

ISOLATED BEARING VISCOUS SPEED RETARDING DEVICE FOR ROTARY NOZZLES

BACKGROUND OF THE DISCLOSURE

[0001] The present disclosure is directed to high pressure fluid rotary nozzle systems. In particular, embodiments of the present disclosure are directed to an apparatus for retarding the speed of rotation of such rotary nozzles.

[0002] High pressure water jet cleaning devices utilizing reaction force rotary nozzles tend to rotate at very high speeds. In many applications it is desirable to slow down such rotary nozzle speed to maximize usable lifetime of the rotary nozzle and effectively improve the cleaning efficiency of such nozzles. A speed reducing device fastened to the shaft of such rotary nozzles is often utilized to retard rotation of the nozzle. Typical viscous fluid speed reducing devices utilize a viscous fluid flowing along a tortuous flow path in a confined space around the rotating shaft to generate a drag on the nozzle shaft.

[0003] Typically the operational lifetime of the speed reducing device is limited by the longevity of the bearings and the medium such as a viscous fluid utilized to produce the speed retardation. As an example, the useful lifetime without maintenance of conventional viscous speed retarders is on the order of 40-60 device operating hours. A typical retarder device has a bearing supported shaft connected to the rotary nozzle such that the shaft rotates with the nozzle. A generally cylindrical housing contains the two support bearings supporting the rotating shaft and contains the retarding mechanism. One such retarding mechanism has a series of roller bearings immersed in a viscous fluid within the housing and between end support bearings that are also immersed in the viscous fluid. Another exemplary conventional retarder is a Warthog WG-1 by Stoneage Inc. This retarder has end support bearings sandwiching a large diameter drag sleeve fastened to or integrally formed around the shaft in the housing instead of utilizing a series of bearings in the viscous fluid. These support bearings and the drag sleeve are immersed in the viscous fluid contained within the cylindrical housing. Together the support bearings and the retarding drag sleeve are contained between two shaft seals, sealing the shaft to the housing, and preventing escape of the viscous fluid. Thus the end

support bearings and the drag sleeve in the WG-1 are immersed in viscous fluid and function together to retard the speed of the rotating nozzle.

[0004]As the retarder rotates in the housing, the viscous fluid is circulated (pumped) within the fluid chamber by a helical groove around the outer surface of the drag sleeve portion of the shaft and through a series of axially extending bores through the drag sleeve portion of the shaft. Additionally, the helical groove serves to uniformly distribute the fluid above the drag sleeve and through the end bearings. In the immersed bearing system, drag is created as a function of the fluid viscosity, the bearing geometry, the surface area of the drag sleeve and the gap size between the drag sleeve and the cylindrical housing. This implementation of a viscous fluid retarder creates drag, and also eventually degrades the viscosity of the viscous fluid. Once the viscous fluid degrades during operation, the rotary nozzle speed increases substantially, frequently audibly indicating to an operator that the viscous fluid needs to be changed. The retarder and nozzle then must be removed from service, disassembled, cleaned and flushed, reassembled and new viscous fluid installed. This is inconvenient to the operator, takes maintenance down time and can result in increased maintenance costs over the life of the tool. Therefore what is needed is a viscous retarder device that has a substantially improved operational lifetime in order to solve these problems.

SUMMARY OF THE DISCLOSURE

[0005]The present disclosure directly addresses such needs. An apparatus in accordance with the present disclosure is a speed reducing or limiting device for a rotary nozzle that exhibits an operational lifetime between maintenance periods of many times that of conventional viscous retarder devices. This remarkable longevity increase is achieved by isolating the shaft support bearings from the viscous fluid in the retarding cavity of the device.

[0006]An exemplary embodiment of a retarder in accordance with the present disclosure includes a hollow generally cylindrical housing that carries an elongated shaft having a retarding portion between forward and rear support bearings. Each of the support bearings is isolated from the retarding portion of the elongated shaft within the housing by an annular seal. A conventional viscous fluid material such as

gear oil or silicone fills the housing around the retarding portion of the shaft between the two annular seals.

