“Check valve"

DESCRIPTION

FIELD OF THE INVENTION

[0001] The present invention concerns a check valve and in particular a check valve for food, chemical, biological and/or pharmaceutical applications.

[0002] In particular, it is known in the art to implement check valves for use inside pipelines to prevent backflow with respect to a predetermined outflow direction. Such check valves comprise at least one shutter element movable from a closed position to an open position, which is in direct contact with the process fluid.

[0003] In many applications, the process fluids or liquids are particularly delicate from a chemical and biological point of view, as in the case of food liquids which are extremely sensitive to the formation of bacteria or microorganisms caused by liquid stagnation or by the formation of foams or emulsions.

[0004] In other cases, the liquids used are particularly chemically aggressive and can lead to corrosion of the shutter element itself.

[0005] Therefore, solutions are known in the art of shutters made of food-grade and anti-corrosive materials: said known shutters are often actuated by means of a spring. The presence of spring means increases the energy consumption of the valves, as well as the pressure losses.

[0006] In fact, springs increase the resistance or elastic return force with the increase of their compression: this means that the force opposing the opening of

the valve is minimal during the opening phase and increases linearly with the degree of opening of the valve. Obviously, during normal operation, the valve remains for the most part in the open configuration, so the consumption of the delivery pumps of the liquid is increased.

[0007] Moreover, the spring means, being directly impacted by the fluid, create turbulence and contribute to the formation of emulsions and foams within the treated fluid. Furthermore, the spring means are subject to breakages due to fatigue and/or corrosion. Possible breakages could lead to serious damage to components mounted in series with the valve, when spring fragments detach and enter circulation carried by the flow.

[0008] Finally, springs tend to cause the shutter to flutter during transition phases and/or pressure variations of the fluid.

[0009] Shutter solutions made of ferromagnetic materials are also known, so as to be actuated by magnetic fields, in order to limit the energy consumption of the valves. However, such ferromagnetic materials are not always compatible for use with certain fluids, especially with food fluids.

[0010] Furthermore, said solutions employing shutters made of ferromagnetic materials are not capable of ensuring precise control of the closing force along the entire opening stroke of the shutter itself.

[0011] In fact, the magnetic means that generate the magnetic field lines have a fixed position with respect to the shutter and therefore, along the stroke, the latter undergoes a variable influencing force.

[0012] T overcome this drawback, it is possible to use several magnetic means

arranged in series: however, such a solution may be disadvantageous since the magnetic fields generated by the magnetic means in series can easily interfere with each other.

[0013] Moreover, during the opening stroke, the shutter is, as seen, subjected to the thrust action of the fluid that must flow out. Furthermore, shutters are subject to even asymmetric thrust actions which, in solutions with magnetic means wherein no springs are provided, tend to make the shutter rotate and possibly seize. Therefore, known solutions with magnetic means are not completely free from jamming.

PRESENTATION OF THE INVENTION

[0014] The object of the present invention is to implement a check valve that solves the aforementioned drawbacks with reference to the known art.

[0015] Such drawbacks and limitations are solved by a check valve in accordance with claim 1.

[0016] Other embodiments of the valve according to the invention are described in the following claims.

DESCRIPTION OF THE DRAWINGS

[0017] Further features and advantages of the present invention will become more apparent from the following description of its preferred and non-limiting embodiments, wherein:

[0018] Figure 1 shows a perspective view in exploded form of a check valve in accordance with an embodiment of the present invention;

[0019] Figure 2 shows two perspective views, in assembled configuration and

from different angles, of the check valve of figure 1;

[0020] Figure 3 shows a front view, in assembled configuration, of the check valve of figure 1;

[0021] Figure 4 shows a sectional view of the check valve of figure 1, along the section plane A-A indicated in figure 3, in a closed configuration;

[0022] Figure 5 shows a sectional view of the check valve of figure 1, along the section plane A-A indicated in figure 3, in a partially open configuration;

[0023] Figure 6 shows a sectional view of the check valve of figure 1, along the section plane A-A indicated in figure 3, in a fully open configuration;

[0024] Figure 7 shows a front view of the shutter of the valve of figure 1;

[0025] Figure 8 shows a sectional view of the shutter of figure 7, along the section plane VIII-VIII;

[0026] Figure 9 shows a perspective view, in exploded form, of the shutter of figure 7;

[0027] Figure 10 shows a graph of the trend of the opening force of a shutter of a check valve according to the present invention (line B) and of a helical spring check valve of the known art (line A), as a function of the opening stroke of the shutter;

[0028] Figure 11 shows a sectional view of the check valve of figure 6, along the section plane XI-XI indicated in figure 6.

