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Gas Lift Valves Troubleshooting to Improve the Gas Lift Wells Performance

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Abstract

Gas lift valves can aid in the unloading and production of a well. With the valves properly spaced and correctly pressured and proper select of the port size, unloading proceeds in a stage-by-stage, valve by valve manner to the ideal point of lift, and maximum liquid production is reached. However, if well situations change, or if the gas lift design data was not very perfectly, maximum liquid production is not achieved .

In this paper, addresses, how the implementation the production optimization platform for gas lift wells that led to a significant increase in oil production by identifying and replacing a damaged valve. The analysis was performed using a digital twin model that simulated operating conditions and was validated through a downhole sensor, on their turn these data are finally used for implementing conscious and forward-looking control actions, ultimate results are improved production profitability due to increase production rate, decrease operations cost, develop availability .

Keywords: Optimized gas injection rate, gas lift valve issues, gas lift valves troubleshooting and Gas Lift Optimization

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حل مشاكل صمامات رفع الغاز لتحسين أداء آبار رفع الغاز

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الملخــــــص
يمكن أن تساعد صمامات رفع الغاز في تفريغ وإنتاج البئر. مع تباعد الصمامات بشكل صحيح وضغطها بشكل صحيح واختيار حجم فتحة الصمام بشكل صحيح، يتم عملية فتح وقفل الصمامات من صمام الي الأخر، الي الوصول إلى النقطة المثالية للرفع، و بالتالي الوصول إلى أقصى إنتاج سائل. ولكن إذا تغيرت الظروف التشغيلية ، أو إذا لم تكن بيانات تصميم رفع الغاز مثالية تمامًا، فلن يتم تحقيق أقصى إنتاج من السائل. في هذه الورقة، يتناول كيف أدى تنفيذ منصة تحسين الإنتاج لآبار رفع الغاز إلى زيادة كبيرة في إنتاج النفط من خلال تحديد واستبدال الصمام التالف. تم إجراء التحليل باستخدام نموذج رقمي مزدوج يحاكي ظروف التشغيل وتم التحقق من صحته من خلال مستشعر أسفل الفتحة، وعند دورهم، يتم استخدام هذه البيانات أخيرًا لتنفيذ إجراءات تحكم في توزيع وضغط غاز الرفع واظهرت والنتائج النهائية تحسين ربحية الإنتاج بسبب زيادة معدل الإنتاج، وتقليل تكلفة العمليات.

الكلمات المفتاحية: معدل حقن الغاز الأمثل، ومشكلات صمام رفع الغاز، وتحسين انتاجية ابار الرفع بالغاز

1. Introduction

At the early stages of the life of a well, the reservoir pressure is usually sufficient to push the oil up to the surface facilities. This so-called "natural" production phase may last several years. Unfortunately, the reservoir pressure tends to decrease over time and, eventually, a point is reached when the pressure difference between the reservoir and the surface is not sufficient to make oil naturally flow. Then, it is necessary to use activation methods, either to keep the reservoir pressure above a certain level, or to lighten the liquid column in the well.[1]

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At this stage of production, artificial lift methods will be used to balance the natural pressure loss and facilitate an efficient recovery of the hydrocarbons from the reservoir. The gas lift system is a very old form of artificial lift method. Compressed air was initially used in the middle 1800, and gas lift became more widely applied in the early 1900's. [2]. The first practical application of air lift was in 1846 when an American named Cockford lifted oil from some wells in Pennsylvania [3]. The first U.S Patent gas lift called an oil ejector was issued to A. Brear in 1865. In the period to 1864 some laboratory experiments were performed with possibly one or two practical applications. From 1864 to 1900 this era consisted of lifting by compressed air injected through the annulus or tubing. From 1900 to 1920 Gulf coast area air for hire boom. Such famous fields as Spindle Top were produced by air lift. From 1920 to 1929 the application of straight gas lifts wide publicity from the Seminole field in Oklahoma. From 1929 to 1946 this era included the Patenting of about 25,000 different flow valves. In 1946 to 1967 the pressure operation valve was used and from 1967 to 1993 more companies formed advancement in the techniques or predicting evaluating and design [4] [3].

