

Description

The invention relates to a fluid driven apparatus for pumping a fluid or a mixture of fluids. The invention relates in particular to a twin rotor screw type pumping apparatus for pumping fluids at remote or difficult accessible locations, such as in a well or in a sub-sea flowline.

Fluid driven pumping apparatus of a twin rotor type are known from US-A-1,702,838; US-A-2,804,260 and US-A-3,184,155. A known fluid driven pumping apparatus comprises a twin rotor screw type positive displacement motor having a driving fluid inlet and a driving fluid outlet, and connected to said motor a twin rotor screw type positive displacement pump having a pumped fluid inlet and a pumped fluid outlet, the apparatus further comprising a pair of parallel shafts rotatably mounted in a housing, each shaft carrying a screw rotor of said pump and a screw rotor of said motor, wherein the rotors of the pump section define working chambers having a different fluid displacement volume than the working chambers defined by the rotors of the motor section.

Known fluid driven pumping apparatus are not designed to mix up the driving fluid with the pumped fluid, which may be desirable if the pumped fluid has a varying gas content and may contain solid debris that could be washed away by the driving fluid. From US-A-2,804,260 it is known to increase the helix angle of one of the rotor pairs in order to increase the fluid displacement volume of one section of the apparatus relative to that of the other section. A disadvantage of this known configuration is that it makes the apparatus large and bulky.

An object of the invention is to provide a compact and reliable fluid driven pumping apparatus which has a low wear rate even if the produced fluid is sand bearing and which can be easily installed in a flowline system.

A further object of the invention is to provide a fluid driven pumping apparatus which is able to pump both gaseous and liquid fluids or mixtures thereof.

To this end the fluid driven pumping apparatus according to the invention is characterized in that the screw rotors of said pump have a larger tip diameter and a correspondingly smaller base diameter than the screw rotors of said motor, and that the driving fluid outlet of said motor is in fluid communication with the inlet of said pump via a chamber formed in the interior of the housing between said motor and said pump.

In a preferred embodiment of the invention the driving fluid outlet is in fluid communication with the pumped fluid inlet so that the driving fluid emerging from the motor mixes with the incoming

pumped fluid before the combined fluid stream passes into the pump.

In a suitable embodiment of the invention the screw rotors of said pump and motor which are mounted on a common shaft are identical in helix angle and pitch diameter.

The invention will now be described by way of example with reference to the accompanying Fig. 1 showing a longitudinal section of a pumping apparatus according to the invention.

The pumping apparatus shown in Fig. 1 comprises a housing 1 enclosed in a protective shell 2. The housing 1 consists of a side wall 3 and upper and lower terminal walls 5 and 6, respectively. The lower part of the housing contains a motor section consisting of a twin rotor screw type positive displacement motor 10, whereas the upper part of the housing contains a pump section consisting of a twin rotor screw type positive displacement pump 11. The motor section 10 comprises a pair of cooperating screw rotors 10A and 10B, and the pump section 11 comprises a similar pair of cooperating screw rotors 11A and 11B. The screw rotors 10A and 11A shown at the left side of the drawing are identical in helix angle and they are mounted on a common shaft 13, whereas the screw rotors 10B and 11B shown at the right side of the drawing are also identical in helix angle and mounted on a common shaft 14. The helix angles of the cooperating pairs of screw rotors 10A, 10B and 11A, 11B, respectively, are opposite to each other and the axes of rotation of the shafts 13 and 14 are parallel to each other.

As illustrated in Fig. 1 the screw rotors 11A, 11B of the pump and the screw rotors 10A, 10B of the motor have identical pitch radii R_p , but the screw rotors 11A, 11B of the pump have a larger tip radius and a correspondingly smaller base radius than the screw rotors 10A, 10B of the motor.

The shafts 13 and 14 are supported by bearings 16 in the upper- and lower terminal walls 5, 6.

