ARTIFICIAL LIFT HYDRAULIC PUMP IMPROVEMENT

By

Michael T. Gracey, PE
Weatherford ALS
Houston, Texas

Harold H. Palmour
The Palmour Group
Livingston, Texas

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ABSTRACT

A leak in the high pressure packing of a artificial lift system hydraulic pump has the potential of causing environmental pollution, safety hazards, loss of energy and costly clean-up. The subject of this paper is a system that prevents the product being pumped from becoming exposed to the atmosphere and surround areas. The technology to be 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 retro-fitted to pumps in service with the proper modifications and sealing assemblies. The paper includes photographs of the Hydro-Balanced Stuffing boxes for sucker rod pumps and a diagram of the artificial lift pump improvement. The presentation will include slides and graphics of the Hydro-Balanced Packing System.

1.0 INTRODUCTION

High pressure pumps are used in almost every industry today. They are used in the oil fields, refineries, petrochemical plants, automotive manufacturing, steel making, forest products industry, offshore & on-shore drilling, shipyards, food processing, marine industry and coating industry. Pumps are used to move fluids such as oil, chemicals, water, lubricants, test fluids, abrasives and slurries. These products are sometime hazardous, sometime pollutants and sometimes inflammable or they may just be poor lubricants for the high pressure pump. A solution to the problem of packing leaks and short working life is being developed in the form of a new technology called the Hydro-Balanced Packing System. This technology is being adapted for use in Weatherford's Artificial Lift Systems as an improvement in the high pressure hydraulic pump.

In a paper given at the last Southwestern Petroleum Short Course (Ref. 7.1), it was stated that for a particular field being studied, "Hydraulic pumping was determined to be the most viable method of artificial lift because of the depth and low inflow capability". Later in the same paper it was stated that "Hydraulic pumping is a high cost artificial lifting technique" and "The two categories of most concern are electrical power consumption and hydraulic pump repair".
The packing life in some pumps could be improved with the Hydro-Balanced Packing System and it is believed that surface pump power consumption can be reduced.

There is a potential energy saving associated with using the improved packing system by reducing the spilled product (such as oil & chemicals) and by a reduction of the energy required to drive a pump. One segment of the petroleum industry where significant energy savings will be realized is from oil wells that are being artificially lifted by hydraulic pumping systems. There are 2,500 domestic and many foreign oil wells using this type of system which involves a high pressure pump that could be fitted with the Hydro-Balanced Packing System. A report by Richard A. Poteet, P.E., indicates that 1,000,000 barrels of oil would be saved annually if the seal life of the pump could be doubled. Additional money would be saved by reducing the service downtime when a packing system needs replacing.

2.0 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.
Figure **1** shows a fluid version (using oil for the barrier fluid) and Figure **2** shows a grease version (using grease for the barrier substance) of the Hydro-Balanced Stuffing box installed on sucker rod pumps.

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 Hydro-Balanced Packing System, on the other hand, 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 fluid 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.

3.0 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 will be an improvement to reciprocating 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. Figure **3** shows a conventional system with packing that separates the product from the atmosphere. Figure **4** shows the Hydro-Balanced system that uses the packing lubricant as the barrier fluid to separate the product from the atmosphere.

4.0 TESTS

In a product engineering report (ref. **7.2),** test procedures were described and the findings were explained. 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

A program is scheduled to begin early in the year 2000, which will include installing the technology into high-pressure plunger pumps. The latest designs will be tested and developed into a marketable product for new pumps and existing pumps. Figure 5 shows a Size 3 Kobe test pump being readied for the Hydro-Balanced Stuffing box system. Testing will include the measurement of pressure, flow, temperature, energy used, packing life and performance as compared with conventional packing. Figure 6 shows the test skid consisting of a product tank, pressure recorder, gauges, filter, supply pump and heat exchanger interface. A heat exchanger is to be used for extended testing of the conventional packing and Hydro-Balanced packing systems. The results of these tests should be available by the time this paper is presented in April 2000.

5.0 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 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 and allowed 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."

6.0 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 material that is suitable for the product being pumped.

A paper (Ref. **7.3)** given at the SPE conference in **1998,** dealt specifically with the selection of artificial lift systems. It was stated that advantages of hydraulic pumping with positive displacement pumps includes:

- Being able to circulate the pump in and out of the well
- Capable of pumping depths of **17,000** feet and deeper
- Deviated wells typically present no problem
- Can handle viscous oils very well
- Corrosion inhibitors can be injected into the power fluid

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.

The authors want to thank the employees of Weatherford Artificial Lift Systems and Weatherford International for the continued interest and assistance in developing and promoting the Hydro-Balanced Stuffing Box technology.

7.0 REFERENCES

7.1 James A. Fretwell, Edward S. Blair, ACHIEVING LOW BOTTOM HOLE PRESSURES IN DEEP WELLS USING HYDRAULIC RECIPROCATING PUMPS, southwestern Petroleum Short Course, **1999.**

7.2 M. Slegers, R.E. Rhodes, PROGRESS REPORT ON HYDRO-BALANCED PACKING SYSTEM FOR TRIPLEX PUMP, Product Engineering Report **#122,**

7.3 James F. Lea and Henry V. Nickens, SELECTION OF ARTIFICIAL LIFT, **1998** SPE Annual Technical Conference and Exhibition, New Orleans, Louisiana, September **27-30,1998.**