[0007] Further features, advantages and characteristics of the embodiments of this disclosure will be apparent from reading the following detailed description when taken in conjunction with the drawing figures.

DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 is an axial cross sectional view through a retarder device in accordance with the present disclosure fastened to a rotary nozzle head.

[0009] FIG. 2 is an exploded perspective view of the retarder device shown in FIG. 1 separated from the rotary nozzle.

[0010] FIG. 3 is an exploded perspective view of the retarder device and nozzle head shown in FIG. 1 showing each subcomponent in assembly sequence.

DETAILED DESCRIPTION

[0011] An exemplary embodiment of a retarder device **100** in accordance with the present disclosure connected to a rotary nozzle **200** is shown in sectional view in FIG. 1. The retarder device **100** includes a tubular shaft **102** carried within a generally cylindrical tubular housing **104**. The shaft **102** has a distal end **106** fastened to the nozzle **200** and an opposite end **108** coupled with an inlet nut **110** that is connected to a high pressure fluid hose (not shown).

[0012] This cylindrical housing **104** also carries within it a first support bearing **112** and a second support bearing **114** which together rotatably support the shaft **102**. Each of the bearings **112** and **114** is sandwiched between a pair of shaft seals **116** and **118**.

[0013] The shaft **102** also has a retarding sleeve portion **120** between the two shaft seals **118**. This sleeve portion **120** is preferably an integral part of the shaft **102** and has a large diameter outer cylindrical surface **122** sized to closely fit within the housing **104**. This surface **122** has a peripheral helical groove **124** that extends from one end to the other of the sleeve portion **120**. The sleeve portion **120** further has a

plurality of axially extending bores **126** spaced around the axial bore **128** through the shaft **102**.

[0014] The sleeve portion **120** is captured on the shaft **102** within the housing **104** by the front and rear inner seals **118**. A pair of threaded ports **130** permits filling the space within the housing **104**, and around and within the sleeve portion **120**, with a high viscosity fluid such as silicone fluid having a kinematic viscosity within a range of 200 to 60,000 cSt, and more preferably within a range of 200 cSt to 15,000 cSt. The speed range of the retarder **100** is determined by the viscous fluid viscosity and the high pressure fluid applied to the nozzle **200**. The retarding capacity of the retarder **100** is determined by the viscous fluid viscosity, the cylindrical surface **122** length and outer diameter, and the gap between the cylindrical surface **122** and the housing **104**. This retarding capacity serves to resist the torque generated by the nozzle **200** when high pressure fluid such as water is applied. The resulting net forces dictate the rotational speed of the nozzle **200** relative to the retarder **100**. There are additional secondary retarding forces, operating torque from the high pressure seal, intrinsic bearing drag and shaft seal drag. However, these forces are essentially fixed as a function of the design and the reasonable life of the related parts. These forces are intended to be dominated by the retarding mechanism and the nozzle torque.

[0015] The front and rear outer seals **116** keep water and external contaminants out of the bearings **112** and **114**. The inner seals **118** keep viscous retarder fluid out of the bearings **112** and **114**. Separation of the bearings **112** and **114** from the viscous fluid accomplishes two things. First, the bearings **112** and **114** are free to rotate the shaft **102** without drag of the viscous fluid and utilizing their own optimal lubricating medium, which tends to increase the bearing lifetime. Second, the seals **118** prevent the bearings from degrading the viscous fluid due to bearing shear forces exerted on the viscous fluid. An alternative embodiment may be implemented utilizing sealed bearings to isolate the bearing components and lubricant from the viscous fluid and retarding mechanism.

[0016] The bearings **112** and **114** may be sealed bearings. Alternatively open bearings may be utilized that are packed with grease. Grease zerk fittings or oil bath

fittings could also be installed in the housing **104** to accommodate such an open bearing configuration.