The bearings 16 may be of any suitable type and it is preferred to lubricate the bearings with clean drive fluid derived from an inlet compartment 17 at the upstream end 18 of the motor. In order to facilitate lubrication of the bearings 16 in the upper terminal wall 5 the shafts 13 and 14 may each be provided with a bore (not shown) forming a fluid communication between the said inlet compartment 17 and the bearings 16 in said upper wall 5.

Furthermore, by means of radial drillings (not shown) in the screw rotors 11A, 11B, communicating with the bores, clean drive fluid can be introduced into close clearance points at the rotor tips, further preventing damage by sand and other erosive matter. Alternatively, clean drive fluid can be supplied to the bearings 16 in the upper terminal wall 5 through a suitable passage (not shown) in

the housing.

During operation of the pumping apparatus driving fluid is injected into the inlet compartment 17 via a driving fluid inlet port 20 passing through the side wall 2 of the apparatus at a location adjacent to the lower housing wall 6. Said injection causes the drive fluid to move in upward direction through the lower compartment 8 towards a chamber 21 formed in the middle of the housing 1 between the downstream end 22 of the motor 10 and the upstream end 23 of the pump, thereby actuating the screw rotors 10A, 10B of the motor to rotate in opposite directions, as indicated by arrows V. The manner in which the drive fluid actuates the screw rotors 10A, 10B of the twin rotor screw type motor is known per se and does not require a detailed description.

Said rotation of the screw rotors 10A, 10B of the motor 10 induces the shafts 13, 14 and thus the screw rotors 11A, 11B of the pump 11 to rotate at the same speed in the direction of arrows V. Due to the large tip diameter and small base diameter of the pump rotors 11A, 11B in comparison to the motor rotors 10A, 10B, or in other words due to the large displacement volume of the pump 11 in comparison to that of the motor 10, the pump rotors 11A, 11B tend to suck more fluid away from the chamber 21 than the amount of driving fluid discharged from the motor 10.

This causes pumped fluid to be sucked into the chamber via a production fluid inlet 24 formed in the side wall 3 of the housing and to be subsequently pumped together with the driving fluid in upward direction by the pump rotors 11A, 11B towards a pumped fluid outlet 25 formed near the upper terminal wall 5.

The pumping apparatus shown in Fig. 1 may be used to pump single- or multiphase fluids such as mixture of hydrocarbon fluids containing crude oil and natural gas, while the pumped fluids may contain solid particles, such as sand, without giving rise to a largely increased wear rate of the apparatus. If the pumped fluid mainly consists of a liquid, it is preferred to use recirculated pumped fluid as driving fluid and to filter solid particles such as sand from the pumped fluid before reinjecting it into the driving fluid inlet 20 of the apparatus as a clean driving fluid. The reinjected pumped fluid may be mixed up with other fluids or lubricants if the viscosity of the pumped fluid is too high to allow it to be used as driving fluid.

If the pumped fluid consists of a gas-liquid mixture it is preferred to separate the liquid phase from the gaseous phase and to use the liquid phase as driving fluid. If the pumped fluid mainly consists of a gas it is preferred to use a liquid as driving fluid. This would enable sufficient lubrication of the bearings 16 and rotor tips 19 and would

further provide sufficient minimum flow of liquid through the pump to enable the pump to continue to develop its full differential pressure.

It will be appreciated by those skilled in the art that instead of arranging the shafts parallel to each other as shown in Fig. 1, the shafts may also be arranged at an angle relative to each other, provided that the screw rotors of the pump and motor have a suitable shape.

The pumping apparatus according to the invention may be used to pump single- or multiphase fluids such as mixture of hydrocarbon fluids containing crude oil and natural gas, while the produced fluids may contain solid particles, such as sand, without giving rise to a largely increased wear rate of the apparatus.