[0029] The elements or parts of elements in common between the embodiments described below will be indicated with the same reference numbers.

DETAILED DESCRIPTION

[0030] With reference to the above-mentioned figures, the numeral 4 globally denotes a check valve adapted to regulate the outflow of a fluid.

[0031] The check valve 4 comprises a valve body 8 delimiting an outflow chamber 12 extending from an inlet 16 to an outlet 20 of the valve 4. According to an embodiment, the valve body 8 is substantially cylindrical with respect to an axis of extension X-X.

[0032] The check valve 4 comprises a shutter 24, housed in said outflow chamber 12, adapted to occlude the inlet 16 of the valve at a closing portion 48 facing said inlet 16.

[0033] The shutter 24 is movable along an operating stroke S between an open position (figures 5-6), in which it allows the outflow of fluid between the inlet and the outlet, and a closed position (figure 4) in which it inhibits said fluid outflow

[0034] In particular, the operating stroke S is of rectilinear type and parallel to said axis of extension X-X.

[0035] At said outlet 20, a rear flange 28 is associated with the valve body 8, adapted to allow the insertion and subsequent locking of the shutter 24 in the outflow chamber 12.

[0036] Furthermore, at said inlet 16, a front flange 32 is associated with the valve body 8. A fastening ring 34 can also be associated with the front flange 32.

[0037] Advantageously, the shutter 24 comprises at least one operating portion, made of ferromagnetic material 36. In the description, ferromagnetic material

also means a permanent magnet.

[0038] For example, the at least one operating portion, made of ferromagnetic material 36, is made of a ferromagnetic stainless steel, such as for instance duplex steel, superduplex steel, etc.

[0039] Advantageously, the valve 4 comprises means for generating a magnetic field 40 arranged on the valve body 8, outside the outflow chamber 12, so as to generate a magnetic field that influences the at least one operating portion, made of ferromagnetic material, of the shutter 24 and not to be impacted by the flow of fluid passing through the outflow chamber 12.

[0040] Advantageously, the shutter 24 comprises a shutter body 44, spherical and hollow, having a plane of symmetry M-M perpendicular to said operating stroke S, which solidly houses, therein, said operating portion 36 made at least partially of ferromagnetic material so as to be influenced by said means for generating a magnetic field 40 to move from the closed position to the open position and vice versa.

[0041] The shutter body 44 in accordance with an embodiment is a spherical cap made of a non-ferromagnetic polymeric material.

[0042] The shutter body 44 has a closing portion 48 configured to selectively occlude said inlet 16 when in the closed position; in particular, the closing portion 48 is comprised between the plane of symmetry M-M and the inlet 16 of the outflow chamber 12.

[0043] The operating portion 36 extends at least from the plane of symmetry M-M to one end of the shutter 24 facing the inlet 16.

[0044] Preferably, the operating portion 36 has a hollow spherical conformation and is coaxial with the shutter body 44.

[0045] The valve body 8, at a front shoulder 52 arranged on the side of the inlet 16 inside the outflow chamber 12, comprises at least one gasket 56 configured to abut hermetically against the closing portion 48 of the shutter body 44.

[0046] Preferably, said gasket 56 is an O-ring.

[0047] The front shoulder 52 is preferably configured according to a truncated cone geometry and defines a closing end-stroke of the shutter 24.

[0048] The gasket 56 is positioned at a peripheral edge 60 of said front shoulder 52.

[0049] For example, the valve body 8 is provided with a rear shoulder 64, configured according to a truncated cone geometry and defining an opening end-stroke of the shutter 24.

[0050] The valve body 8 has a plurality of peripheral recesses 68 arranged downstream of said closing portion 48, so as to allow the outflow of fluid when the shutter 24 is in an at least partially open position.

[0051] Preferably, said peripheral recesses 68 are arranged at a constant angular pitch, coaxially to the shutter body 44.

[0052] Advantageously, said peripheral recesses 68 extend between the front shoulder 52 and the rear shoulder 64.

[0053] Advantageously, said peripheral recesses delimit together with the shutter body 44 a constant flow section between the front shoulder 52 and the rear shoulder 64. Thanks to the constancy of the flow section, it is possible to

achieve a laminar fluid flow, that is, free from turbulence.