The concept of gas lift system is injected high pressure gas continuously or intermittently into the well through casing and U-Tubed to tubing. Thus, resulting in the reduction of the hydrostatic pressure of the heavy column of the fluid and reducing bottom-hole flowing pressure also the purpose of gas lift installation to bring hydrocarbons to the surface at a desirable quantity while keeping the bottom-hole pressure at a value that is small enough to provide high drawdown pressure within the reservoir. A simplified diagram of particular gas lift system in show in figure 1 that shows from the bottom to the point of gas injection; the well is flowing with the natural formation gas liquid ratio (FGLR).and from the point of injection up to the surface; the well is being gas lifted, and flows with gas lift (GLR).Point of injection is ability of reservoir to produce fluid matches the ability of the tubing to remove fluids [5].

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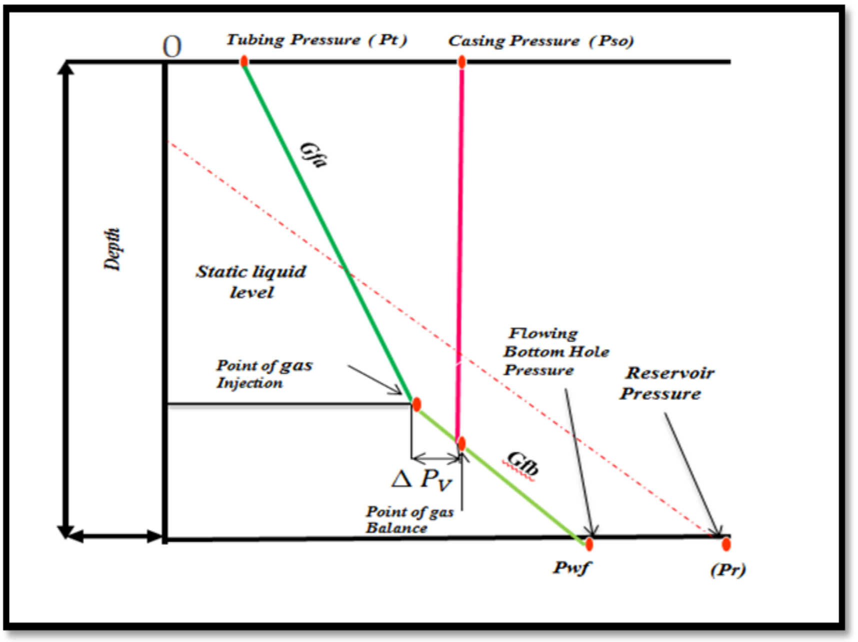

Fig.1: illustrates the gas lift mechanism.

The required injection gas volume is usually controlled by one (or more) orifices in the valve, and by the movement of the ball and stem. Selection of the correct orifice size is usually carried out with the help of charts supplied by the manufacturer. It can therefore be seen that the gas passage of this valve will be significantly affected by the bellows pressure [6]. Decker, et.al. declared that, one manufacturer had been fostering valve performance knowledge since 1962 and defined the gas lift valves as the quantitative measure of a valve flow rate response to change in casing and / or tubing pressure for a given set [7]. Faustinelli,et.studied a new unified model that predicts the flow performance of nitrogen charged injection pressure operated gas lift valves [8]. Stewart, Goodacre, and Cruicksank, 1989) decreased orifice sizes of the gas lift valves and redesigned the gas lift headers to remove the problems of slugging and hydrate formation [9]. Lagerlef, et.al informed that the gas lift valve quality assurance program was in place for Eastern Operation Area (EOA) since 1981 [10]. Guerrero, et.al. studied the heading that common problems in the operation of the continuous flow gas lift wells and the effect of operation valve design on gas lift stability were discussed [11]. Kenneth studied the gas lift valve performance design using 1 inch injection pressure operation valve (IPO). Cullick, et.al they presented the impact of the valve failure

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on oil production used simulation-based analysis and automated procedures to optimize the valve control strategies. The results showed the oil production was maximized when water production was managed [12].

