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Application and effect evaluation of new oval multi-head oil and gas mixing pump

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Abstract

In the process of crude oil gathering and transportation, the screw pump is very suitable for oil and gas mixed transportation because of its uniform flow, low noise, strong self-priming ability, and the characteristics of allowing a certain amount of gas in the medium. The key equipment for crude oil export from the station. However, the design problems of the friction pair structure of the rubber stator and the metal rotor and the main shaft sealing structure seriously affect the service life of the screw pump. This project proposes a new type of elliptical multi-head oil and gas mixing pump, which has been applied and promoted in the oilfield crude oil gathering and transportation site, effectively improving the operating efficiency and service life of the screw pump, and the average failure frequency has dropped by 72.5%.

Keywords

New ellipse, linear, mechanical seal, hollow rotor.

1. Introduction

Due to its wide range of flow and head, simple structure and simple operation, screw pumps are widely used in oil field oil transportation, sewage oil and polymer fields. However, the sealing design, stator service life and stator-rotor coordination of conventional single-screw oil pump seriously affect the service life of the screw pump [1-2]. In recent years, the No. 9 Oil Production Plant of Changqing Oilfield has made a number of efforts to improve the life of the screw pump, how to solve the problem of stator and rotor locking, reduce the leakage of mechanical seals, eliminate the axial movement of the pump, and improve the operating efficiency of the screw pump. Research and put forward a new type of elliptical multi-head oil and gas mixing pump, which effectively improves the operating efficiency and service life of the screw pump.

2. Problems of conventional single screw pump

(1) The friction pair of the rubber stator and the metal rotor of the conventional single-screw pump has a short service life and is prone to locking.

(2) The mechanical seal structure of the conventional single screw pump has frequent leakage, which reduces the volumetric efficiency of the screw pump and increases the failure frequency of the screw pump.

(3) The traditional bracket of the conventional single-screw pump cannot carry the axial thrust, resulting in axial movement and reducing the life of the reducer.

(4) There are three-phase flows of oil, gas and water in oil transportation, and the flow pattern of the mixed pipeline is multiphase flow, which requires high mixed transportation capacity of the ground gathering and transportation equipment.

(5) The oil and gas components are different, and the salinity is different. In addition to the secondary and tertiary oil recovery stages, after the oilfield enters the high water cut period,

the produced fluid will show rheological properties, the produced fluid has a high degree of emulsification, and the The acid, etc. after the measures are contained, which puts forward higher requirements on the stator rubber of the screw pump.

3. Design scheme of oval new multi-head oil and gas mixing pump

3.1. Profile Design

In view of the short life of stator and rotor of the screw pump during operation, the stator and rotor are easy to lock, and the profile design of the stator and rotor is optimized. In the radial direction, modern bionic and quadratic element technology is used to further optimize the profile of the rotor, so that the relative movement of the rotor and the stator is smooth, and the interference between the stator and the rotor in the entire circumferential direction is guaranteed to be consistent. This greatly improves the stability of the relative movement between the stator and the rotor, reduces the mechanical loss, and greatly improves the service life of the stator and rotor. In the axial direction, the pitch of the stator is scientifically densified, which reduces the length of the axis under the same pressure, optimizes the liquid inlet conditions of the material, reduces the cavitation phenomenon, and is more conducive to the entry and transportation of the material. The structural design of the new oval multi-head oil and gas mixing pump advantageously improves the volume ratio of the pump and further improves the pump efficiency [3-5].

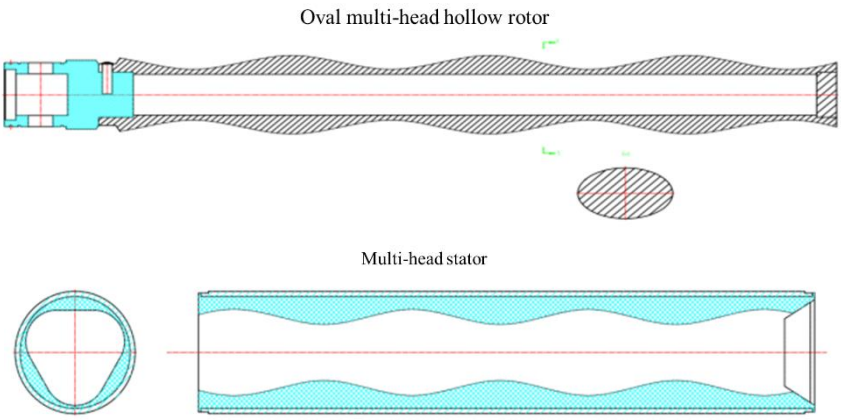

Figure 1. Stator and rotor profile of the new oval multi-head oil and gas mixing pump

3.2. Seal structure design

The single-screw oil pump has the problem of shaft seal when it is running or shutting down, and the engineering often uses the built-in mechanical seal or other seals to deal with it. However, the sealing is not complete, the service life of the mechanical seal is short, and it is difficult to fundamentally solve the sealing problem. This project proposes an external mechanical seal plus a self-lubricating balanced seal system structure to avoid leakage of the pump chamber medium through the gap between the main shaft and the bearing bushing.

