ABSTRACT: A mechanical seal assembly for paper pulp pumps in which clean fluid flows between the seal faces and flushes the pulp from the seal assembly. Such an assembly in which fluid also flows along the outer periphery of the seal rings.
MECHANICAL SEAL FOR PULP PUMPS

BACKGROUND OF THE INVENTION

In the making of paper, pulp material comprising a mixture of various liquids and suspended solid materials, ranging from relatively large chips of wood to shredded or partially digested fibrous material, is moved through the treating stations by pumps, the seals for which have posed problems in use.

For example, it has been the practice to employ the usual stuffing box packings in the pumps, but large quantities of clean liquid or water are employed to flush the stuffing box free of pulp. While mechanical seals have been employed for such service, they have not been satisfactory due to the tendency of the seal assembly to become clogged by the solid material in the pulp and thereby rendered ineffective.

SUMMARY OF THE INVENTION

The present invention provides a mechanical seal for use in the stuffing box of a pump for paper pulp, wherein the mechanical seal is particularly adapted for such service.

More specifically, the present mechanical seal includes a structure which enables flushing of the pulp from the seal assembly with a small volume of flushing fluid, such as water.

In accomplishing the foregoing, the invention contemplates a mechanical seal assembly in which a rotary seal ring assembly is carried on a shaft, a stationary seal ring is carried by a fixed portion of the seal assembly, and passageways are provided for conducting a flushing fluid, such as water, between the seal faces at a pressure in excess of the internal stuffing box pressure. More particularly, the flushing fluid passageways are in the nonrotatable seal ring, and in accordance with one embodiment of the invention, a further passageway or path is provided for the flow of flushing fluid past the outer periphery of the seal rings which is exposed to the pulp.

An object of the invention is to provide a mechanical seal assembly for use in the stuffing box of a pump which is used to pump a liquid containing solids, such as paper pulp, the assembly being easy to manufacture and install and requiring the use of substantially less flushing water than has been heretofore the practice with conventional packings.

This invention possesses many other advantages, and has other purposes which may be made more clearly apparent from a consideration of forms in which it may be embodied. These forms are shown in the drawings accompanying and forming part of the present specification. They will now be described in detail, for the purpose of illustrating the general principles of the invention; but it is to be understood that such detailed descriptions are not to be taken in a limiting sense.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a view in longitudinal section of a pump stuffing box and a mechanical seal made in accordance with the invention;

FIG. 2 is a vertical section, as taken on the line 2-2 of FIG. 1;

FIG. 3 is an enlarged fragmentary section, as taken on the line 3-3 of FIG. 2, showing the details of the mechanical seal elements; and

FIG. 4 is a view corresponding to FIG. 3, but showing a modified embodiment of the invention.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 through 3, an embodiment of the present mechanical seal is illustrated as being applied to a pump housing 1 having a stuffing box 2. Rotatable in the stuffing box 2 is a pump shaft 3 on the inner end 4 of which is disposed the hub 5 of the usual pump impeller (not shown).

More particularly, the seal assembly comprises a shaft sleeve 6 of cylindrical form disposed about the shaft 3. A key 7 is disposed in a key slot 8 in the shaft 3 and in a keyway 9 in the inner periphery of the shaft sleeve 6, whereby the shaft 3 and sleeve 6 are rotatable as a unit. An end flange 10 of the sleeve 6 is held against a shaft shoulder 11 by the impeller hub 5, and a suitable sealing gasket 12 is interposed between the flange 10 and the shoulder 11 to preclude leakage from the pump housing between the sleeve 6 and the shaft 3.

Leakage from the pump housing through the stuffing box 2 is precluded by a stationary seal ring 13 and a rotatable seal ring 14 which are respectively provided with radial seal faces 15 and 16 disposed in confronting relation and preferably lapped to an optical flat, as is customary in the case of mechanical seals.

The stationary seal ring 13 is carried by the usual seal flange 17 which is secured to the pump housing 1 as by a suitable number of screw fasteners 18. An appropriate sealing gasket 19 is interposed between the seal flange 17 and the pump housing 1 to prevent leakage therebetween. The seal flange 17 is provided with a bore 20 in which the seal ring 13 is disposed, axial movement of the seal ring 13 being precluded by a marginal lip 21 of the seal flange 17 which defines an opening 22 through which the shaft sleeve 6 extends.