Injection pressure operated valve is the most type of gas lift valve used in oil industry a pressure-operated valve will pass gas until the casing pressure drops to the closing pressure of the valve. As a result, the operating valve can often be estimated by shutting off the input gas and observing the pressure at which the casing will hold. This pressure is the surface closing pressure of the operating valve, or the closing-pressure analysis. The opening-pressure analysis assumes the tubing pressure to be the same as the design value and at single-point injection. These assumptions limit the accuracy of this method because the tubing pressure at each valve is always varying, and multipoint injection may be occurring. [13]. Laboratory gas dynamic throughput indicates that each injection operated GLV often does not open fully in actual operated based on [14].

In the last ten years, numbers of intelligent wells solution being installed around the world was increased significantly, with next two to three years, the total number of installed well should reach to 2,000th installation milestone [15]. Bohannon defined the Automate simply means to use equipment which is self-operation to replace low level or repetitive human tasks [16]. Andrew,et.al, discussed the application of automated control system in optimizing continuous flow gas lift operations [17]. El-Massry.et.al, described the construction and use of a network and gas allocation model simulating the combined performance of the reservoir and production wells and gas lift system [18] Kwnar, et.al, described automation of gas lift operation in Bombay offshore field. Hardware and software were applied in Bombay field to improve oil production from continuous gas lift wells [19] Jansen, et.al, described automation control system for oil production and new model based on automation controller to find out a solution of unstable of production from gas lift wells [20]. Correa, et.al. Described intelligent automation for intermittent gas lift wells in Petrobras onshore field [21]. Al-Kasim, et.al discussed the design and installation of remotely controlled in situ gas lift in horizontal well on the North subsea field on Norwegian Continental shelf [22].

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Reeves, et.al presented paper that discussed the difficulties engineers experienced understanding daily production variance before automation control was installed in Amberjack oil field in the Gulf of Mexico [23].

Nederlof.et.al, described the results of a study to implement a real time production optimization on initiative for a mature onshore field in Austria. Rodriguez et al. discussed how intelligent gas lift works and presented a case history in North Kuwait's intelligent digital oil field [25]. Ezzine, et.al. presented gas lift optimization by real time monitoring using SCADA (Supervisory Control and Data Acquisition) [26]. Xu et al., presented smart gas lift valves with time controller disintegrable nanostructured composite material technology [27]. These are the implicit assumptions that have been related with gas lift for the last half century or more. But in that time the oil industry has undergone significant transformation; moving geographically from its original land base to deep water offshore provinces; and moving technically from slick wire intervention to remote real time management of digital intelligent completions [28].

Garcia, et.al developed unloading procedure with control of liquid flow rate through gas lift valve and focused on the erosion problems, thus aiming at limiting the liquid velocity inside the valve [29]. A large proportion of gas lifted wells around the world is under-performing. Most commonly it is due to 'multi-pointing', where instead of all the lift gas being injected via the operating valve at the planned injection depth, some (unintentionally) enters the tubing via one or more of the shallower unloading valves. In other cases, wells may underperform as the planned injection depth cannot be reached with the available lift gas pressure. These issues are often the result of unloading valve reliability problems or inadequate gas-lift design.[30]

Injecting a high amount of gas increases the bottom hole pressure which leads to reduction of the production rate. This is due to the high gas injection rate which causes slippage. In this case the gas phase moves faster than liquid phase, leaving the liquid phase behind and less amount of liquid will flow along the tubing. Hence, there should be an optimum gas injection rate[31].Unfortunately, traditional gas lift technologies have design limitations on gas lift valve, However, traditional gas lift technologies most of which have

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been developed since 1950, do not meet all of the high pressure, high temperature and high performance and safely needs of today's Deepwater and subsea completion traditionally, lift gas flow is not actively controlled. However, it was suspected that stability could be brought to the unstable well.[32].

2. Methodology

Today, the technology of acquiring data, sending data, and analyzing data is so powerful that installing an additional device in each well will create a long-term benefit and help avoid shutdowns, accidents, and unnecessary cost. Furthermore, collecting real-time data on production rates, pressures, temperatures, fluid compositions, and other relevant parameters. This data facilitates identifying deviations from expected performance, detecting potential production concerns.

