CONCEPTUAL DOCUMENT

ARTIFICIAL HYDROLIFT-UMBILICAL PUMP LIFT SYSTEM PERMANENT DEPLOYED ON UMBILICAL OR CONCENTRIC PIPE INSTALLATION AND REMOVAL METHOD® Patent Pending 62/230,115

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GPT Global Petroleum Technologies Artificial Lift and Production Solutions
The GPT US - ARTIFICIAL LIFT SYSTEM PERMANENT DEPLOYED ON UMBILICAL OR CONCENTRIC PIPE INSTALLATION AND REMOVAL METHOD (PAT-Pending).

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FOREWORD

GPT© and the authors (2) of this invention thru this document probe the technical benefits and reduced cost of this invention over the traditional lifting systems such as beam pumps, ESP, gas-lift, PCP and others.

Oil and Gas recovery technology has advance tremendously in the last decade. Oil and gas in shale formations, horizontals, multiples leg wells and hydraulically fractured reservoirs introduce major changes in oil production. New challenges in the oil industry together with low oil prices induce a crisis mode throughout the industry that is changing the way business is conducted and how we create or approach advances in the technology.

GPT© fundamentally pursues advances and developments of new technology in artificial lift identifying maximum production rates defined by the reservoir inflow performance relationship and the well design. The hydraulic lift system makes major contributions to the total cost of wells by providing high production capacity that can be installed in reduced well bores. This introduces lower cost in fuel consumption, drilling services, completion cost, rig size and consumables. Surface facilities are also much smaller reducing environmental impact.

The hydraulic lift system was introduced in the 50’s with rapid acceptance and extensive applications, later other lifts systems introduced advances that led to replacement of hydraulic lift. Minor advances were claimed by hydraulic lift for many years. Recently horizontal wells have opened new applications for hydraulic lift especially when used in conjunction with coil tubing (CT) that facilitates deployment in high angle and horizontal well profiles.

Hydraulic artificial lift systems have been successfully pumping fluids from oil wells for over 60 years providing benefits and features that include, high production capacity, no moving parts, tolerance to sand, tolerance to gas, reverse circulation, retrievability, deep wells and multiple well pad applications. There is an extensive history of successful applications in land and offshore wells.

GPT© has submitted the patent for an innovative combined solution that can be applied as a unique lift system without compromising the wells’ production and in most cases increasing production while reducing well cost and facilities. Well maintenance is also reduced along with time required for well intervention. The system impacts drilling, completion, production, energy consumption, environmental and visual pollution, and is not limited to the well configuration, location and operation (inland and offshore). Applications include mature reservoirs where cost are more critical.
ABSTRACT OF THE INVENTION

The present invention is directed to methods for extracting fluids from oil and gas wells. More specifically, it is directed toward methods and apparatuses to power and control downhole hydraulic or pneumatic devices using subterranean pumps. This invention represents a primary improvement over current hydraulic artificial lift systems and can be applied to any fluid in the power system. The invention uses umbilical, coil tubing (CT) or internal tubing string(s) deployed by a spooler unit or CT unit and is permanently installed in the wellbore. The umbilical tubing string will be landed inside the existing production tubing or in a landing cavity or bottom-hole assembly (BHA). The umbilical tubing string or concentric pipe is spaced and landed in the wellhead with a seal assembly and BOP system to permit work under pressurized well conditions. The system facilitates injection of special fluids with chemicals, conventional water or oil that may help reduce the impact of high viscosity production. Fluid injection options can also include hot fluids to help clean or prevent deposits of solids in the tubing string. The concentric configuration can also be expanded to dual or multiple string well completions. The deployment system facilitates reaching further into deviated or horizontal sections while providing lift conditions suitable to each producing zone.
This solution is applicable in verticals, slant and horizontal wells as well as multiple legs or multilateral wells. The downhole pump can be a positive displacement device, a jet/venturi, a centrifugal device or any type of action that can be powered by the hydraulic or pneumatic power transmission.

This invention provides a cost effective, safe, efficient, and innovative timely deployment (installation/ removal) method of downhole lift system without the need of a workover rig or pulling unit (Rig-less).

The hydraulic lift system is deployed with pressure sensors and other devices to communicate operating conditions of the lift system by cable transmission to the surface which can be sent to the central office to provide “Real Time” optimization parameters.

Deployment on umbilical or concentric pipe system introduces a solution for artificial lift on new wells where drilling cost has been reduced with the application of slim-hole drilling technologies that often leaves casing diameters that limits other lift systems.