[0017] The isolated bearing innovation of the present disclosure resulted from lengthy testing performed on conventional viscous fluid retarders. A custom made tool tester was utilized to control various permutations of input torque, speed and temperature on a conventional retarder configuration. It was found that the conventional retarder configuration lasts, on average, about 40 hours on this tester. The failure mode was a speed runaway resulting from viscosity change in the fluid. By analyzing the viscous fluid before and after speed runaway, it was learned that the rolling contact of the bearings shears the molecules of the silicone viscous fluid at a rate that is a function of the rotary nozzle speed. This shearing results in a steady and predictable reduction in fluid viscosity and relatedly an increase in tool rotation speed.

[0018] By separating the bearings **112** and **114** from the viscous fluid via an extra set of inner seals **118** and containing each bearing **112** and **114** also with a set of shaft outer seals **116**, an average of 1000 hours or more of useful lifetime between maintenance intervals for the retarder **100** was established based on test and measurements performed on the aforementioned tool tester. Such a drastic improvement of lifetime manifests a gross improvement in the tool's performance.

[0019] More consistent, sustainable rotational speed can also be achieved by removing the primary means for viscous fluid degradation (bearings) from the retarding mechanism. The rotational speed becomes predictable as a function of part geometry and fluid viscosity. Therefore the retarder **100** can be characterized such that users can install fluid of different viscosity (within a recommended range of viscosities) to achieve different rotational speeds for a given nozzle rotational torque. Removing the bearings from the braking mechanism also permits the retarder to reliably function at higher speeds. In the prior device, the immersed bearings served to multiply harmful shear characteristics due to their geometry and higher speed operation could not be sustained due to the revolution dependent breakdown of fluid viscosity. Removing the bearings from the retarding mechanism results in more consistent retarding. When the mechanism is reduced to a drag sleeve, cylindrical housing and viscous fluid, the retarding capability is more reliable and predictable.

[0020] Another improvement in the speed retarder **100** in accordance with the present disclosure is the inclusion of replaceable centralizer vanes **210**. Conventional retarder designs such as Stoneage's WG retarder devices have historically had radial fins welded to a separate cylindrical sleeve that installs to the exterior surface of the housing of the retarder. These radial fins must be replaced together with the cylindrical sleeve.

[0021] In the retarder **100** shown in FIGS. **1-3**, the housing **104** is a cylindrical tube provided with six axially extending exterior slots **202**. The rear end of the housing **104** is closed by the threaded inlet nut **110**. The front end of the housing **104** is closed by a front end nut **206**. The front end nut has a peripheral annular rearwardly facing recess **208**, shown in FIGS. **1** and **3**. The inlet nut **110** closing the housing **104** is fitted with a removable annular rear end cap **204**. This rear end cap **204** similarly has a forwardly facing annular recess **212** (visible in FIG. **1**). The rear end cap **204** is fastened to the inlet nut **110** by a series of six threaded fasteners **214** such as Torx ® bolts.

[0022] Each of the vanes **210** is a plate having a generally equilateral trapezoidal shape preferably made of a hardened steel material. Vanes made of a plastic or composite material may alternatively be utilized. These vanes **210** are captured within the slots **202** and the vane ends are captured within the recesses **208** and **212**. The vanes **210** may be removed and replaced without disassembly of the retarder **100**, simply by removing the fasteners **214** and removing the end cap **204**. The vanes **210** can then simply slip out of the slots **202** and a new vane or vanes **210** installed.

[0023] Another improvement in the speed retarder **100** in accordance with the present disclosure is the inclusion of a hardened face seal pair **300** between the inlet nut **110** and the rear end **108** of the rotary shaft **102**. This seal pair **300** comprises two elements: a nut flanged tubular high pressure rear face seal **302** that fits within a hexagonal recess in the inlet nut **110**, and a nut flanged tubular shaft high pressure front face seal **304** that fits within a complementary hexagonal recess in the proximal end **108** of the shaft **102**. These seals **302** and **304** are held in their respective recesses via O-rings **306** and biased toward each other via a wave spring **308** around the stem portion of each seal **302** and **304**. These high pressure seals permit

rotation of the shaft **102** relative to the inlet nut **110** with minimal high pressure water leakage.