Furthermore, advanced data analytics and machine learning techniques can be applied to detect patterns, identify anomalies, and make predictions for wells performance optimization.

Integrated Production Optimization Services (IPOS) is becoming an essential element in the operation of any Oilfield. The Digital Oilfield enhances Return of Investment (ROI), improves operations efficiency, drives staff productivity, and improve operational safety. Whether it is protecting the environment or maintaining a competitive edge, digital oil fields help companies stay ahead. Furthermore, digital oil fields help gather information to support E&P business decisions. The DOF offers a wide range of advantages and benefits for companies including:

- Faster & Reliable Data leading to faster response time & smarter decision making.
- Secure Data & Controlled Knowledge sharing between all the business stakeholders.
- Improve Production, Operational efficiency and reduced operational cost.

View software Monitor collects the real-time operations data from Oil Fields and related Assets (Oil Well, Oil Tanks, Sale Meters, RTUs, Sensors etc.)

Enerview software is a real-time surveillance & production optimization platform for the digital oilfield (DOF). The Enerview is uniquely qualified to deliver a comprehensive solution that addresses the Operating units (OUs) near-term and long-term needs. The Enerview platform is an Enterprise Level Solution for the

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Digital Oilfield, providing an integrated approach for IoT Hardware, surveillance, analysis & diagnostic. In this paper Enerview software has been used for gas lift well for one of Libyan oil field

3. The Results Analysis

A discrepancy between the sensor pressure value and the casing pressure value indicated that the sensor pressure was significantly lower than the casing pressure, which indicated a potential issue. Our initial model, adjusted based on the surface closing pressure (SCP) of the valves, suggested that with an injection pressure of 1038 psi, the well should be operating at valve number 4, resulting in a much higher bottom-hole pressure of 1558 psi than the pressure sensor reading of 820 psi.

Table 1: Illustrates the Well test with injection pressure.

Valve depth TVD. (ft.)	Surface Opening pressure SOP) psi)	Surface closing pressure SCP (psi)
2255	1247	1206
3110	1247	1189
3715	1223	1166
4320	1200	1142
4925	1179	1121
5530	1150	1093
6135	1122	1065
6740	1095	1040
7345	1070	1015
7950	1044	990
8555	1021	966
9165	883	848

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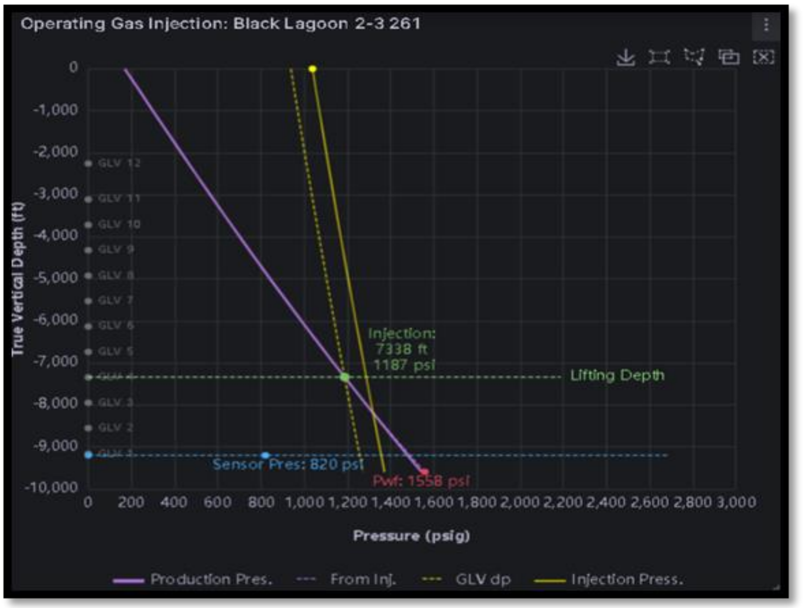

Fig. 2: The Initial pressure model comparison. Model calibrated by PSC vs Downhole sensor

The continuous-flow installation models modify conditional on whether complete and accurate well information is identified. The inflow well performance and a correct multiphase-flow correlation are required to determine the estimate point of gas injection in deep wells. When the well data are limited or questionable, the exact point of gas injection cannot be calculated accurately in several wells. If there is inadequate injection-gas pressure to reach the bottom of the well, a required depth of gas injection may not be possible. If there is no modification in injection-gas pressure or well requirements, the point of gas injection should stay at the maximum depth for the life of the gas lift installation.