**WHAT IS NEW**

GPT© introduces the CUT-HYDROPUMP™ system that consist of: state of the art umbilical spooler to deploy small diameter tubing (1- 2 ½” external diameter, umbilical continuous pipe), a special hydraulic pump (jet or piston) depending on the application and designed to install inside existing well tubing. The assembly is seated on a special landing device or expandable unit in cases where removing the completion is not desired. The system includes monitoring system to track the PIP (Production Intake Pressure) and the injection pressure as well as the temperature. Other parameters such as the rate of power fluid injected to operate the downhole hydraulic pump can be equally monitored on surface or bottom. Due to the flexibility of the string and the pump size, the operation can be run in vertical, high angle and horizontal profiles including cases where the tail effect or recovery can be reduced such as in extreme long horizontal wells.

The CUT-HYDROPUMP™ system does not require a gas separator, the gas is vented by the well completion where gas flows up the casing annulus and the concentric umbilical tubing inside the production tubing handle the hydraulic pump operation. Power fluid to operate the hydraulic pump is injected down the umbilical tubing and mixed exhaust power fluid and production flow up the tubing inside diameter. Proper downhole gas separation engineering should be applied as in all other lift systems.

The CUT-HYDROPUMP™ can be run inside larger tubing strings with large umbilical line or CT while maintaining the benefits of the umbilical system with much larger production capacity.

The CUT-HYDROPUMP™ systems’ main advantage is the zero skin effect that allows it to be run in high pressure or low pressure sensitive formations. The lift system can be installed without killing the well and does not require the use expensive fluids that can cause formation damage.
Heavy oil and viscous fluids can be produced by injecting chemical or hot fluids with the hydraulic fluid. Some filters can also be added below to reduce the effect of solids in the system.

Isolation of damaged casing, undesired perforations or wells with extremely low fluid levels can be managed with the CUT-HYDROPUMP™ system by deploying the pump below the damaged casing or perforations. This is also applicable and advantageous in mature wells or reservoirs.

The CUT-HYDROPUMP™ is deployed or pulled by the GTP® special spooler or conventional CT Unit. The time required to recover the pump to perform maintenance and well interventions can be done with the same equipment and in record time reducing the loss of production and improving the overall cost effect.

In the larger cost scale, the CUT-HYDROPUMP™ system allows wells to be drilled with smaller diameters and completed with less components. Installation and pulling is performed rig-less without fluids reducing drilling cost by 50-60% and lift cost by up to 40%. The decreased surface and downhole components makes the CUT-HYDROPUMP the lowest cost artificial lift alternative for the same production in close to 20% of the industries oil wells.

In multi pad location, wells are drilled in the same location reducing land cost and environmental impact while the CUT-HYDROPUMP™ system can be deployed in any angle with significant advantages.
To provide the most reliable system the CUT-HYDROPUMP™, is offered with engineered surface power fluid treatment systems combined with either positive displacement pumps or multistage horizontal pumps. These systems are designed to reduce the effect of solids and gas in the power fluid. Multiple well pads are produced with less initial investment, lower energy consumption and reduced downtime. Offshore and land applications requiring less foot print can be powered with canned ESP systems.

GPT© provides the turn key engineering, fabrication, installation and optimization.
HOW IS WORKS

Prior to installation, the CUT-HYDROPUMP™ system, the previous lift system is removed and the tubing is set at the maximum depth possible as per the best well performance requirements.

A GPT© umbilical spooler drum and injector is assembled and positioned. BOP and raisers can be assembled on the wellhead along with the GPT© wellhead and umbilical line hanging system.

A device is set by cable in the tubing with a collar stop or tubing slips to receive the special bore seating assembly and lock system for the hydraulic pump.

A jet or reciprocating pump is connected to the umbilical pipe. The pump and connection is assembled and hydrostatically tested on the surface (with a dummy lockout pump) and run thru the GPT© wellhead control and landing assembly. If filters are required, these can be added along with the integral standing valve. A disconnect sub or circulating sub can be added as part of the umbilical string.

The downhole hydraulic pump (Jet or piston) is run in the well with a special design umbilical pipe to fit inside production tubing.

The pump is landing in the seal bore and the CT string is space out to land and seal. The umbilical pipe is cut followed by installation of the spacer pipe and ball valve. The spacer, connectors are pressure tested.
The BOP and raisers are removed (under pressure control) and the GPT© wellhead control and landing assembly is activated with the spacer pipe hung with landing clamps. The master valve is installed and pressure tested so the surface power fluid equipment can be connected.

