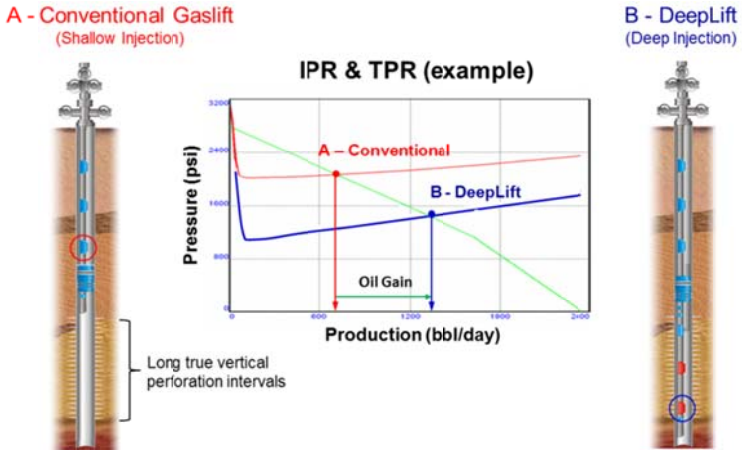
DeepLift

Innovation Features

Gaslift remains one of the most common artificial lift methods currently used for oil producing wells. Conventional gaslift well systems have been used worldwide for decades. However, the depth-limit bottleneck for such wells also remains, meaning that the deepest gaslift injection point must be located above the packer, whereas normally it is set just above the top perforation. Above packer placement must be maintained for gaslift well design and integrity reasons. A new gaslift well design, "DeepLift", has proved suitable for use in many types of wells, particularly those containing long true vertical perforation intervals. This completion design was de-bottlenecked by deepening the gaslift injection point, which resulted in well deliverability improvement and reserve recovery.



Designing a production system cannot be separated into inflow and outflow performance independently; the entire production system must be analyzed as a unit. However, well deliverability may often be drastically constrained by the performance of only a single component in the system. By isolating each component, performance can be optimized in the most cost-effective way. The crucial part of well performance is governed by two major curves: Inflow Performance Relationship (IPR) and Tubing Performance Relationship (TPR). Improving inflow performance is more complicated and expensive e.g. costs for well stimulation and maintaining or increasing Reservoir Pressure (P_R) by waterflooding. Deepening the gaslift injection point system helps improve TPR by increasing drawdown pressure or decreasing the hydrostatic column. This new design was granted a patent by the U.S. Patent and Trademark Office, Patent No. 7,770,637 B2, on August 10th, 2010 (filed on October 12th, 2007, Patent Application No. 11/871,746). The Continuation-In-Part (CIP) design, Patent No. 8,191,624, June 05th, 2012 (filed on August 11th, 2009, Patent Application No. 12/539,050), was also granted to strengthen the patent for this new approach. This single completion design uses the same tubing for producing hydrocarbons and delivering gaslift. A system for gas lifting fluids from a wellbore, therein defining an upper portion and a lower portion of the gaslift injection, comprises the primary string, a secondary string as gaslift bypass tube, and a linkage between those two strings in a closed system to allow placement of the gaslift bypass packer in close proximity to the perforation. The top section of the tubing is used for production while the bottom section of the tubing is used for delivery of the gaslift to the wellbore. The gaslift flows first through the perforated tube above secondary port of the dual packer and then to the bypass packer downward via a gaslift bypass tube, which is connected to the lower tubing section. The gaslift is injected out of a bottom side pocket mandrel via a reverse gaslift valve to the wellbore approximately at the bottommost perforation intervals to improve the outflow of the well. This design provides full well intervention from the surface down to the tailpipe and wellbore while also maintaining well integrity standards. Operational flexibility is thus fulfilled for reservoir

management purposes, e.g. changeability of gaslift valve for gaslift rate optimization, replaceability of downhole gauge for pressure and temperature monitoring.

