ALS HYDRAULIC PUMP IMPROVEMENT ADDITIONAL DEVELOPMENT

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ABSTRACT

A new technology called the Hydro-Balanced Stuffing Box System used successfully to prevent pollution caused by polished rod pumps, was designed for use in Artificial Lift Systems using a positive displacement plunger pump. The development was discussed in a paper presented at the 2000 Southwestern Petroleum Short Course and this paper will discuss the field testing and further developments in the technology. **A** leak in the high pressure packing of a pump has the potential of causing environmental pollution, safety hazards, loss of energy and costly clean-up. The technology described transfers the pressure of the product being pumped to a sacrificial barrier fluid of known characteristics. When the seals wear sufficiently to leak, only the environmentally friendly fluid leaks to the atmosphere. The presentation will include slides and drawings of the Hydro-Balanced Packing System.

INTRODUCTION

The subject of this paper is a new patented technology that prevents the product being pumped by a rod pump or a triplex pump used in artificial lift installations, from becoming exposed to the atmosphere and surrounding areas. The technology described transfers the pressure of the product being pumped to a sacrificial barrier fluid of known characteristics. When the seals wear sufficiently to leak, only the environmentally friendly fluid leaks to the atmosphere. The technology can be built into new equipment or be retrofitted to equipment in service with the proper modifications and sealing assemblies. It can also be adapted to other devices such as centrifugal pumps and progressive cavity pumps used in fluid transfer applications.In a paper given at the 2000 Southwestern Petroleum Short Course (Ref. 7.1), the development of a Hydro-Balanced stuffing box was discussed as being used on rod pumps in the field and also the on-going development of Hydro-Balanced packing systems for artificial lift pumps. Some of the artificial lift systems use a positive displacement plunger pump in the 3,000-psi range. A leak in the pump packing has the potential of causing environmental pollution, safety hazards, loss of energy and costly clean up. Since writing the previous paper two field tests have been conducted on a high-pressure pump (10,000 psi) and a medium pressure pump (2650 psi). The tests will be discussed and illustrated in this paper. The 10,000-psi pump was pumping methanol and the 2650-psi pump was pumping salt water.

HISTORY

One of the authors of this paper (Harold Palmour) started developing the idea of a balanced stuffing box back in **1994.** Remote pressure transmitters were retrofitted to stuffing boxes in eight Polk County, Texas wells to prevent pollution caused by leaking seals on oil wells using sucker rod pumps. The "Unitized" version (without the remote pressure transmitter) of the Hydro-Balanced Stuffing Box was first used on a well in Luling, Texas in 1997. The invention was marketed by Trico Industries, Inc. (later purchased by Weatherford International) to control the leakage of rod pumps at the well sites in Texas, Oklahoma, Kansas and Wyoming.

Most packing systems used in industry today have one primary seal that is exposed to the product being pumped and separates the product from the atmosphere. When the seal leaks, the product goes on the ground, into a sump or into the air; everywhere but where it is suppose to go. The evolution of the technology has progressed from using a remote pressure transmitter to incorporating the pressure transmitter into the body of the stuffing box and still allowing it to be an independent unit which operates in its own housing. The latest advancement is to combine the pressure transmitter piston with the secondary seal. In this configuration the secondary seal is a free-floating piston or "sealing element". This free-floating piston seals on both the outer diameter and the inner diameter. It also equalizes or balances the pressure across itself while separating the fluid being sealed from the sacrificial barrier fluid. Therefore, the Hydro-Balanced Sealing System is designed to control the product with a barrier fluid that is chosen by the operator. The technology could best be described as having a primary seal that is exposed to a barrier fluid and a pressure transmitter which is used as a secondary seal to separate the product being pumped from the barrier fluid. The piston / transmitter transfers the pressure to the barrier fluid which is the only tluid exposed to the primary seal. If and when the primary seal leaks, an environmentally friendly barrier fluid can go to the ground, into a Sump or elsewhere. The technology could also find application in sealing rotating shafts, such as Progressive Cavity pumps and in stationary seals such as

high pressure valve stems or anywhere it is desirable to keep the fluid that is under pressure from being exposed to the atmosphere.