Power fluid is injected at pre-determinate conditions and the production is returned up the tubing annulus to the flow-line through the pumping Tee and on to the production facilities or to the GPT© UNIWELL system. The annulus allows venting of produced gas or deployment of sensors as well as use of fluid level monitors.

The most significant features of the CUT-HYDROPUMP™ is the gas vented well completion that allows the hydraulic pump to operate similar to beam pumps.

The GPT© umbilical wellhead control and landing assembly (UWCL) includes a stuffing box and blow out preventer along with a pumping Tee to control pressure, seal the casing annulus and provide connections to allow injection of high pressure power fluid down the continuous umbilical tubing.

GPT© provides the complete package including wellhead control and hanging assembly, bottom-hole assembly (if necessary), high pressure surface power units, fit to purpose power fluid treatment systems with solids control and standing valve options.
WHAT IS THE LIFT CAPACITY OF THE CUT-HYDROPUMP™?

GPT downhole pump performance simulations are provided by the SNAP (1) computer program provided by Ryder Scott. The attached calculations probe the maximum capacity with respect to the depth of the pump, a table with the results is attached for review.

**Simulated Well General Data:**

<table>
<thead>
<tr>
<th>Depth, foot</th>
<th>Estimated Lifted Production, BPD</th>
<th>PIP, psi</th>
<th>Fluid to be injected, BPD</th>
<th>Pressure, psi</th>
<th>HP to consume</th>
</tr>
</thead>
<tbody>
<tr>
<td>HYDROLIFTOIL - Hydro-jet-pump 2 7/8”x 2.000”</td>
<td>4000</td>
<td>700</td>
<td>355</td>
<td>994</td>
<td>4900</td>
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<tr>
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<td>6000</td>
<td>530</td>
<td>600</td>
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<td></td>
<td>12000</td>
<td>150</td>
<td>1575</td>
<td>1126</td>
<td>4900</td>
</tr>
<tr>
<td>HYDROLIFTOIL- Hydro-reciprocating-pump, 2 7/8”x 2 1/16”</td>
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<td>500</td>
<td>300</td>
<td>1530</td>
<td>2504</td>
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<td>12000</td>
<td>400</td>
<td>700</td>
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</tr>
</tbody>
</table>

In the case of the 2” jet pump in 2-7/8”, the pump can produce more than 700 bfpd efficiently when pump intake pressure is at least 355 psi per hundred feet of lift while the reciprocating pump is capable of more than 500 bpd at a very low pump intake pressure. Actual well characteristics must be considered to determine maximum lift for each well. Lower production rates are controlled by varying the power fluid injection pressure and volume. Internal pump components can also extend the range of production capacity for changing well conditions at a lot lower cost than some other lift systems. CUT HYDROPUMP™ systems can be extended for larger production tubing sizes (3-1/2” and 4”) allowing the benefits of “RIGLESS” gas vented concentric installations for production rates to 3000 bpd.

WHY IS DIFFERENT THE CUT-HYDROPUMP™ FROM THE CONVENTIONAL HYDRAULIC LIFTING SYSTEM?

The most common hydraulic lift application is installed in a casing free configuration where all of the produced gas must flow through the pump. These conventional system work well in some reservoir conditions, but many wells produce moderate to high gas. In hydraulic lift, these conditions require downhole separation and completions that allow produced gas to flow to surface separate from fluids. In the past, gas vented completions have provided successful hydraulic lift results, but these completions have been considered complex and costly. The GPT® CUT-HYDROPUMP™ system optimizes tubing sizes to minimize friction losses.

GPT® also designs surface equipment to suit the needs of each well including the latest process technology with reciprocating and/or multistage surface pumps. Other accessories include solids control screens, standing valves, and straw umbilical pipe that may be required to divert oil gravities to pump suction placed below perforations in high water producing formations.
BENEFITS OF THE UMBILICAL CUT-HYDROPUMP™

- Provides “RIGLESS” installation and retrieval.
- Quick retrieval for economical access for well maintenance and intervention.
- The downhole pump is installed and retrieved “RIGLESS” in record time.
- Enables deep pump setting depths.
- Allows pump to be set in deviated or horizontal position.
- Ability to set pump deep into horizontal section to insure recovery from deep zones.
- Capable of the widest range of production volume capacity other than gas lift.
- Achieves high volume production capacity (Hydro-Jet-Pump).
- Provides high lift capacity (Hydro-Reciprocating-Pump).
- Produces low pressure (low fluid level) reservoirs
- Produces (high gas) wells with moderate or high gas production
- Provides the highest possible artificial lift efficiency
- Provides an economical gas vented well completion to increase hydraulic lift efficiency.
- Economic potential in multiple well pads.
- Canned wells or offshore platform legs can be used for surface power systems.
- Offshore applications require deep safety valves below the HYDROLIFT Pump to meet safety requirements.