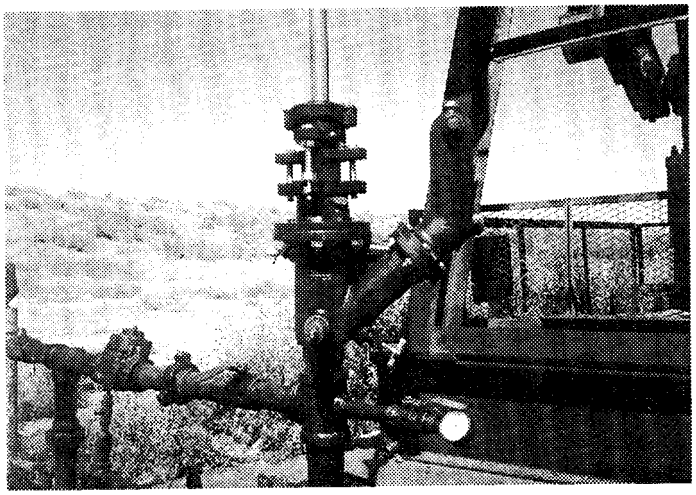

Figure 1 - Fluid Version of the Hydro-Balanced Stuffing Box on a Sucker Rod Pump

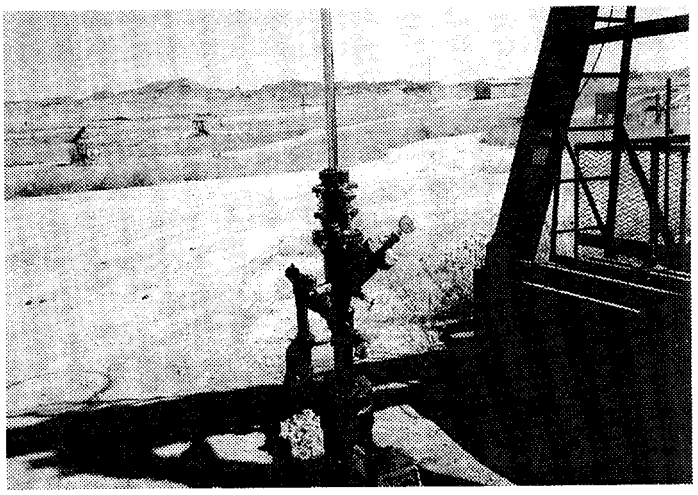

Figure 2 - Grease Version of the Hydro-Balanced Stuffing Box on a Sucker Rod Pump

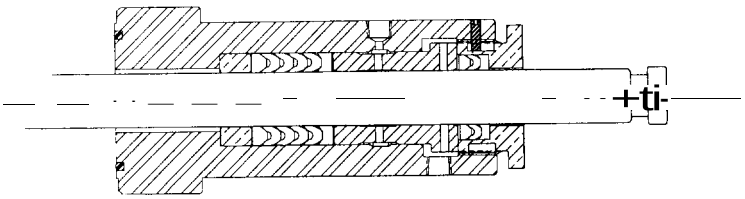

Figure 3 - Conventional Packing System for a Plunger Pump

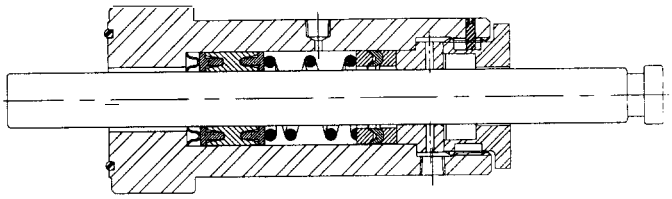

Figure 4 - Hydro-Balanced Packing System for a Plunger Pump

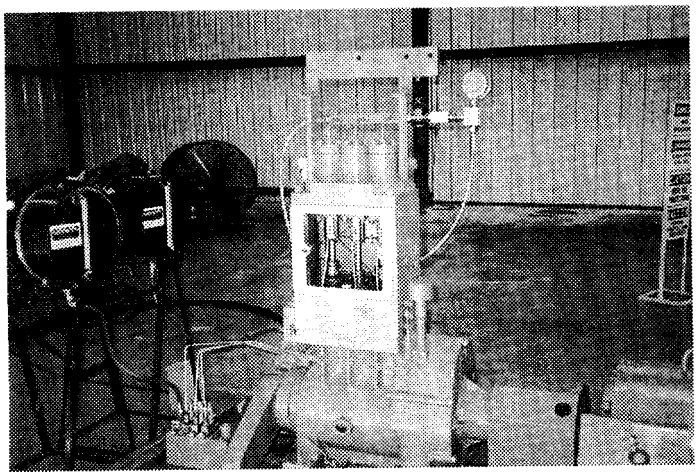

Figure 5 - Size 3 Kobe Pump Being Set-Up with Hydro-Balanced Stuffing Boxes

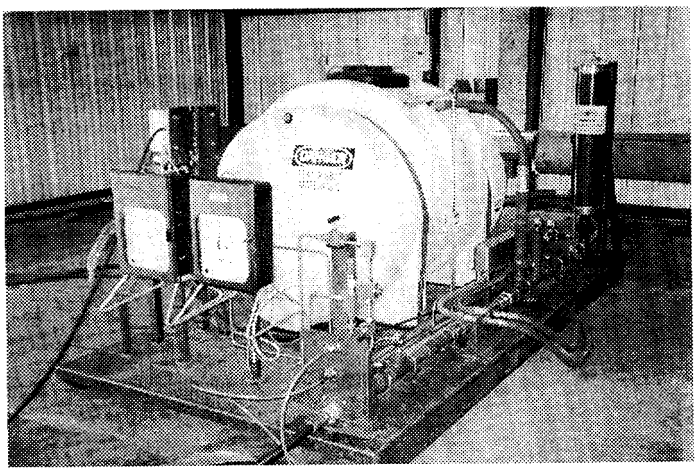

Figure 6 - Test Skid Consisting of a Product Tank, Pressure Recorder, Gauges, Filter, Supply Pump and Heat Exchanger Interface