PATENTS

The concept of hydro-balancing the pressure across the secondary seal of a stuffing box is the subject of U.S. Patent No. 5,209,495 which covers a commercial product for reciprocating sucker rod pumping systems. The patented technology features the pressure transmitter as a separate component in its own housing or cylinder. A patent is being obtained under the United States Non-provisional Application Serial No. 60/091,941 which will cover the stuffing box assembly having an internal pressure transmitter piston to equalize the pressure across the secondary seal in a stuffing box. The transmitter in the stuffing boxes of reciprocating or rotating rod pumps is to be used to transfer the pressure of the fluid being pumped to a sacrificial safe-lubricant of known characteristics. The present work is to develop improvements to reciprocating multiplex plunger pumps that are used for artificial lift of oil wells and can be used in other industries also. One great advantage of the technology is that it can be retrofitted to most any make of multiplex plunger pump. The internals of the stuffing boxes are the main items effected. In some cases the present stuffing box can be modified to receive the Hydro-Balanced packing consisting of primary seal, secondary seal (or transmitter piston) and the barrier fluid. Therefore, part of the present work is to design systems that can be fitted to various pump brands. The tests done since the last paper on this subject utilized the Kobe Size 3 Triplex pump and the National 100 T- 4 Triplex pump. Both of these pumps are used in artificial lift applications as well as other Oil Field and Chemical Industry applications.

TESTS

In a product engineering report referenced in last year's paper described the first test of the Hydro-Balanced stuffing box for an ALS pump. A 60 horsepower triplex pump was fitted with a version of the Hydro-Balanced Packing System and run at 2500 psi for 11 hours. The tests showed that the concept was sound and very promising for the development of the following advantages:

- Reduced operating costs and down time due to longer packing life
- Elimination of potentially contaminating fluids reaching the environment
- Improved mechanical efficiency due to lower friction losses
- Improved volumetric efficiency due to less leakage

The second test was done on December 27, 1999 and included installing the technology into a Kobe high-pressure plunger pump. A methanol test loop shown in Figure 1, consisting of a product tank, pressure recorder, gauges, filter, supply pump and heat exchanger was furnished by Downhole Assemblies Specialty of Louisiana. The pump used in the tests was an electric driven, Size 3 Kobe triplex pump with 7/8" plungers to operate up to 15,000 psi. The stuffing box for the standard pump was modified for the Hydro-Balanced system test and a pressurized tank was used to supply rock drill oil as the barrier fluid. An air supply and regulator enabled the oil supply pressure to be varied during the tests. The first arrangement tried had the floating piston with a standard packing spring behind it. The first trial run was at 3500 psi and then the pressure was adjusted to around 5,000 psi and then to 7,000 psi. The pump ran smooth and the efficiency was measure to be around 98 per cent. After a run of about 30 minutes, methanol mist was observed around the center cylinder. The test was stopped and the stuffing box was removed for inspection. The piston was damaged in the unsupported area toward the fluid being pumped. Figure 3 shows the high-pressure pump with one of the Hydro-Balanced stuffing boxes removed for inspection. Figure 4 shows the Hydro-Balanced Stuffing Box being inspected after running in the test loop. New pistons were installed in all three stuffing boxes and the pistons were supported by a throat ring toward the fluid being pumped. The test continued for about 15 minutes at 4,000 psi until the center cylinder started smoking through the drain hole in the stuffing box. The barrier fluid (rock drill oil) pressure was 70 psi and the suction pressure (methanol) was 50 psi. The temperature reached 109 degrees F and the smoking continued until the system was shutdown. The stuffing boxes were removed and a preliminary inspection revealed that there was no oil (barrier fluid) in the stuffing boxes, as was expected. The small check valves used to keep the barrier fluid in the stuffing boxes may have had a cracking pressure that was too high for the 20 psi to 30-psi differential desired for the barrier fluid. The lack of oil in the chamber caused the heating and smoking observed. The pistons and packing were in good shape and the tests suggested two changes for future tests: (1) place the spring on the pumped fluid side of the piston and (2) drill & tap for a gauge to read the barrier fluid pressure in the chamber.