[0024] The seal pair **300** permits the inlet nut **110** to be removed from the assembled retarder **100** for high pressure face seal **300** maintenance and/or centralizer vane **210** replacement without disturbing the bearing **114** and inner seal **118** and thus violating the integrity of the viscous fluid cavity within the housing **104** containing the viscous fluid. Similarly, the front end nut **206** may be removed from the housing **104** without violating the integrity of the bearing **112**, inner seal **118**, and integrity of the viscous fluid cavity within the housing **104**.

[0025] Another improvement in the speed retarder of the present disclosure is a series of features designed to permit removal of the nozzle **200** without any additional disassembly of the retarder **100**. A hex key, Torx ® tool, rod or screwdriver having the appropriate shaft diameter can be inserted into the retarder **100** front end nut **206** at the hole **207**. When the shaft **102** is properly clocked relative to the front end nut **206**, the inserted tool will engage a slot **209** in the shaft **102** and lock the shaft **102** to the front end nut **206**. Once the tool has been properly inserted and shaft **102** locked, an open end wrench can be applied to the flats on the front end nut **206** and similarly to the flats on the nozzle **200** to remove the nozzle **200** from the shaft **102** of the retarder **100**. An entry portion of the hole **207** may be threaded and plugged with a complementary set screw to prevent debris from filling and stopping the shaft from rotation during tool operation.

[0026] Many changes may be made to the device, which will become apparent to a reader of this disclosure. For example, the helical groove **124** may have an Acme thread profile, a buttress thread profile, or a 55 degree or 60 degree thread profile. The seals **302** and **304** may have a shape other than hexagonal as described above. They may have any shape to fit in complementary recesses in the inlet nut **110** or in the proximal end **108** of the shaft **102**. Although the rear face of the nozzle **200** is shown flush with the front face of the nut **208**, there is a gap therebetween as the nozzle **200** rotates with the shaft **106**. The nozzle **200** may be further spaced from the nut **208** than as shown and its rear face may be tapered outward so as to prevent collection of debris between the two rotating surfaces. All such changes, alternatives and equivalents in accordance with the features and benefits described

herein, are within the scope of the present disclosure. Any or all of such changes and alternatives may be introduced without departing from the spirit and broad scope of my disclosure and invention as defined by the claims below and their equivalents.

CLAIMS

What is claimed is:

1. A speed retarding device for a rotary nozzle comprising:

a hollow cylindrical housing;

a rotatable tubular shaft rotatably carried by the housing, the shaft having a drag sleeve portion in the housing and having a shaft end extending through at least one end of the housing, wherein the shaft end is adapted to receive a rotary nozzle thereon;

a pair of lubricated support bearings sandwiching the drag sleeve portion of the shaft in the housing;

an annular axial inner seal between each of the support bearings and the drag sleeve portion, wherein the inner seals sandwich the drag sleeve portion therebetween and isolate the drag sleeve portion from the support bearings, and wherein the inner seals, the housing and the drag sleeve portion define a cavity within the housing; and

a viscous fluid confined within the cavity.

2. The retarding device according to claim 1 further comprising an outer annular seal on the shaft adjacent to each support bearing whereby each support bearing is sandwiched between inner and outer annular seals in the housing and separated from the viscous fluid in the cavity.

3. The retarding device according to claim 1 further comprising a plurality of removable centralizing vanes radially extending outward from the housing.

4. The retarding device according to claim 3 wherein the housing has a plurality of axially extending outwardly open slots each receiving one of the plurality of removable centralizing vanes therein.