Annex 1-Hydraulic Pumping System REVIEW

Hydraulic downhole pumps
Reciprocating Pump
The downhole pump is selected based on well reservoir and well characteristics. Each downhole pump has different benefits and features. Engineering required to select a pump is beyond the purpose of this document. We would be pleased to provide a complete training session.

The reciprocating positive displacement piston pump has two sections;

1) The pump section that operates the same as a sucker rod (beam pump) downhole pump.

2) The hydraulic motor consists of a piston that is driven by the power fluid injected from surface and acts on the surface of the piston to provide the force that drives the pump through the stroking action. An engine control valve governs flow of the power fluid to the piston to provide the upstroke and downstroke.

The pump stroke is define by the design of the pump and can vary from 15” to over 30” with standard maximum stroking speeds in excess of 100 strokes per minute (SPM). Several combinations of pump plunger diameter and engine piston diameter are available to provide a variation in pump capacity and lift capacity. A large engine piston combined with a small pump plunger will pump from very deep wells with low suction pressure but
provides lower production rates than a larger plunger. The Pump to engine ratio (P/E) is used as a guide to the lift capacity of the combination of plunger to engine piston areas.

Hydraulic reciprocating pumps have pumped wells from over 25,000 feet where the production rate was under 100 bfpd but the pump operated successfully for many years.

Jet Pump

The Jet Pump receives power fluid at the nozzle where the decreasing area in the nozzle converts the pressure head of the power fluid to a velocity head reaching speeds greater than 400 feet per second that reduce the static pressure around the nozzle. The reduced static pressure is less than the wellbore pressure causing well fluids to flow to the nozzle. Power fluid mixes with well fluid in the mixing tube and continues to the diffuser where the mixtures’ homogeneous velocity is converted to a pressure head sufficient to flow to the surface.

Hydraulic lift has provided many solutions to specific problems adapting the downhole pump to circulation sleeves, gas lift mandrels or standard coil tubing. It is used in drill stem testing, flow back and well cleaning. GPT can provide all these configurations along with engineering and technical assistance to insure a satisfactory system.

Authors

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GPT- Vice President  
Professional Petroleum Engineer with more than 35 years in the oil and gas industry... Multi task oilfield geo-engineer, 20 years in drilling, work-over and completions operations. Latest responsibility: Director of Drilling and Completion. 18 Years working in Colombia, South America and US, 12 years working in Russia and CIS countries including Kazakhstan basins, 5 years in Central Africa. Previously employed by Texaco, Occidental, HEMCO, Maersk Oil, Vitol-Arawak, Condor Petroleum, Sedona Oil and Gas, Aladdin Oil and Gas, Schlumberger-Progressive (Chad) and Caracal/Glencore Energy Corporation (Calgary- Chad). University professor (UIS- Colombia), for BS degree in geology and petroleum engineers. Recent responsibilities with Caracal Energy was to manage a 2.0 billion drilling and completion project with more than 10 drilling rigs and 1200 people.

Jesse Hernandez Vega  
GPT-PRESIDENT  
33 years’ experience in the Oil and Gas Industry specializing in artificial lift, well completions and production operations. Founded and operated 7 oil industry service companies in Colombia, Indonesia and Kazakhstan. Established sales and service in most Middle East, African, South American and European countries. Previously employed by National Oilwell, Lufkin, Oilwell Hydraulics Inc. Prime Oil & Gas Kazakhstan, and at present serves as Director of Engineering and Marketing for Best Tools Colombia, PT CYTRAYA Indonesia and Global Petroleum Technologies USA.

References

[1 ] GPT using The Ryder Scott jet pump performance simulation program “SNAP” is a third party program with no ties to any jet pump manufacturer allowing simulation of any size nozzle and throat. The program also includes options for vertical multiphase flow correlations, well productivity interpretation and viscosity factors along with other options. The program generates a well productivity curve of your choice and based on the information available.

[2] The ideas and drawings are generated by the authors and the product is protected by ™ seal.