On January 5, 2000 the third test of the Hydro-Balanced System was conducted using an engine driven National brand pump in a field location. The pump used a 1-3/8" plunger with conventional packing to pump salt water from the well site near Houston, Texas. A cylinder tank with a sight gage, fill port and a fluid-charging connection, was used to furnish the barrier fluid (rock drill oil). The tank was charged from the well tank and the pressure could be adjusted

from 50 psi to 100 psi. The purpose of the test was to determine if a close fitted plunger & bushing could be used for salt water pumping by the installation of the Hydro-Balanced system, which separates the fluid being pumped from the primary sealing system. The metal to metal, close fitted plunger & bushing usually can not be used to pump "non lubricating" fluids. Figure 5 shows the Hydro-Balanced Stuffing Box being installed at the field site. Figure 6 shows the triplex pump running with one Hydro-Balanced Stuffing Box and two stuffing boxes with conventional packing. Figure 7 shows the barrier fluid tank pressured by the well tank to supply the barrier fluid to the Hydro-Balanced Stuffing Box.The pump ran smooth and a small amount of water and oil was observed dripping from around the plunger, but the plunger & bushing ran well under this condition. The stuffing box was disassembled on January 6, 2000 and the parts were found to be in good shape. The plunger had water / oil droplets on it indicating that the mixture was lubricating the bushing which eliminated the usual galling when pumping a non-lubricating fluid. A pressure gauge suggested by the former testing indicated the pressure fluctuation inside the barrier fluid chamber and a spring was used on each side of the piston. Figure 8 shows the components for the field test including piston, liner, plunger and gauge. The test showed promise for the plunger / bushing arrangement with the Hydro-Balanced system for pumping non-lubricating fluids.

CASE STUDY

Two prototype Hydro-Balanced stuffing box units were installed on rod-pumped stripper wells in cooperation with Rocky Mountain Oilfield Testing Center (RMOTC) around August 1998. The two producing wells at the Naval Petroleum Reserve No. **3** near Casper Wyoming, have a history of packing element wear and stuffing box leaks. During the 60 day test period, performance of the stuffing box was measured by monitoring the pressure on the tubing and the inner chamber with a Barton two-pen recorder. Other parameters were recorded including polished rod temperature, ambient temperature, safe fluid pressure and fluid leakage. The test arrangement provided a better seal between the well fluids and the environment while allowing the polished rod to operate cooler. During a test by RMOTC, for example, the polished rod temperature held constant at 50 degrees F, while the well was pumping. The life of the packing elements was extended and leakage was reduced compared to the conventional stuffing box design. RMOTC reported "The tests indicate that when the Hydro-Balanced Stuffing Box is installed and adjusted properly, it is capable of significantly reducing the spillage of well fluids from the stuffing box for rod pumped wells, compared to the conventional stuffing box design." The latest progress made on the new rod pump version of the Hydro-Balanced System included an installation of a prototype kit on a Utex test pump in Weimar, Texas. This short test that lasted less than an hour, was to prove the concept of using an in-line piston on rod pumps. Mr. Rob Puckett, an engineer with Weatherford was involved in the test and he reported that the kit performed well. He suggests that the next step should be extensive testing in ALS pumps.

