferably less than 20 windings of the yarn. In one embodiment the second layer comprises less than 25 windings of the yarn. In another embodiment the third layer comprises less than 35 windings of the yarn.

In a preferred embodiment the first layer comprises between 7 and 14 windings of the yarn. In another preferred embodiment the second layer comprises between 8 and 14 windings of the yarn, and in yet another preferred embodiment the third layer comprises between 14 and 24 windings of the yarn.

In order to facilitate a good flow of the fluid through the filter without applying excessive pressure, each of the three layers comprises, preferably, less than 50 - 70 windings of yarn.

One way of providing a particular winding pattern is by using a particular winding angle, and may be the applicant has found it advantageous if the first layer of yarn has been wound around the outer surface of the core at an angle larger than 60 degrees with

respect to an axis parallel to the tubular core. In another ~~advantageous~~ embodiment of the invention the second layer of yarn has been wound around the outer surface of the core at an angle larger than 55 degrees with respect to an axis parallel to the tubular core, and in yet another embodiment the third layer of yarn has been wound around the outer surface of the core at an angle larger than 50 degrees with respect to an axis parallel to the tubular core. Preferably, the angle with which the yarn has been wound around the core is different for two consecutive layers, in order to facilitate winding patterns that are able to trap particles of different sizes.

10 Preferably, the yarn comprises a mix of natural and synthetic fibers. Since natural fibers are hydrophilic, while synthetic fibers generally are hydrophobic, a filter wherein the yarn is made of a mix of both natural and synthetic fibers may have~~has~~ the additional advantage that in addition to being able to filter particles from the fluid, also water may be absorbed by the yarn and thereby filtered from the fluid without having to
15 heat the filter.

In a preferred embodiment the natural fibers are chosen from a list of fibers comprising cotton and/or wool and the synthetic fibers are chosen from a list of fibers comprising any of the following materials: acryl, polyester, flax, polyamide, acetate and/or viscose.
20 Cotton and wool are cheap natural fibers that are easy to mix with any or a plurality of the synthetic fibers mentioned above. This may facilitate~~Thus facilitating~~ an effective, yet cheap yarn that for the filter.

In one embodiment according to the invention the yarn comprises less than 40% natural fibers. In another embodiment the yarn comprises more than 17% acryl. In yet another embodiment the yarn comprises more than 12% polyester, and in yet even another embodiment the yarn comprises more than 12% flax.

Preferably, the yarn comprises less than 2% polyamide or between 3% and 15% polyamide or between 5% and 9% polyamide.
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Alternatively, or in addition to the above, the yarn may comprise more than 1% acetate or between 1% and 10% acetate, or between 1 % and 6% acetate or between 2% and 4% acetate or between 1% and 2,5% acetate.

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In an alternative embodiment the yarn comprises more than 1% viscose, or between 1% and 10% viscose or between 1% and 5% viscose or between 1% and 3% viscose.

5 | ~~According to a second aspect of the invention, there is provided~~ pertains to a filter comprising a tubular core with a plurality of apertures and a hollow interior, said core having an open end for fluid communication with the hollow interior, a length of yarn wound in a series of at least three layers around an outer surface of the core, at least two of the at least three layers being wound in accordance with different winding patterns, the yarn comprising a mixture of natural and synthetic fibers, wherein the
10 | natural fibers constitutes less than 40% of the yarn, and the reminder constitutes fibers or a mix of fibers made from one or more of the following synthetic materials: acryl, polyester, flax, polyamide, acetate.

By providing a layered filter with a yarn that is made from a mix of natural constituting
15 | less than 40% (of the yarn) and synthetic fibers made from any of the synthetic materials mentioned above, ~~it may be achieved a filter-is achieved~~ that is particularly effective for filtering particles having a diameter or an average particle size between 0.5 μm and 50 μm from a petrochemical fluid such as oil.

20 | In one embodiment of the second aspect of the invention the yarn comprises more than 17% acryl. In another embodiment of the second aspect the yarn comprises more than 12% polyester, and in yet another embodiment the yarn comprises more than 12% flax.