Claims

1. Fluid driven pumping apparatus comprising a twin rotor screw type positive displacement motor having a driving fluid inlet and a driving fluid outlet, and connected to said motor a twin rotor screw type positive displacement pump having a pumped fluid inlet and a pumped fluid outlet, the apparatus further comprising a pair of parallel shafts rotatably mounted in a housing, each shaft carrying a screw rotor of said pump and a screw rotor of said motor, wherein the rotors of the pump section define working chambers having a different fluid displacement volume than the working chambers defined by the rotors of the motor section, characterized in that the screw rotors of said pump have a larger tip diameter and a correspondingly smaller base diameter than the screw rotors of said motor, and that the driving fluid outlet of said motor is in fluid communication with the inlet of said pump via a chamber formed in the interior of the housing between said motor and said pump.
2. The apparatus of claim 1, wherein the screw rotors of said pump and motor which are mounted on a common shaft are identical in pitch diameter and helix angle.
3. The apparatus of claim 1, wherein the pumped fluid inlet consists of a port opening formed in the housing wall, which port opening discharges into said chamber.
4. The apparatus of claim 1, wherein the driving fluid inlet is located near one end of the housing and the pumped fluid outlet is located near an opposite end of the housing.

Revendications

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Said rotation of the screw rotors 10A, 10B of the motor 10 induces the shafts 13, 14 and thus the screw rotors 11A, 11B of the pump 11 to rotate at the same speed in the direction of arrows V. Due to the large tip diameter and small base diameter of the pump rotors 11A, 11B in comparison to the motor rotors 10A, 10B, or in other words due to the large displacement volume of the pump 11 in comparison to that of the motor 10, the pump rotors 11A, 11B tend to suck more fluid away from the chamber 21 than the amount of driving fluid discharged from the motor 10.

This causes pumped fluid to be sucked into the chamber via a production fluid inlet 24 formed in the side wall 3 of the housing and to be subsequently pumped together with the driving fluid in upward direction by the pump rotors 11A, 11B towards a pumped fluid outlet 25 formed near the upper terminal wall 5.

The pumping apparatus shown in Fig. 1 may be used to pump single- or multiphase fluids such as mixture of hydrocarbon fluids containing crude oil and natural gas, while the pumped fluids may contain solid particles, such as sand, without giving rise to a largely increased wear rate of the apparatus. If the pumped fluid mainly consists of a liquid, it is preferred to use recirculated pumped fluid as driving fluid and to filter solid particles such as sand from the pumped fluid before reinjecting it into the driving fluid inlet 20 of the apparatus as a clean driving fluid. The reinjected pumped fluid may be mixed up with other fluids or lubricants if the viscosity of the pumped fluid is too high to allow it to be used as driving fluid.

If the pumped fluid consists of a gas-liquid mixture it is preferred to separate the liquid phase from the gaseous phase and to use the liquid phase as driving fluid. If the pumped fluid mainly consists of a gas it is preferred to use a liquid as driving fluid. This would enable sufficient lubrication of the bearings 18 and rotor tips 19 and would

further provide sufficient minimum flow of liquid through the pump to enable the pump to continue to develop its full differential pressure.

It will be appreciated by those skilled in the art that instead of arranging the shafts parallel to each other as shown in Fig. 1, the shafts may also be arranged at an angle relative to each other, provided that the screw rotors of the pump and motor have a suitable shape.

The pumping apparatus according to the invention may be used to pump single- or multiphase fluids such as mixture of hydrocarbon fluids containing crude oil and natural gas, while the produced fluids may contain solid particles, such as sand, without giving rise to a largely increased wear rate of the apparatus.

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2. The apparatus of claim 1, wherein the screw rotors of said pump and motor which are mounted on a common shaft are identical in pitch diameter and helix angle.
3. The apparatus of claim 1, wherein the pumped fluid inlet consists of a port opening formed in the housing wall, which port opening discharges into said chamber.
4. The apparatus of claim 1, wherein the driving fluid inlet is located near one end of the housing and the pumped fluid outlet is located near an opposite end of the housing.