In accordance with the invention, a flushing fluid is employed to flush pulp or other solid material entrained in fluid passages 23 to the rotary seal ring 14 from the passage region of the seal faces 15 and 16 and from the stuffing box 2. Accordingly, the seal flange 17 includes a flushing fluid inlet passage 23 which leads to an annular passageway 24 formed within the bore 20 of the flange 17. The seal ring 13 has a number of radial passages 25 which communicate with annular passage 24, and, in addition, the ring 13 has a number of circumferentially spaced passages 26 which connect the passages 25 with a like number of circumferentially spaced arcuate fluid passages 27 forming flushing fluid chambers between the seal faces 15 and 16. In the illustrated embodiment, the chambers or passages 27 are formed in the seal face 15 of the seal ring 13, but it will be understood that such chambers may, if desired, be formed in the seal face 16 of the rotary seal ring 14.

In the embodiment now being described, flushing fluid is confined to the path defined by the inlet passage 23, the annular passage 24, the radial passages 25, and the connecting passages 26 which lead to the chambers 27. More particularly, the stationary seal ring 13 is provided with a pair of axially spaced, circumferentially extended, resilient seal rings 28 and 29 which sealingly engage within the bore 20 at opposite sides of the annular passageway 24.

The rotary seal ring 14 is driven by a spring carrier 30 which includes an annular body section 31. This body section 31 of the spring carrier 30 is clamped to the shaft sleeve 6 by one or more set screws 32 which are threadedly engaged in the body 31 at one side of a diametrical line extended across the spring carrier 30. In the illustrated embodiment, a pair of the set screws 32 is spaced 90° apart, and, when threaded inwardly into engagement with the shaft sleeve 6, the set screws 32 cause a clamping of the opposite side of the spring carrier 30 against the shaft sleeve 6, causing, for a purpose which will hereinafter be described, a gap 33 between the spring carrier 30 and the shaft sleeve 6.

The rotary seal ring 14 is disposed within an axially extended skirt portion 34 of the spring carrier 30, the skirt portion 34 having a cylindrical bore 35 in which the outer periphery of the seal ring 14 is slidable disposed. A resilient seal ring 36 is carried by the rotary seal ring 14 and sealingly engages within the bore 35. In addition, an inner peripheral resilient seal ring 37 is carried by the rotary seal ring 14 and sealingly engages about the shaft sleeve 6.

A suitable number of circumferentially spaced coiled compression springs 38 is disposed in spring pockets 39 in the spring carrier 30 and engage the end wall 40 of the rotary seal ring 14 so as to normally provide a bias to force the rotary seal ring 14 axially toward the stationary seal ring 13. Means are provided for transmitting rotative movement from the spring carrier 30 to the rotary seal ring 14, and, for this purpose, in the illustrated embodiment, a suitable number of drive pins 41...
is disposed in circumferentially spaced pockets 42 in the spring carrier 30 and engaged in sockets 43 in the rotary seal ring 14.

It will now be apparent that the stationary seal ring 13 remains stationary in relation to the rotary seal ring 14 which is driven by the pins 41 in response to the rotation of the pump shaft 3. If desired or necessary, the seal ring 13 may be appropriately keyed to the flange 17, but in the illustrated embodiment, the ring 13 is press fitted into the bore 20 of the flange 17.

If desired, moreover, the bore 35 of the spring carrier 30 behind the seal ring 14, the spring pockets 39 and drive pin pockets 42 may be packed with a suitable lubricant.

Since the present seal construction is adapted to be employed in pumps wherein pulp is being pumped, the outer periphery 44 of the spring carrier 30 is preferably formed as a frustum of a long cone tapering towards the inner end of the spring carrier 30, whereby the annular space 45 within the stuffing box 2 flares inwards so as to enhance the displacement of pulp or fibrous material from the space 45 during operation of the seal assembly.

In the use of the seal assembly as thus far described, the rotary seal ring 14 is biased by the springs 38 toward the stationary ring 13 to maintain the sealing correlation between the seal faces 15 and 16. This spring force is supplemented by the pump housing fluid pressure which finds access to the rear face 40 of the rotary seal ring 14 through the gap 33 formed between the spring carrier 30 and the shaft sleeve 6. However, this gap 33 is so small that fibrous material or the solids in the pulp will not readily pass through the gap.

Flushing fluid, such as clean pulp liquor or water, is admitted to the inlet passage 23 of the seal flange 17 and flows through the ports or passages 24, 25, 26 and 27. This flushing fluid is maintained at a pressure slightly greater than housing or pump fluid pressure so as to maintain a film of flushing fluid between the faces 15 and 16. Part of such flushing fluid will flow radially inwardly across the seal faces 15 and 16 and will pass from the assembly through the opening 22 around the sleeve 6, but the remainder of the flushing fluid will flow radially outwardly between the seal faces 15 and 16 into the space 45, and thence it will congregate with the pulp or other liquid in the pump housing.

The volume of flushing fluid need not be great, so that, when water is employed, the pulp liquor or other fluid in the pump housing is not substantially diluted.