25 | Preferably, the yarn used in a filter according to the second aspect comprises less than 2% polyamide or between 3% and 15% polyamide or between 5% and 9% polyamide.

Alternatively, or in addition to the above, the yarn used in a filter according to the
30 | second aspect may comprise more than 1% acetate or between 1% and 10% acetate, or between 1 % and 6% acetate or between 2% and 4% acetate or between 1% and 2,5% acetate.

In an alternative embodiment of the second aspect the yarn comprises more than 1%
35 | viscose, or between 1% and 10% viscose or between 1% and 5% viscose or between 1% and 3% viscose.

In a preferred embodiment of the second aspect of the invention the natural fibers are made of cotton or wool or a mix of cotton and wool.

In a preferred embodiment of the filter according to the second aspect the first layer closest to the surface of the core comprises at least 5 windings of the yarn, the second layer comprises at least 6 windings of the yarn and the third layer comprises at least 10 windings of the yarn and wherein two consecutive layers have been wound in accordance with different winding patterns.

In one embodiment according to the second aspect of the invention each of the three layers have been wound in accordance with a winding pattern that is different from the winding pattern of the other layers. Hereby is achieved a filter wherein each layer mainly filters particles from the fluid up to a certain size. This may allow ~~Thus, allowing~~ a more effective utilization of the total volume of the filter for the filtering purpose.

In another embodiment of the second aspect of the invention the first layer comprises preferably less than 20 windings of the yarn. In yet another embodiment of the second aspect the second layer comprises less than 25 windings of the yarn, and in an even further embodiment of the second aspect of the invention the third layer comprises less than 35 windings of the yarn.

In a preferred embodiment of the second aspect of the invention the first layer comprises between 7 and 14 windings of the yarn. In another preferred embodiment of the second aspect of the invention the second layer comprises between 8 and 14 windings of the yarn, and in yet another preferred embodiment of the second aspect of the invention the third layer comprises between 14 and 24 windings of the yarn.

In order to facilitate a good flow of the fluid through the filter without applying excessive pressure, each of the three layers of the filter according to the second aspect of the invention comprises, preferably, less than 50 - 70 windings of yarn.

One way of providing a particular winding pattern is by using a particular winding angle, and ~~the applicant has found it~~ may be advantageous if the first layer of yarn of the filter according to the second aspect has been wound around the outer surface of the core at an angle larger than 60 degrees with respect to an axis parallel to the tubular core.

In another ~~advantageous~~ embodiment of the second aspect of the invention the second layer of yarn has been wound around the outer surface of the core at an angle larger than 55 degrees with respect to an axis parallel to the tubular core, and in yet another embodiment according to the second aspect of the invention the third layer of yarn has been wound around the outer surface of the core at an angle larger than 50 degrees with respect to an axis parallel to the tubular core. Preferably, the angle with which the yarn has been wound around the core is different for two consecutive layers, in order to facilitate winding patterns that are able to trap particles of different sizes.

10 In a preferred embodiment according to any of the aspects of the invention the yarn has been wound around the outer surface of the core with different winding resistance in at least two of the three layers. Hereby is provided a simple way to vary the density of the yarn in the different layers. This influences the flow of the fluid through the layer and therefore the way the particles are deposited in the different layers. In a particularly preferred embodiment of any of the aspects of the invention the yarn of the first and third layer has been wound around the outer surface of the core with a winding resistance that is larger than the winding resistance that has been used for the second layer. Hereby the fluid under a certain pressure will meet first a harder resistance then a lesser resistance and then again a harder resistance when passing through the flow media. This may also ~~have~~has the effect of first slowing down, then accelerating and then slowing down again of the fluid when passing through the filtration media (layers of yarn). By a suitable adjustment of the winding resistance the filter may be designed to be particularly effective in filtering particles of a particular size from the fluid, which means that it can be optimized for a particular use, wherein particles of a certain size are a problem.