Revendications



1. Appareil de pompage entraîné par fluide, comprenant un moteur à cylindrée positive du type à double rotor en vis sans fin, comportant une entrée de fluide menant et une sortie de fluide menant, ainsi qu'une pompe à cylindrée positive du type à double rotor en vis sans fin qui est accouplée audit moteur et qui comprend une entrée de fluide pompé et une sortie de fluide pompé, l'appareil comprenant en outre deux arbres parallèles montés à rotation dans un carter, chaque arbre portant un rotor en vis sans fin de ladite pompe et un rotor en vis sans fin dudit moteur, les rotors de la section-pompe définissant des chambres de travail ayant un volume de déplacement de fluide différent des chambres de travail définies par les rotors de la section-moteur, caractérisé en ce que les rotors en vis sans fin de ladite pompe ont un plus grand diamètre de sommet et un plus petit diamètre de base correspondant que les rotors en vis sans fin dudit moteur et en ce que la sortie de fluide menant dudit moteur est en communication fluidique avec l'entrée de ladite pompe par l'intermédiaire d'une chambre formée à l'intérieur du carter entre ledit moteur et ladite pompe.
2. Appareil selon la revendication 1, dans lequel les rotors en vis sans fin de ladite pompe et dudit moteur qui sont montés sur un arbre commun sont identiques en diamètre de pas et en angle d'hélice.
3. Appareil selon la revendication 1, dans lequel l'entrée de fluide pompé se compose d'un orifice d'admission formé dans la paroi du carter, ledit orifice d'admission débouchant dans ladite chambre.
4. Appareil selon la revendication 1, dans lequel l'entrée de fluide menant est située à proximité d'une extrémité du carter et la sortie de fluide pompé est située à proximité d'une extrémité opposée du carter.

Patentansprüche

1. Fluidangetriebene Pumpvorrichtung mit einem Doppelschraubenrotor-Verdrängungsmotor, der einen Fluideinlaß und einen Fluidauslaß aufweist, wobei mit dem Motor eine Doppelschraubenrotor-Verdrängungspumpe verbunden ist, die einen Einlaß für gepumptes Fluid und einen Auslaß für gepumptes Fluid aufweist, wobei die Vorrichtung ferner ein Paar von parallelen, in einem Gehäuse drehbar gelagerten Wellen aufweist, von denen jede einen

Schraubenrotor der Pumpe und einen Schraubenrotor des Motors trägt, wobei die Rotoren des Pumpabschnittes Arbeitskammern definieren, deren Fluidverdrängungsvolumen sich von jenem der Arbeitskammern unterscheidet, die von den Rotoren des Motorabschnittes definiert werden, dadurch gekennzeichnet, daß die Schraubenrotoren der Pumpe einen größeren Kopfkreisdurchmesser und einen dementsprechend kleineren Basisdurchmesser als die Schraubenrotoren des Motors haben, und daß der Antriebsfluidaustausch des Motors über eine im Inneren des Gehäuses zwischen dem Motor und der Pumpe ausgebildete Kammer in Fluidverbindung mit dem Einlaß der Pumpe steht.

2. Vorrichtung nach Anspruch 1, bei welcher die Schraubenrotoren der Pumpe und des Motors, die auf einer gemeinsamen Welle montiert sind, identischen Schraubensteigungsdurchmesser und Schraubenwinkel haben.
3. Vorrichtung nach Anspruch 1, bei welcher der Einlaß für gepumptes Fluid aus einer im Gehäuse ausgebildeten Öffnung besteht, die in die Kammer ausmündet.
4. Vorrichtung nach Anspruch 1, bei welcher der Antriebsfluideinlaß nahe einem Ende des Gehäuses und der Auslaß für gepumptes Fluid nahe einem gegenüberliegenden Ende des Gehäuses angeordnet ist.