CONCLUSIONS

The primary purpose of the Hydro-Balanced Stuffing Box system, as an improvement to the artificial lift hydraulic pump, is to reduce the potential for pollution and to increase the high-pressure packing life. The invention's technical advantage over current technologies and a special feature of the system is that the primary seal is always sealing the operator's chosen fluid versus the current technology that requires a seal material that is suitable for the product being pumped. The Hydro-Balanced Stuffing Box System will add to these advantages by increasing the life of the plungers and packing systems of the surface power fluid multiplex plunger pumps. Another significant advantage is it will eliminate the possibility of a fire hazard when some products leak to the atmosphere, because only a controlled safe fluid would leak when the packing wears. The Hydro-Balanced stuffing box system will be an ARTIFICIAL LIFT HYDRAULIC PUMP IMPROVEMENT to enhance this method of artificial lift.Weatherford and Utex are presently discussing an agreement to develop the Hydro-Balanced Stuffing Box system for various pump brands and pressure ratings. A new test facility is being planned for further testing in 2001.The authors want to thank the employees of Weatherford Artificial Lift Systems and Weatherford International including Trae Rogers, Jimmy Fretwell, Gary McCann, Roger McCelvy, Jerry Kluz, Casey Birte and employees of Downhole Assemblies Specialty for the continued interest and assistance in developing and promoting the Hydro-Balanced Stuffing Box technology.

REFERENCES

Michael T. Gracey, Harold H. Palmour, ARTIFICIAL LIFT HYDRAULIC PUMP IMPROVEMENT, southwestern Petroleum Short Course, 2000.

Michael T. Gracey, HYDRO-BALANCED STUFFING BOX TEST REPORT, dated December **27,** 1999.

Michael T. Gracey, HYDRO-BALANCED STUFFING BOX TEST REPORT, dated January 5, 2000.

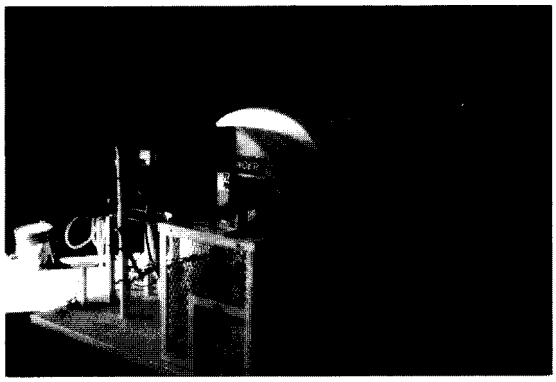

Figure 1 - Methanol Test Loop with Product Tank, Pressure Recorder, Gauges, Filter, Supply Pump and Heat Exchanger