[0054] Advantageously, said constant flow section is equal to a flow section at said inlet 16 and said outlet 20 of the valve 4. Thanks to the constancy of the flow section, it is possible to achieve a laminar fluid flow, that is, free from turbulence.

[0055] The means for generating a magnetic field 40 are arranged coaxially to the valve body 8 at said inlet 16 and comprise a toroidal magnet 72 arranged coaxially to the valve body 8 at an annular seat 76 of the valve body 8 opposite said outflow chamber 12.

[0056] The toroidal magnet 72 can be made in one piece arranged coaxially with respect to the valve body 8.

[0057] Alternatively, said toroidal magnet 72 can be made in two halves or half-rings 76 arranged coaxially with respect to the valve body 8.

[0058] In accordance with a possible embodiment, the valve body 8 comprises sealing means 80 adapted to lock in place the means for generating a magnetic field 40 and to prevent contact of the means for generating a magnetic field 40 with the external environment of the check valve 4.

[0059] The operation of a check valve according to the invention will now be described.

[0060] In particular, the magnetic field generation means 40 exert an attractive force on the shutter 24 so as to bring it into a closed configuration (figure 4).

[0061] When the force exerted by the fluid entering the valve body 8 on the closing portion 48 of the shutter 24 exceeds the magnetic attraction force and

the return force of the shutter due to the outlet fluid pressure, the shutter 24 begins to open and allows fluid passage (figure 5). In particular, the fluid flows through the peripheral recesses 68.

[0062] Advantageously, following the movement of the shutter 24 away from the closed position, the magnetic attraction force acting thereon decreases and therefore, with equal inlet fluid pressure, the opening effect of the shutter 24 tends automatically to amplify until bringing the shutter into the fully open condition (figure 6) in which the shutter abuts against the rear shoulder 64.

[0063] The fluid is therefore free to pass through the valve body 8 via a preferably constant flow section which, by limiting the velocity variations of the fluid, contributes to achieving a laminar flow, free from turbulence and the consequent formation of foams and emulsions.

[0064] As can be appreciated from what has been described, the check valve according to the invention makes it possible to overcome the drawbacks described of the known art.

[0065] In particular, the valve has limited energy consumption thanks to its low actuation energy, as well as a low pressure drop between the inlet and the outlet.

[0066] The check valve allows a very smooth fluid passage with minimal pressure loss and therefore with minimal pressure drop between the inlet and the outlet of the valve.

[0067] The components of the valve have very low roughness which limits fluid turbulence and the consequent pressure losses as well as the formation of foams and emulsions.

[0068] The valve is capable of achieving a laminar flow that further limits the formation of foams and emulsions.

[0069] The shutter of the check valve is not subject to fluttering as in the case of known spring solutions.

[0070] The valve according to the present invention exhibits high resistance to mechanical and chemical corrosion due to the low turbulence and the possibility of using stainless steels that are resistant to chemical and mechanical attacks and compatible with applications involving food, chemical and biological fluids.

[0071] Advantageously, the magnet is positioned outside the valve body so as not to come into contact with the liquid passing through the valve. In this way, the magnet is not subject to any type of mechanical and/or chemical corrosion.

[0072] Advantageously, the magnet is in turn protected from external corrosive agents by a surface chemical treatment and through the use of a gasket.

[0073] Advantageously, the magnet exerts a maximum attractive force on the shutter in a closed configuration of the valve. In other words, in the closed configuration, the attractive force between the shutter and the magnet is maximum since the distance between the two components is minimal; whereas, when the valve is open, the attractive force between the magnet and the shutter is minimal since the distance between the same components is maximum.

[0074] This operation is opposite to that of classic spring check valves in which the elastic force of the spring is minimal in closure and is maximum in opening, thereby increasing the energy consumption of the valve which operates most of the time in the open configuration.

[0075] A person skilled in the art, in order to meet contingent and specific needs, may make numerous modifications and variants to the check valves described above.

[0076] The scope of protection of the present invention is defined by the following claims.

REFERENCE NUMERALS

4: check valve

8: valve body

12: outflow chamber

16: inlet

20: outlet

24: shutter

28: rear flange

32: front flange

34: fastening ring

36: operating portion

40: means for generating a magnetic field

44: shutter body

48: closing portion

52: front shoulder

56: gasket

60: peripheral edge

64: rear shoulder

68: peripheral recesses

72: toroidal magnet

76: half-rings

80: sealing means

S: operating stroke

X-X: axis of extension

M-M: plane of symmetry