From figure 2 which indicated that injection pressure points at 7338 ft (lifting depth) when the surface pressure reached to 1187 psi.

Given that the sensor indicated much lower pressure than the model, we decided not to adjust the model's calculated pressure magnitude based on the PSC of the valves. Without this adjustment, our model predicted a pressure of 818 psi at the sensor depth (Figure 5), which was only 2 psi different from the sensor reading, indicating high model precision and that the sensor was providing an accurate representation of the well's operational reality, ruling out sensor malfunction. Additionally, the trends for casing, tubing, and sensor pressures were stable.

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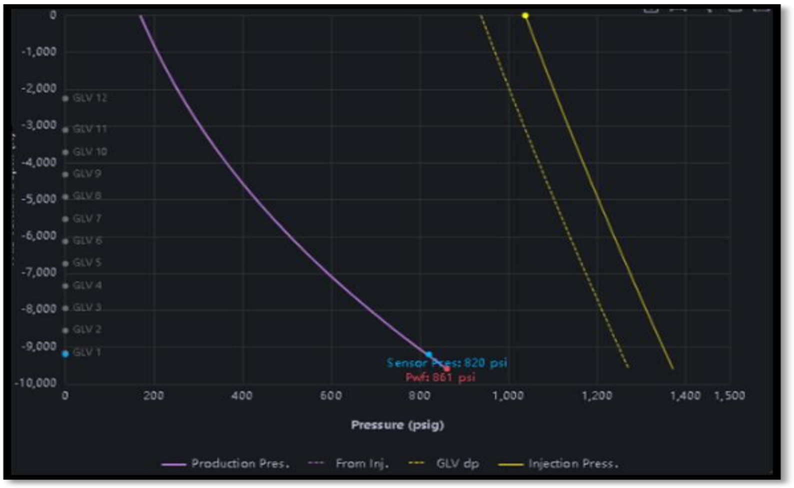

Fig. 3: Model vs sensor pressure comparison

The depths of the unloading gas lift valves are calculated to unload the kill (load) fluid to the design depth of the operating valve with the injection-gas pressure and gas volume available at the wellsite. As the injection gas is initially injected into the casing annulus, the injection-gas pressure downstream of the control device on the injection-gas line increases as the load-fluid level in the casing annulus is lowered during U-tubing of the load fluid from the figure 3 which clearly illustrates that the sensor pressure is 820 psi when the following pressure (pwf)

