NEW SAND FLUSH PLUNGER™ FOR PARTICULATE PRODUCING WELLS USING RECIPROCATING LIFT PUMPS

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ABSTRACT AND SCOPE

The design of traditional sucker rod pump plungers has taken several approaches to reducing plunger wear with the goal of extending reciprocating lift pump run times. These methods with their advantages will be reviewed, and the concept of flushing sand and other particulates from the plunger's leading edge will be introduced by explanation of the patent-pending Sand Flush Plunger™.

INTRODUCTION AND BACKGROUND

Historically, the first plungers were soft-packed plungers with leather valve cups adopted from contemporary water well pumps. Interestingly enough, these plungers were fairly good in abrasive production conditions which would hang up a metal plunger (to be invented later.) In fact, valve cups and other types of soft-packed plungers are still good choices when metal plungers hang up due to certain types of abrasive particles.

The first metal plungers that had wide-spread use in the industry were cast iron, sectional plungers. The sections were about 12 inches long and were assembled end-to-end on a mandrel and carefully lined up during the assembly process. Although the sectional plungers had good wear characteristics they were unsafe when pressure was trapped inside and frequently blew up in the pump shop during repair.

When metal sprayed and chrome plated plungers were introduced they replaced most of the sectional plungers almost overnight. The sprayed metal process deposited a hard, thin layer of corrosion resistant, nickel-based material on the outside wearing surface of the plunger. The hard chrome plating process likewise produced a hard wearing surface but without the corrosion resistance of the metal sprayed plungers. After precision grinding of either of these outside surfaces, a smooth, hard wearing surface was left which increased plunger run times dramatically in abrasive production conditions.

TECHNICAL CHARACTERISTICS OF PLUNGERS

The addition of the hard wearing surface to metal plungers made users of the product aware of the slippage or leakage of fluid between the plunger and barrel whenever a pressure differential existed across the plunger(1). Even when new, there exists some slippage of fluid which is necessary for lubrication of the plunger/barrel interface. When this slippage becomes excessive, due to wear of the plunger and/or barrel, the efficiency of the pump is too low and repair of the pump is needed.

Therefore, one of the goals of reciprocating pump design is to maximize the wear resistance of the plunger and barrel. What comes to the design mind first is to increase the hardness and/or wear resistance of the surface of the barrel and plunger. The most dramatic, relatively recent developments are the addition of small carbide particles to the plunger sprayed metal coating or the barrel nickel plating (Nickel Carbide plating.)

However, there are also dynamic fluid flow considerations:

- Short plunger and long barrel pump. Please refer to Figure A. Traditional reciprocating pumps use a metal plunger which is much shorter than the barrel. The metal plunger length and below-base-diameter (actual size) is generally chosen based on fluid slippage calculations and clearance for particulates, while the barrel length is chosen based on plunger length and stroke length. Thus, the plunger is stroking up and down in the barrel during pumping. On the upstroke of the rugged and popular stationary barrel pump there is a pressure differential across the plunger. Fluid is being lifted toward the surface above the plunger (high pressure side) while fluid is entering the pump from the formation below the plunger (low pressure side.) As the plunger is moving up the pressure of the fluid column is pushing fluid between the plunger and barrel in the form of slippage of fluid. If abrasive particulates are being produced then they also are being forced between the plunger and barrel by the pressure. To make matters worse the plunger is helping with the deterioration of the plunger/barrel wear surfaces by running over the particulates as it moves up.

- Long plunger and short barrel pump. Please refer to Figure B. For this pump the metal plunger's actual size below base is chosen based on fluid slippage and clearance for particulates, and its length is chosen based on stroke length and barrel length. The barrel length is chosen simply based on fluid slippage. The advantage of this inside-out arrangement is that it works better in particulate production, wearing out slower and resisting plunger sticking. The fluid dynamics of this design are responsible for its success in these conditions. There are two considerations. The first consideration is that the plunger is always stroked out of the barrel, top and bottom, which allows it to be continually bathed in fluid. This fluid helps keep particulates from accumulating at the plunger/barrel interface. The second consideration is that as the plunger moves up it is leaving the barrel and pulls particulates away from the plunger/barrel interface where the pressure is trying to force them between the plunger and barrel.

SAND FLUSH PLUNGER™

The Sand Flush Plunger™ Pump configuration has a short plunger and long barrel of the traditional style, Figure A. However, it uses another fluid dynamic concept to increase plunger/barrel life.

The discharge point of traditional plungers is located a few inches above the plunger/barrel interface and thus there is a relatively stagnant area between this fluid discharge point and where particulates can enter the plunger/barrel interface. In this area particulates can accumulate before being forced between the plunger and barrel.

The patent-pending Sand Flush Plunger™, Figure C, has an integral valve rod connecter with fluid discharge ports right at the plunger/barrel interface. When fluid is flowing through the plunger on the downstroke of the pump it washes clean this area at the top of the plunger/barrel interface. This cleansing action prepares the plunger/barrel interface for the next upstroke. Also, by keeping the particulates moving up and away from this area it keeps the particles in suspension above this critical part of the pump.

SUMMARY

Testing of this concept was completed two years ago and sales were begun in production areas with severe particulate problems. The concept was successful and it is now offered in all plunger sizes, lengths and fits.

ACKNOWLEDGEMENTS

The inventors of the Sand Flush Plunger™ are:

- Justin Conyers, Harbison-Fischer
- Ian Rimmer, Harbison-Fischer
- Brad Rogers, Harbison-Fischer

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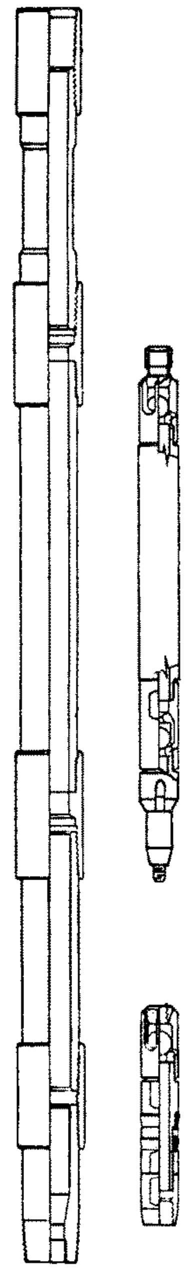

Figure A

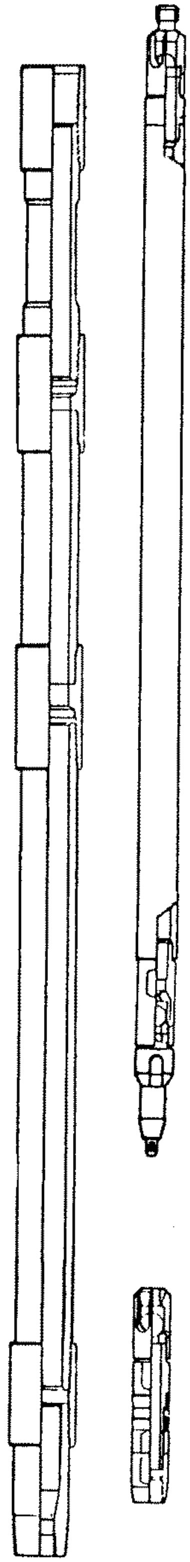

Figure B

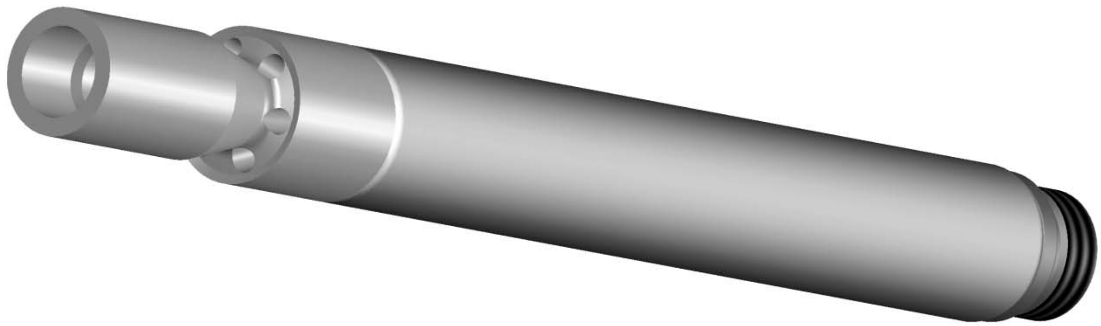

Figure C