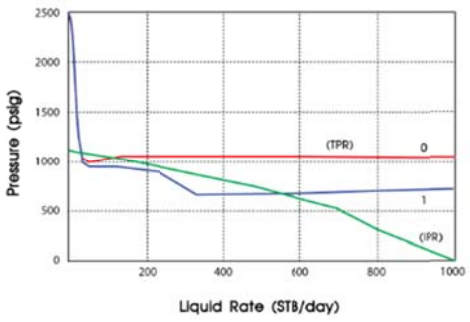
Thai E&P Industry Impact and Value

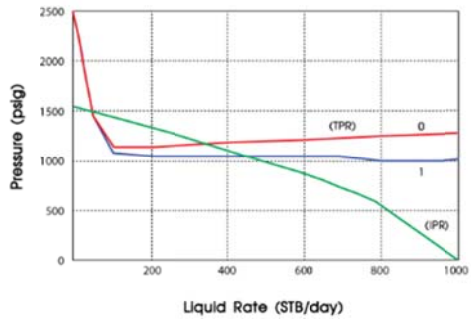
The S1 concession continues to serve as Thailand's largest onshore oilfield, covering approximately 90 percent of the onshore wells in the country. The most common method of artificial lift in S1 is gaslift. At present, about 60% of the producing wells use the gaslift technique while only 20% use the downhole pumping technique; the remaining 20% are not yet equipped with artificial lift systems for some reasons. The discussed innovative DeepLift design has been implemented successfully for the first time at the S1 Field, Thailand.

Gaslift enhances production rate by lowering the wellbore flowing pressure. Injection of gaslift into the production tubing aerates the flowing fluid, thus decreasing the hydrostatic pressure and reducing backpressure at the wellbore. The production rate is increased by decreasing bottomhole flowing pressure. Generally speaking, the deeper the operating gaslift injection point is, the better the lifting efficiency and production of the well is expected to be. Still, it must be noted that the deepest gaslift injection point of a Conventional Gaslift Well is limited by the packer setting depth, which must be at just above the top perforation intervals. In order to deepen the gaslift injection point limited by shallow production packer setting depths, the gaslift bypass packer is inevitably determined. DeepLift – The Innovative Gaslift Bypass Packer Technique is proposed to de-bottleneck this constraint. It is suitable for use in many types of wells, particularly those containing long true vertical perforation intervals. Two wells that contained 500 – 600 mTVD, which is a significantly long distance between the top and the bottom perforation depth, were selected for a field trial. The relationship between gaslift injection depth and well production rate (with constant gaslift supply) are presented graphically in a well performance nodal analysis model. An enormous increased percentage of production was gained in Well No.2 compared to Well No.1 due to 1) much lower water cut, reduction from 80% to 20%, resulting in much less hydrostatic pressure, and 2) genuine higher drawdown pressure, improvement from 150 to 300 psi. The production rates were satisfactory and overall well results turned out as good as expected when compared to the forecast from the Prosper Simulation Model. Results showed well deliverability improvement and reserve recovery gain of several hundred barrels of oil per day.

Well No.	Conventional Mode				DeepLift Mode			
	Gross (bpd)	Net (bopd)	Average BSW (%)	Average FBHP (psi)	Gross (bpd)	Net (bopd)	Average BSW (%)	Average FBHP (psi)
1	317	59	80	1500	427	95	76	1350
2	66	53	18	1180	221	172	22	880

Well No.1





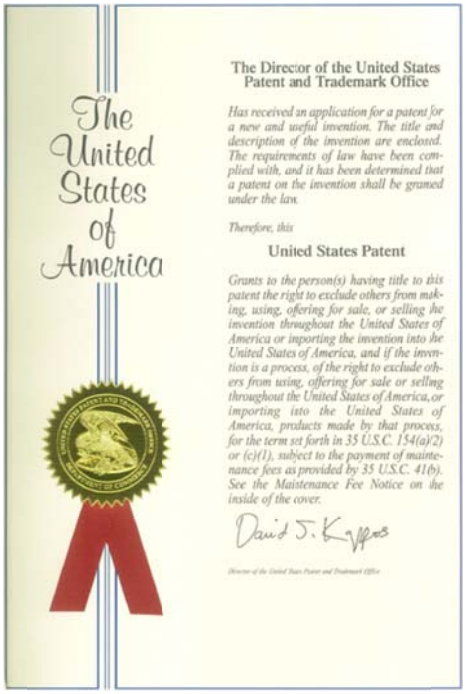
Well No. 2

DeepLift

The DeepLift – Innovation Gaslift Bypass Packer Technique, has proven to be suitable for use in several types of wells, particularly those containing long true vertical perforation intervals (500 – 600 mTVD) resulting in value-add not only for Thai E&P Industry but also for the industry worldwide in that it unlocks the potential for long true vertical perforation intervals.

Why this project should win the award?