In another preferred embodiment of any of the aspects of the invention, the yarn of the first layer (closest to the core) has been wound around the outer surface of the core with a winding resistance that is larger than the winding resistance that has been used for the second layer, and wherein the yarn of the third layer has been wound around the outer surface of the core with a winding resistance that is larger than the winding resistance that has been used for the second layer. It may ~~Hereby~~ is achieved an embodiment wherein the fluid is slowed down more and more for each layer it passes through during its flow through the filtering media (the layers of yarn).

i.e. how much fluid is needed to be filtered pr. hour. For example a filter according to any aspects of the invention having a longitudinal extension between 24 cm and 30 cm will be suitable for filtering up to 250 – 500 l/h (liters/hour), while a filter that has a longitudinal extension between 45 cm and 60 cm will be suitable for filtering up to 1000 – 1500 l/h.

According to a third aspect of the invention, there is provided ~~pertains to~~ a method of manufacturing a filter, where the method comprising the steps of

- mounting a tubular core with a plurality of apertures and a hollow interior, said core having an open end for fluid communication with the hollow interior, in a winding machine,
- rotating the core at a rate controlled by the winding machine. This could for example be done manually or at a pre-programmed rate,
- feeding a yarn to the core through a head in such a way that it winds onto an outer surface of the core,
- moving the head forward and backwards along the longitudinal axis of the core,
- winding a first layer of yarn onto the core comprising at least 5 windings of yarn, a second layer comprising at least 6 windings of the yarn and a third layer comprising at least 10 windings of yarn, by varying the speed of rotation of the core and/or speed of movement of the head between each layer.

The method according to the third aspect of the invention may further comprise the step of winding each of the three layers in accordance with pre-programmed winding patterns different from the winding patterns of the other layers.

In one embodiment the method according to the third aspect of the invention may further comprise the step of winding less than 20 windings of the yarn in the first layer. In another embodiment the method according to the third aspect of the invention may further comprise the step of winding less than 25 windings of the yarn in the second layer. In yet another embodiment the method according to the third aspect of the invention may further comprise the step of winding less than 35 windings of the yarn in the third layer.

In a preferred embodiment the method according to the third aspect of the invention may further comprise the step of winding between 7 and 14 windings of the yarn in the first layer. In another preferred embodiment the method according to the third aspect of the invention may further comprise the step of winding between 8 and 14 windings

between 1 % and 6% acetate or between 2% and 4% acetate or between 1% and 2,5% acetate.

In an alternative embodiment of the method according to the third aspect the yarn may
5 comprise more than 1% viscose, or between 1% and 10% viscose or between 1% and 5% viscose or between 1% and 3% viscose.

In a preferred embodiment of the yarn used in a method according to the third aspect
10 of the invention, the natural fibers are made of cotton or wool or a mix of cotton and wool.

The method according to the third aspect of the invention may further comprising the
step of varying the winding resistance of the yarn by varying the speed at which the
yarn is feed through the head relative to the speed of rotation of the tubular core.

15 The step of winding the yarn around the outer surface of the core may in a preferred
embodiment of the method according to the third aspect be done with different winding
resistance in at least two of the three layers.

20 Preferably, the step of winding the yarn of the first and third layer around the outer
surface of the core is performed with a winding resistance that is larger than the
winding resistance that has been used for the second layer.

In a preferred embodiment of the third aspect of the invention, the method may further
25 comprise the step of winding the yarn of the first layer around the outer surface of the
core with a winding resistance that is larger than the winding resistance that is used for
the second layer, and winding the yarn of the second layer around the outer surface of
the core with a winding resistance that is larger than the winding resistance that is
used for the third layer.

30 In another preferred embodiment of the third aspect of the invention, the method may
comprise the step of covering at least in part the outer surface of the tubular core with
a fluid permeable sheet, prior to the step of winding the yarn onto the core.

35 | According to a fourth aspect of the invention, there is provided pertains to a method of
filtering a fluid comprising the steps of: