



HARP™ (High Angle Reciprocating Pump)

Overview

The HARP is an innovative, patented, reciprocating rod pump designed to provide operators with a solution for landing artificial lift pumps at high inclination (up to 90 degrees) in deviated and horizontal well bores. The HARP was specifically designed to pump at high efficiency in varied and challenging flow regimes. This includes conditions such as elevated gas/liquid ratio's (GLR's) that result in gas locking, low reservoir pressures that result in insufficient drawdown for pumps landed higher up in the wellbore, and inconsistent slugging of fluids that result in inconsistent pump efficiency. The HARP provides operators with a pumping solution to maximize reservoir drawdown and production rates in their deviated and horizontal wells.

Description of Components

Unique Valve and Cage Design

The HARP'S standing and travelling valves assemblies are engineered to re-seat on every stroke regardless of the pump orientation. Standard reciprocating pumps were designed to work in vertical and slightly deviated wells and experience a reduction in efficiency beyond 45degree inclination. The HARP has a unique guided spring-loaded valve assembly that allows valves to always re-seat on the central line of the pump independent of well inclination (0-90 degrees). The valve and seat designs are fluid load tested in the company's horizontal test apparatus to ensure they are suitable for deeper well bores (up to 3000m and 9840ft). Various materials can be supplied to address well specific corrosion issues.

Proprietary Spring Design

The Raise design engineering group utilize spring design software to ensure that springs meet the requirements of well conditions, fluid loads and life cycle. Special alloy spring materials have been tested in both sweet and sour conditions up to 110,000ppm (11%) H₂S. Raise's ability to do accelerated cycle testing of proprietary spring designs can be used to extended pump run times for operators.

Patented Articulated Plunger

This leading-edge technology specifically targets deflection issues that standard "rigid" plunger designs face in deviated well bores. The articulated plunger is capable of "bending" to function in relatively high doglegs. The design reduces the friction and wear as the articulated plunger can track along the deflection plane of the pump barrel when landed in higher doglegs.

"Always on Tap" Pump Design

The HARP is designed to be run on tap throughout its life cycle. This design feature maximizes pump efficiency and minimizes operator time and expense required to put wells and tap and take them off tap to address gas locking issues. The pump is designed to be run in this manner without any reduction to the life of the pump.



Technical Support

Raise provides the following technical and support for operators:

- Technical evaluation on well candidate suitability and optimization of pump design and landing dept.
- Provide Rod String design recommendations (rod size, scraper configuration and sinker rod) which are based on Raise's experience landing HARP's at high angles while addressing dogleg severity(DSL) and maximum side load effects.
- Field installation and training.

Features

Valve System

- Valve and seat are lapped for a perfect seal.
- Energized to ensure valve will re-seat on every stroke.
- Works at any angle (0-90 degree).

Spring Technology

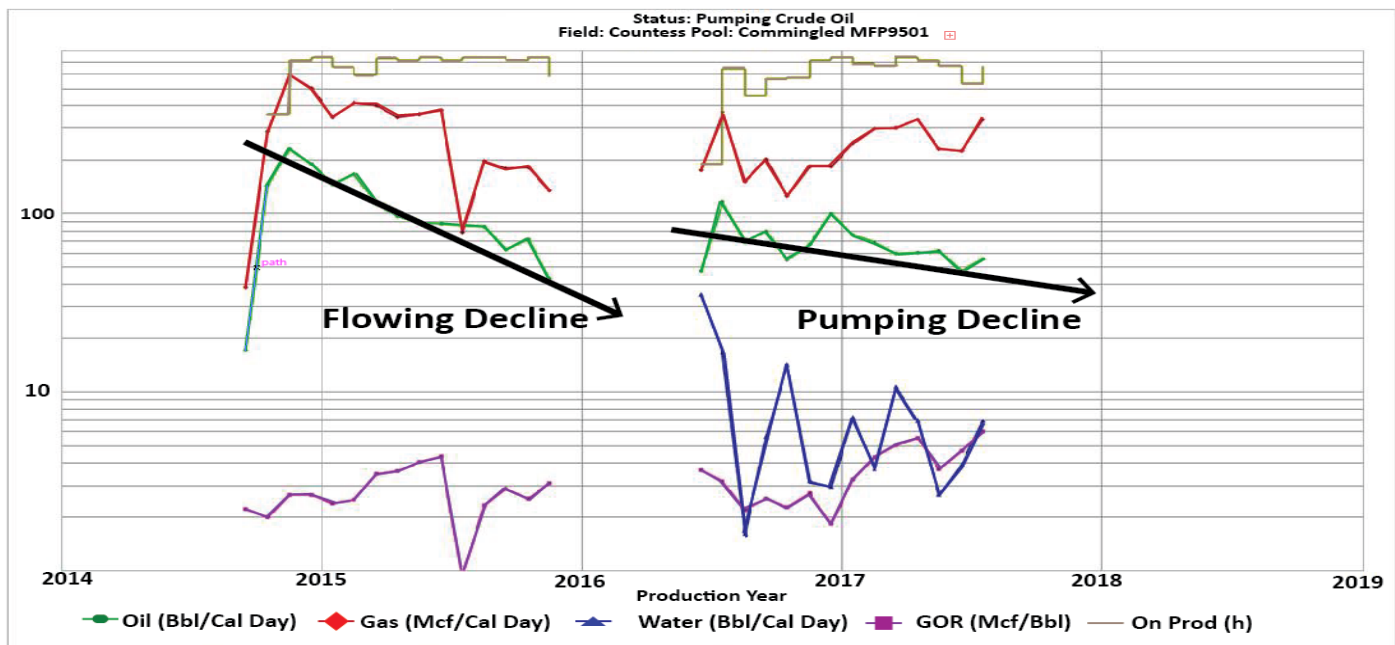
- Cycle tested for long run times.
- Materials selected to resist degradation.

Maximum Efficiency

- Gas locking mitigated.
- No redundant gas compression stroking.
- Optimal for high gas/liquid ratio's.
- Efficient at slow speed (SPM).
- Always on tap.

Wear Resistance

- Articulated Plunger reduces wear when pump is landed in relatively high doglegs.
- Swiveling joint minimizes friction in deflected pump barrels.
- Designed for minimum forced required to stroke Plunger (reduced friction).
- Designed to be capable of pumping efficiently at low strokes per minute (SPM) to maximize pump life.
- Designed to maximize overall reliability of for longer pump life.



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