5. The retarding device according to claim 1 further comprising the shaft having an inner end in the housing facing an inlet nut threaded into one end of the hollow cylindrical housing and a high pressure face seal assembly captured between the inlet nut and the inner end of the shaft.

6. The retarding device according to claim 5 wherein the high pressure face seal assembly comprises a pair of nut flanged tubular face seals.

7. The retarding device according to claim 6 wherein one face seal of the pair of face seals is a nut flanged tubular rear face seal received within a recess in the inlet nut and the other one face seal of the pair of face seals is a nut flanged tubular front face seal received within a recess within a rear end of the tubular shaft.

8. A speed retarding device for a rotary nozzle comprising:
a hollow cylindrical housing;
a rotatable tubular shaft rotatably carried by the housing, the shaft having a drag sleeve portion in the housing and having a shaft end extending through at least one end of the housing, wherein the shaft end is adapted to receive a rotary nozzle thereon;
a pair of lubricated support bearings supporting and sandwiching the drag sleeve portion of the shaft between the bearings in the housing;
an annular axial inner seal between each of the support bearings and the drag sleeve portion isolating the drag sleeve portion from the support bearings, wherein the inner seals, the housing and the drag sleeve portion define a cavity within the housing;
a viscous fluid confined within the cavity; and
a plurality of centralizing vanes radially extending outward from the housing.

9. The device according to claim 8 wherein the centralizing vanes are removable.

10. The retarding device according to claim 9 wherein each of the plurality of centralizing vanes is slidably captured within a slot formed in the exterior surface of the housing.

11. The retarding device according to claim 10 wherein the centralizing vanes are made of a plastic material.

12. The retarding device according to claim 8 further comprising an outer annular seal on the shaft adjacent to each support bearing whereby each support

bearing is sandwiched between inner and outer annular seals in the housing and separated from the viscous fluid in the cavity.

13. The retarding device according to claim 8 further comprising a plurality of removable centralizing vanes radially extending outward from the housing.

14. The retarding device according to claim 13 wherein the housing has a plurality of axially extending outwardly open slots each receiving one of the plurality of removable centralizing vanes therein.

15. The retarding device according to claim 8 further comprising the shaft having an inner end in the housing facing an inlet nut threaded into one end of the hollow cylindrical housing and a high pressure face seal assembly captured between the inlet nut and the inner end of the shaft.

16. In a high pressure water blasting tool assembly having a rotatory nozzle for cleaning inside surfaces of a piping system, a speed retarding device connected between a hose and the rotary nozzle, the retarding device comprising:

- a hollow cylindrical housing;

- a rotatable tubular shaft rotatably carried by the housing, the shaft having a drag sleeve portion in the housing and having a shaft end extending through at least one end of the housing, wherein the shaft end is adapted to receive a rotary nozzle thereon;

- a pair of lubricated support bearings on the shaft supporting and sandwiching the drag sleeve portion of the shaft in the housing;

- an annular axial inner seal between each of the support bearings and the drag sleeve portion isolating the drag sleeve portion from the support bearings, wherein the inner seals, the housing and the drag sleeve portion define a cavity within the housing around the drag sleeve portion;

- a viscous fluid confined within the cavity; and

- an outer axial annular seal on the shaft adjacent to each support bearing whereby each lubricated support bearing is sandwiched between inner and outer annular seals in the housing and separated from the viscous fluid in the cavity.

17. The retarding device according to claim 16 wherein the drag sleeve portion has a central bore, at least one outwardly open helical groove therearound and a plurality of axially extending bores around the central bore.

18. The retarding device according to claim 16 further comprising a plurality of removable centralizing vanes extending radially outward from the housing.

19. The retarding device according to claim 18 wherein the housing has a plurality of axially extending outwardly open slots each receiving one of the plurality of removable centralizing vanes therein.

20. The retarding device according to claim 16 further comprising the shaft having an inner end in the housing facing an inlet nut threaded into one end of the hollow cylindrical housing and a high pressure face seal assembly captured between the inlet nut and the inner end of the shaft.