Producing more oil, but demanding less input power consumption while doing so challenges all E&P companies as they pursue sustainable energy resources. The innovative DeepLift technique makes the odds for surmounting this challenge greater. An enormous percentage of the production gain stems from the genuine higher drawdown pressure improvement from 150 psi to 300 psi. Using DeepLift has resulted in a significant production improvement and is a new completion gaslift well design innovated successfully by the Thai Well Engineering and Production Technology Team. This achievement does not only utilizes our domestic natural resources worthily, but also encourages people industry-wide to innovate technology to sustain world's energy resources more effectively.



The United States of America

The Director of the United States Patent and Trademark Office

Has received an application for a patent for a new and useful invention. The title and description of the invention are enclosed. The requirements of law have been complied with, and it has been determined that a patent on the invention shall be granted under the law.

Therefore, this

United States Patent

Grants to the person(s) having title to this patent the right to exclude others from making, using, offering for sale, or selling the invention throughout the United States of America or importing the invention into the United States of America, and if the invention is a process, of the right to exclude others from using, offering for sale or selling throughout the United States of America, or importing into the United States of America, products made by that process, for the term set forth in 35 U.S.C. 154(a)(2) or (c)(1), subject to the payment of maintenance fees as provided by 35 U.S.C. 41(b). See the Maintenance Fee Notice on the inside of the cover.

David J. Kappos

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(12) **United States Patent**
Phloi-montri et al.

(10) **Patent No.: US 8,191,624 B2**
(45) **Date of Patent: *Jun. 5, 2012**

(54) **BYPASS GAS LIFT SYSTEM FOR PRODUCING A WELL**

(75) Inventors: **Pramote Phloi-montri**, Bangkok (TH); **Chatchai Kongdachudomkul**, Bangkok (TH); **Thanawee Kreethapon**, Bangkok (TH); **Pattara Pittrapan**, Bangkok (TH); **Suwin Sompopsart**, Bangkok (TH); **Wararit Toempromraj**, Bangkok (TH)

(73) Assignee: **PTT Exploration and Production Public Company Limited.**, Bangkok (TH)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 147 days.

This patent is subject to a terminal disclaimer.

(21) Appl. No.: **12/539,050**

(22) Filed: **Aug. 11, 2009**

(65) **Prior Publication Data**

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Related U.S. Application Data

(63) Continuation-in-part of application No. 11/871,746, filed on Oct. 12, 2007, now Pat. No. 7,770,637.

(58) **Field of Classification Search** 166/401, 166/269, 306, 372, 129, 126, 131, 142
See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

4,407,362	A *	10/1983	Bechthold	166/117.5
4,708,595	A	11/1987	Maloney et al.	
2003/0056958	A1	3/2003	Allan	
2006/0076140	A1	4/2006	Rouen	
2006/0113082	A1	6/2006	Moffett et al.	

* cited by examiner

Primary Examiner — Cathleen Hutchins
(74) *Attorney, Agent, or Firm* — Westerman, Hattori, Daniels & Adrian, LLP

(57) **ABSTRACT**

A completion system delivers lifting gas supplied from the surface via a casing annulus through the packer for injecting to the wellbore at bottom hole. So, lifting gas maximizes hydrocarbon producing from a subterranean well while maintaining integrity and serviceability as a typical gas lift well. More specifically, a single completion system uses the same tubing string for both producing the well and delivering lifting gas to the wellbore at downhole. The top section of the tubing is used for producing the well, while the bottom section of the tubing is used for delivering lifting gas for injecting at bottom hole. The lifting gas will be injected to the wellbore proximately at perforation intervals for helping unloading liquid and producing the well. The use of modified equipment

Project Team Members

1.	Mr. Pramote Phloi-montri	VP, Well Engineering & Production Technology, Project Leader
2.	Mr. Pattana Pittrapan	Manager, Onshore Well Operations
3.	Mr. Suwin Sompopsart	Manager, Production Technology
4.	Mr. Wararit Toempromraj	Senior Engineer, Production Technology
5.	Mr. Kittithuch Hnuruang	Engineer, Projection Technology
6.	Mr. Amnuay Prayadsup	Superintendent, Onshore Well Operations
7.	Mr. Potchara Promwikorn	Senior Supervisor, Onshore Well Operations
8.	Mr. Chatchai Kongdachudomkul	Senior Engineer, Well Engineering, Co-Author
9.	Mr. Thanawee Kreethapon	Engineer, Well Engineering, Author