3.3. Bracket structure design

The new elliptical multi-head oil and gas mixing pump is usually connected to the reducer through a bracket. Since the new oval multi-head oil and gas mixing pump will generate axial pulsation and generate axial thrust, the traditional bracket cannot carry the axial thrust, so that the reducer is subjected to excessive pressure. damage due to large axial thrust. The traditional bracket has no support for the drive shaft, and the entire pump must be disassembled during the replacement of the reducer and maintenance, which requires a lot of work. In view of the above-mentioned shortcomings in the prior art, the new oval multi-head oil and gas mixing

pump adopts a brand-new bracket structure. The structure is simple, the axial length is short, the bracket can bear a large axial thrust, and it is compatible with the The connection of the reducer is positioned by the shaft hole, which is easy to assemble and maintain; because the transmission shaft on the bracket has been positioned in the axial and radial directions, the transmission shaft runs smoothly, which greatly improves the service life of mechanical seals and other accessories.

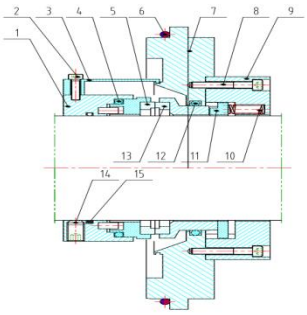

Fig. 2 Seal design of new oval multi-head oil and gas mixing pump

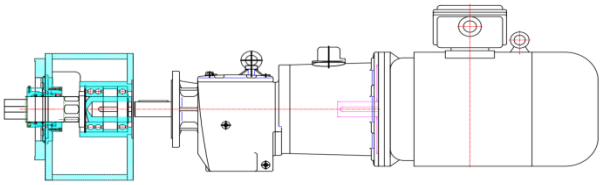

Figure 3 The bracket structure of the new oval multi-head oil and gas mixed pump

3.4. Stator and rotor design

The screw pump rotor adopts high carbon steel quenching and tempering treatment, the surface is plated with hard chrome with a thickness of 20-30um, and has a hardness of HRC56-60, which enhances its corrosion resistance and wear resistance. It adopts a hollow rotor structure and is 1/3 lighter than the same type of rotor. The stator rubber adopts imported high propylene hydrogen content nitrile oil-resistant rubber with oil-resistant, wear-resistant, anti-aging, anti-corrosion, anti-swelling, dilute acid-resistant and compression-resistant properties suitable for the properties of oil, gas and water currently produced on site. 1-2 times longer stator life [6]

4. Field application effect analysis and evaluation

In this project, 10 single-screw pumps with low pump efficiency, high energy consumption, unmatched external pressure and flow rate and process, and high failure rate were selected at the site to carry out the technical test of the new oval multi-head oil and gas mixed pump. application is explained.

Station 1: flow Q = 3-5m3/h, head h≥300m, outlet pressure P≥3.0MPa, pump output speed n≈251r/min. Equipped with 7.5kW motor and reducer, directly connected to IEC reducer; explosion-proof grade ExdIIBT4, protection grade IP55; the material contacting the rotor is made of chrome-molybdenum alloy steel with a coating thickness of 0.25mm. Hardened, hollow, 1/3 of the weight is reduced; the stator is made of integral molding, using imported high propylene hydrogen content nitrile rubber.

It was installed and put into use in June 2020, and the pressure and displacement were stable throughout the day. There was no failure or maintenance for a total of 15,120 hours of operation, and the failure frequency of the original conventional single-screw pump was reduced by 75%.

Station 2: Flow rate Q=4-6 m3/h, head h≥300m, outlet pressure P≥3.0MPa, pump output speed n≈251r/min; equipped with 11kW motor and reducer, directly connected to IEC reducer; explosion-proof grade ExdIIBT4 , protection grade IP55; the rotor contact material is made of chrome-molybdenum alloy steel, the thickness of the coating is 0.25mm, the double-head T-type 4-level geometric structure is adopted, the surface is hardened, it is hollow, and the weight is reduced by 1/3; the stator is integrally molded Manufactured, using imported nitrile rubber with high propylene hydrogen content; the shaft seal is in the form of mechanical seal.

It was installed and put into use in August 2020, and it was continuously exported throughout the day, with stable pressure and displacement. There was no failure or maintenance for a total of 13,680 hours of operation. Compared with the original conventional single-screw pump, the failure frequency decreased by 70%.

5. Conclusion and understanding

(1) From the overall structure of the new oval multi-head oil and gas mixing pump, the pump head, motor and reducer adopt the configuration of the bracket integrated linear design. The appearance is simple and the structure is compact, which greatly compresses the axial length of the pump, saving volume and location space.

(2) The motor power is 1/3 less than that of the same type of pump. The motors are all general-purpose products and are directly connected to the IEC reducer.

(3) The rotor is processed by hollow thick-walled steel pipe, which reduces the weight of the rotor (reduces 1/3 of the weight), reduces the moment of inertia generated by friction with the stator, improves the pump efficiency and saves electricity.

(4) The stator rubber adopts a special formula, and the fluorinated rubber is integrally molded, and its service life is 2-3 times that of other conventional rubbers.

(5) The bearing seat assembly adopts a new type of bracket structure, which has a simple structure and a short axial length. The bracket can bear a large axial thrust, reduce the axial thrust borne by the reducer, and cancel the coupling. , The assembly is easier, the operation is stable, and the service life of mechanical seals and other accessories is greatly improved.

(6) The screw rotor and stator adopt special profile design, the interference of the stator and rotor is small, and even at low speed, it has sufficient sealing and the ability to carry solid fibers or particles, and its volumetric efficiency will not change significantly with the change of rotation speed, so High pump efficiency.

(7) It can realize multi-phase continuous mixing of oil, gas and water, with low internal flow rate and stable pressure, without eddy current and agitation.

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