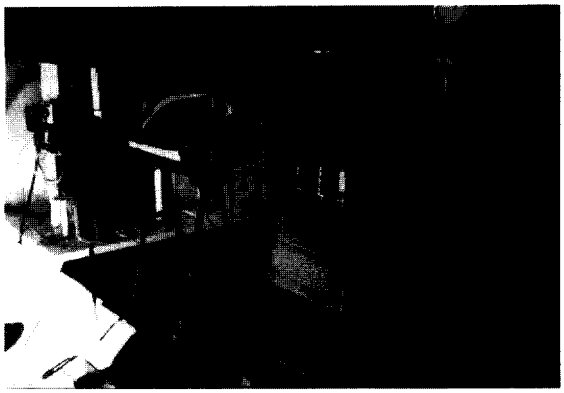

Figure 2 - Kobe Size 3 Pump with Hydro-Balanced Stuffing Box System

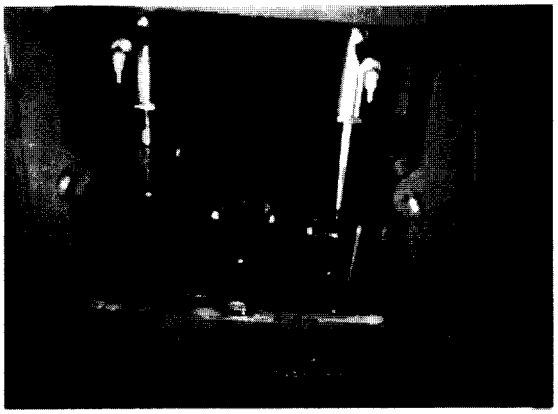

Figure 3 - Kobe High Pressure Pump with Stuffing Box Removed for Inspection

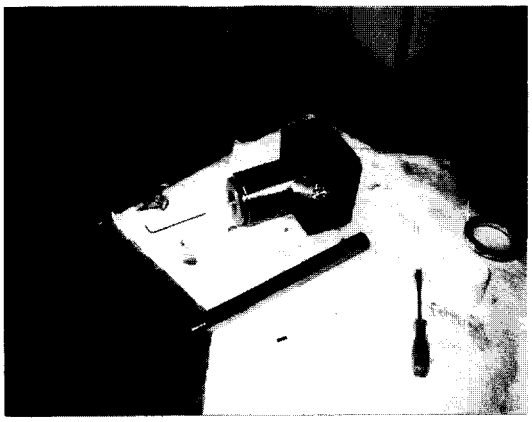

Figure 4 - Hydro-Balanced Stuffing Box Being Inspected After Running in Test Loop

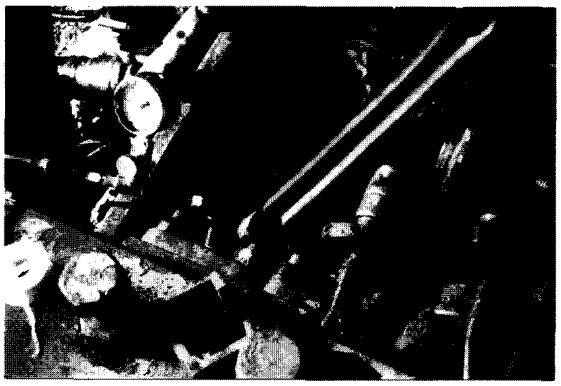

Figure 5 - Installing Hydro-Balanced Stuffing Box into National Pump in the Field

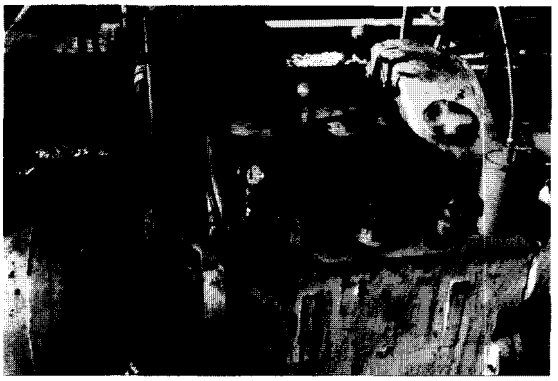

Figure **6** - National Pump Running with One Hydro-Balanced Stuffing Box

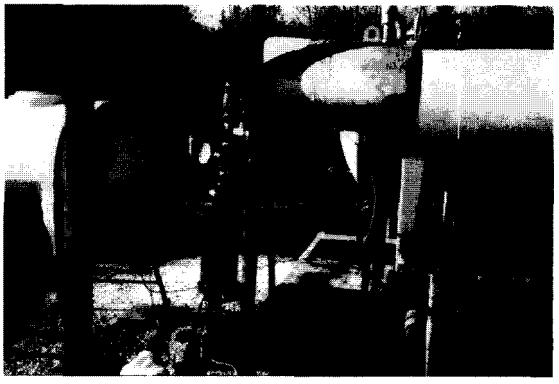

Figure 7 - Barrier Fluid Being Pressurized by the Well Pressure

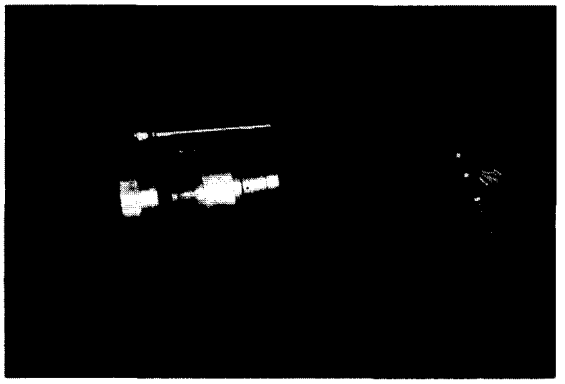

Figure 8 - Hydro-Balanced Stuffing Box Being Inspected After Running at Field Site