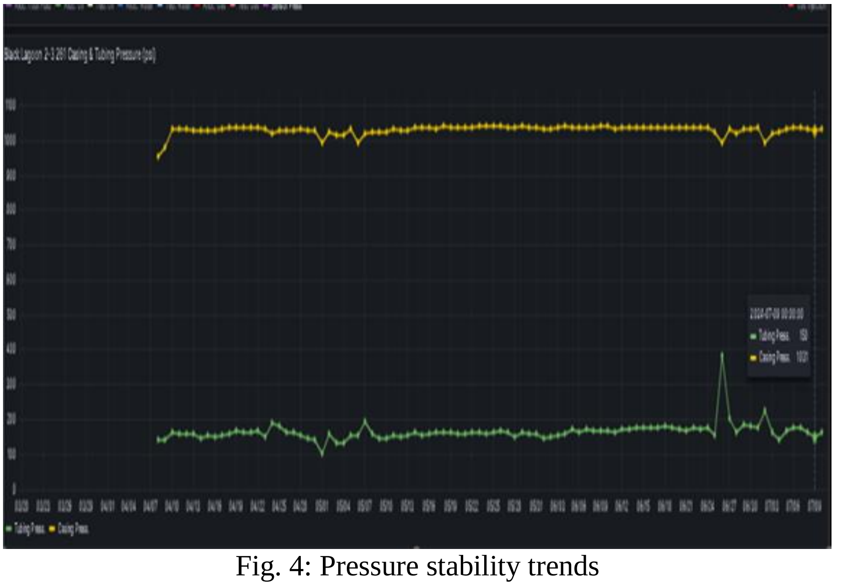
Fig. 4: Pressure stability trends

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The pressures in the casing and tubing are essentially equal to the instant a gas lift valve is uncovered. Immediately after injection gas begins to enter the tubing through the next lower gas lift valve, the injection-gas pressure in the casing begins to decrease because the newly uncovered gas lift valve is set to remain open at a lower injection-gas pressure than the unloading valve above. Less and less injection gas enters the tubing through the upper unloading valve. The injection-gas rate through the newly uncovered valve increases until the injection-gas pressure in the casing decreases to the closing pressure of the upper unloading valve. The depth of gas-injection transfer is complete when all injection gas is entering the tubing through the lower valve and all upper gas lift valves are closed. The principles of continuous-flow operation are illustrated by a pressure/depth diagram shown in figure 4.

Fig.5: Gas Lift Valve Number Busted Bellow

After replacing the damaged valve that is illustrated in the figure 5 and updating the valve arrangement, the well's performance improved dramatically. Incorporating the latest available production test results, the model update revealed a noticeable improvement: the well now injects at the end of the tubing (EOT) and has increased production to 107 BOPD with significantly lower injection pressure 200 psi less than before.

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Table 2 illustrates the production results before and after intervention.

Before Intervention		After Intervention
Injection Pressure	1038 psi	817 psi
Gas Injection Rate	0.84 mmscf	0.8 mmscf
Oil Production	84 BOPD	107 BOPD

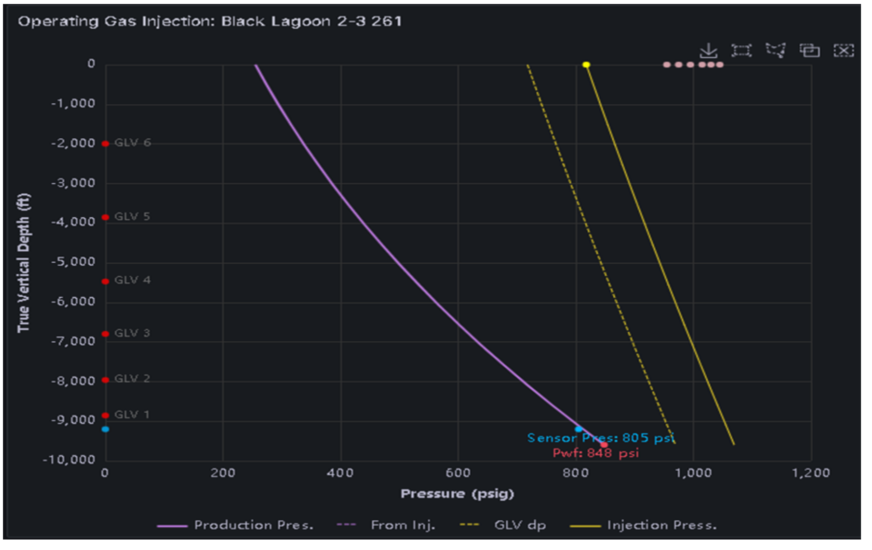

Fig. 6: Production improvement with reduced injection pressure.

4. Results

The identification and replacement of the damaged valve not only resolved the overpressure issue in the annulus but also led to a significant increase in oil production. The updated model now accurately reflects the well's improved performance and is available for further analysis and presentation.

5. Conclusion

- This case study demonstrates the effectiveness of our monitoring and optimization platform in diagnosing and resolving well performance issues. By identifying a damaged valve and recommending its replacement, we facilitated a substantial improvement in oil production and operational efficiency.
- The results indicated that the oil production was increased by, and the injection pressure was reduced to 221. However, optimized gas injection rate with minimal change, resulting in production that is more efficient.

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