FINAL REPORT FOR
RECIPIROCATING ROD PUMP SEAL ASSEMBLY (R.R.P.S.A.)
PROJECT I.D. NUMBER 01-97EE15682

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EXECUTIVE SUMMARY

The invention, “R.R.P.S.A.,” was evaluated by the National Institute of Standards and Technology (N.I.S.T.)’s Office of Technology Innovation (O.T.I.) in accordance with the N.I.S.T. role in the joint N.I.S.T.-Department of Energy (D.O.E.) Energy-Related Inventions Program (E.R.I.P.). After examining the technical and commercial feasibility and the energy impact of the invention, N.I.S.T. recommended that the D.O.E. support the invention’s further development and commercialization.

This technology provides a simple yet clever idea for preventing oil and saltwater polluting spills by sucker rod pumping oil wells, as well as prolonging the life of the stuffing box seals and pressure lubricating the polished rod. This objective is accomplished by introducing a non-polluting, food grade, high viscosity lubricant into the void space between two sets of seals in a typical stuffing box. This safe-fluid acts as a sacrificial fluid that will be the fluid that is exposed to the atmosphere when the primary seal in the stuffing box leaks for any reason. In addition, the pressure on this sacrificial safe-fluid is maintained at the same pressure as the pressure on the produced fluid in the flow line at the pumping tee, thereby equalizing the pressure across the secondary seal in the stuffing box that separates the safe-fluid from the produced fluid. The unique feature, of equalizing the pressure across the secondary seal, is accomplished by using a pressure transmitter which is monitoring the pressure in the flow line (which is the fluid under the secondary seal) and transmitting that pressure to the safe-fluid (which is the fluid above the secondary seal) thereby equalizing the pressure across this secondary seal. The primary seal will be sealing the safe-fluid and will be operating under optimum conditions, extending the life of this primary seal.

The principle of the invention was proven by equipping eight oil wells with Field Retro-Fit Packages of Independent component parts to hydro-balance the existing stuffing boxes. The objective of receiving support through the E.R.I.P. program was to design and manufacture a unitized Hydro-Balanced Stuffing Box (H.B.S.B.) incorporating all of the component parts of the Field Retro-Fit Packages. This objective has been achieved.
INTRODUCTION AND BACKGROUND INFORMATION

Approximately 80% of the artificially lifted producing oil wells in the U.S. are produced by sucker rod-pumping systems. This system utilizes a prime mover (gas engine or electric motor) which actuates the surface-pumping unit which in turn reciprocates a polished rod connected to a string of sucker rods attached to a subsurface pump. When the produced fluids (oil, saltwater, and gas) reach the surface it is necessary to seal off around the polished rod to force the produced fluid to proceed through the flow line to the lease treating and storage facilities. Depending upon the pumping conditions, and the oil well’s characteristics, the pressures in the flow line can reach above 1500 psi. However, most pumping wells have flow line pressures under 500 psi. The piece of equipment that seals this pressure around the reciprocating polished rod is called a stuffing box. It is the stuffing box that this technology is directed toward.

The stuffing box leaking on a sucker rod pumping well is as sure as death and taxes! Every surface sucker rod pumping stuffing box will leak at some point in time, causing various degrees of pollution around the wellhead, some of which result in costly clean-up operations and even considerable loss of production.

There have been many approaches to solving this production problem. Most attempts have been to gather the leakage in some manner until the operator discovers the leak and remedies it by tightening the packing or repacking the stuffing box. Every operator and every lease pumper has had to cope with this problem. Many attempts have been made to control it.

The most popular approach has been to attach a catch container to the stuffing box and attempt to direct the leakage into the container (see Figure 1). The catch container may be equipped with a shut-down switch to stop the pumping unit when the leakage of well fluids fills the container. Since the stuffing box was leaking when the pumping unit was shut down, it continues to leak until the pressure on the flow line diminishes to the point where the packing is able to contain the leakage or pressure. To attempt to solve this continuing leakage problem, some operators have installed a trapping device (see Figure 2). When the “trapper” collects sufficient fluids, an overflow hose directs the leakage into a drum to be collected and disposed of by the operator, if it doesn’t rain and overflow the drum.
PROOF OF CONCEPT

To prove the concept, a retrofit kit was designed in 1992 that could be attached to existing equipment and functionally demonstrate the soundness of the concept. These kits (see Fig 3) were installed on eight wells and from these installations reservoir size and lubricants were evaluated and the performance showed the concept to be practical and successful.

A patent application was submitted to the patent office and a patent (U.S. Patent #5,209,495) was granted in May, 1993.

PROGRAM INITIATION

A Financial Assistance Grant Request was prepared and submitted as D.O.E. #682. Upon approval, an engineering firm was contracted to prepare a preliminary design based on the parameters set forth by the principal investigator.

PRELIMINARY DESIGN

A preliminary design (see Figure 4) was completed that incorporated all of the features of the original concept. Several changes were made and, upon finalization, manufacturing drawings were prepared.

LICENSE AGREEMENT

Upon completion of the preliminary design, a license agreement was reached with Trico Industries, Inc. (a wholly owned subsidiary of Paccar) to manufacture and market the stuffing box. Three assemblies were manufactured and successfully tested at the Trico factory. Upon review it was decided that the preliminary design was too costly for production and a redesign was undertaken.
FINAL DESIGN

The assembly was redesigned, keeping all of the original features, but providing a more cost effective and more easily maintained product. Prior to completion of the castings, a model was made for display purposes (see Figure 5) utilizing the Laminated Object Manufacturing (LOM) method. This model was displayed at the “Texaco June Jubilee” in Oklahoma City, the Offshore Technology Conference in Houston, Texas, and The Society of Petroleum Engineers Conference in San Antonio, Texas. After critical design review, the product was approved for manufacturing and distribution.

CURRENT STATUS

Although Trico experienced some problems with the first castings, the product is currently in production and early market introduction.

CONCLUSIONS

The program has been successfully concluded with all objectives met. A design has been developed, detailed and introduced to the market. License arrangements have been concluded with a major production equipment supplier that will assure broad distribution and availability. The design has proved sound and will provide improved environmental protection as well as reduced service and maintenance expense for the operator.
Figure 1

Figure 2
Figure 3
Figure 4
Preliminary Design

Figure 5
Final Design