Referring now to FIG. 4, a modified construction is shown. In this embodiment, the seal ring 28 of the first described embodiment is eliminated, and instead a flow path 128 is provided for the flow of flushing fluid from the annular passage 24 in the flange 17, along the outer periphery of the stationary seal ring 13. Otherwise, the structure of FIG. 4 is the same as that previously described.

With the flow path 128 of FIG. 4, a portion of the flushing fluid flows directly into the stuffing box 2 from the source, without passing between the seal faces 15 and 16, whereby to more effectively flush the space 45 between the spring carrier 30 and the stuffing box wall. Such an arrangement is better suited to use where large solid particles exist in the pulp or other liquid being pumped, thus requiring larger flushing fluid flow to maintain the assembly free from clogging.

The clearance afforded by the space 128 should be sufficiently small as to throttle the flow of flushing fluid throughout the housing. This efficient flushing fluid pressure may be maintained in the annular passage 24 to cause at least some flow between the faces 15 and 16.

In each of the embodiments described above, it is apparent that the bore 35 of the skirt portion 34 of the spring carrier 30 defines with the outer periphery of the shaft sleeve 6 an annular piston chamber. The rotary seal ring 14 with its seal rings 36 and 37, respectively, sealingly engaged within the bore 35 of the skirt 34 and with the shaft sleeve 6 constitutes an annular piston which is spring loaded toward the stationary seal ring 13 by the springs 38. In addition, the pressure of fluid in the stuffing box 2 finds access through the gap 33 to the piston chamber behind the end wall or face 40 of the rotary seal ring 14 and acts across the effective annular area of the seal ring 14 to force the latter toward the stationary seal ring 13. The gap 33 is small so as to preclude the entry of solid matter into the piston chamber, and when this chamber is filled with a lubricant, the latter serves as a pressure medium and transmits the fluid pressure from the stuffing box to the seal ring face 40 and the lubricant further prevents access of solids into the region of the springs 38. The force acting in the opposite direction to cause the flow of flushing fluid between the seal faces 15 and 16 is a function of the flushing fluid pressure in the circumferentially extended passages 27. This pressure should be such as to provide a pressure gradient across the seal faces 15 and 16 and such as to maintain the flow of at least a film of the flushing fluid between such seal faces.

It will now be apparent that the present invention provides a mechanical seal assembly which is ideally suited for use in paper pulp pumps, but the seal may also be employed in other applications where there is a likelihood of clogging of the mechanical seal with solids in the pump fluid.

1. A mechanical seal assembly comprising: a stuffing box, a shaft rotatable in said stuffing box, mechanical seal means for sealing said shaft in said stuffing box, said mechanical seal means including a stationary support, a stationary seal ring carried by said support and disposed about said shaft, a rotary seal ring disposed about said shaft, said stationary seal ring and said rotary seal ring having radial seal faces disposed in opposed sealing relation, a spring carrier having an annular body portion disposed about said shaft and an annular skirt portion radially spaced from the outer periphery of said shaft, said rotary seal ring being slidably disposed between said shaft and said skirt, said shaft, said body portion, said skirt and said rotary seal ring defining a substantially closed chamber, means providing a seal between said skirt portion and the outer periphery of said rotary seal ring, means providing a seal between the inner periphery of said rotary seal ring and said shaft, spring means within said chamber, carried by said spring carrier and engaged with said rotary seal ring to bias the latter toward said stationary seal ring, fluid pressure orifice means communicating said chamber with the interior of the stuffing box surrounding said spring carrier, and fluid passage means for conducting a flushing fluid between said chamber and said outer periphery of said stuffing box a divergent space for flow of flushing fluid.

2. A mechanical seal assembly as defined in claim 1 wherein said fluid pressure orifice means comprises a gap between said body portion and said shaft.

3. A mechanical seal assembly as defined in claim 1 wherein the outer periphery of said spring carrier is tapered so as to provide between said outer periphery of the spring carrier and the inner periphery of said stuffing box a divergent space for flow of flushing fluid.

4. A mechanical seal assembly as defined in claim 1 wherein said chamber is packed with a lubricant.

5. A mechanical seal assembly as defined in claim 1 wherein said body portion and the inner end of said rotary seal ring define the end walls of said chamber, a drive pin having one end affixed to one of said end walls and the other end slidingly and drivingly engaged with the other of said end walls, a setscrew extending radially through a wall of said spring carrier in driving engagement with said shaft, whereby said shaft, said spring carrier and said rotary seal ring are engaged for rotatory movement in concert.

6. A mechanical seal assembly as defined in claim 1 wherein said stationary support has a bore, said stationary seal ring is disposed in said bore, said stationary seal ring and the wall of said bore providing an annular path for conducting into said stuffing box, and means for conducting additional flushing fluid into said stuffing box through said annular path.