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Optimizing Gas Lift for Improved Oil Recovery in a Middle East Field: A Genetic Algorithm Approach

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Abstract

This paper presents a study of the application of gas lift (GL) to improve oil production in a Middle East field. The field has been experiencing a rapid decline in production due to a drop in reservoir pressure. GL is a widely used artificial lift technique that can be used to increase oil production by reducing the hydrostatic pressure in the wellbore. The study used a full field model to simulate the effects of GL on production. The model was run under different production scenarios, including different water cut and reservoir pressure values. The results showed that GL can significantly increase oil production under all scenarios. The study also found that most wells in the field will soon be closed due to high water cuts. However, the application of GL can keep these wells economically viable. The economic evaluation of the study showed that the optimum GL design is feasible and can significantly improve oil production. This suggests that GL is a promising technology for improving oil production in fields that are experiencing a decline in production. The study also provides a new approach to GL optimization using a genetic algorithm, which can be used to find the optimal GL design for a given field.

Keywords: Gas Lift, Optimization, Genetic Algorithm, Artificial Lift, Water Cut.

تعزيز انتاج النفط عن طريق تحسين تقنية الرفع بالغاز لحقل نفطي في الشرق الأوسط: باستخدام الخوارزمية الجينية

الخلاصة:

يقدم هذه البحث دراسة لتطبيق تقنية الرفع بالغاز (GL) لتحسين إنتاج النفط في حقل نفطي. يعاني الحقل من تراجع سريع في الإنتاج بسبب انخفاض الضغط المكمني، حيث تعد تقنية الرفع بالغاز تقنية رفع صناعي مستخدمة على نطاق واسع يمكن استخدامها لزيادة إنتاج النفط عن طريق تقليل الضغط الهيدروستاتيكي في البئر. استخدمت الدراسة نموذج حقل كامل لمحاكاة تأثيرات الرفع بالغاز على الإنتاج. تم تشغيل النموذج تحت سيناريوهات إنتاج مختلفة، بما في ذلك قيم مختلفة لنسبة انتاج الماء (WC%)

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وضغط المكمن. أظهرت النتائج أن الرفع بالغاز يمكن أن يزيد بشكل كبير من إنتاج النفط تحت جميع السيناريوهات. ووجدت الدراسة أيضاً أن معظم الآبار في الحقل ستغلق قريباً بسبب ارتفاع نسبة الماء المنتج. ومع ذلك، يمكن أن تجعل تطبيق تقنية الرفع بالغاز هذه الآبار اقتصادية وقابلة للتشغيل. أظهرت التقييمات الاقتصادية للدراسة أن تصميم الرفع بالغاز الأمثل ممكن ويمكن أن يحسن بشكل كبير من إنتاج النفط. هذا يشير إلى أن لبتقنية واعدة لتحسين إنتاج النفط في الحقول التي تعاني من تراجع الإنتاج. تقدم الدراسة أيضاً نهجًا جديدًا لتحسين رفع الغاز باستخدام البخوارزمية الجينية، والتي يمكن استخدامها لإيجاد تصميم رفع الغاز الأمثل لحقل معين.

1. Introduction:

Over 70% of active oil reservoirs are mature, and it is inevitable that nearly all wells in these fields will eventually require artificial lift techniques to compensate for the decline in natural reservoir pressure [1].

Artificial lift techniques are used when natural energy in oil wells decreases due to reservoir depletion. These techniques include sucker rod pumps, gas lifts, progressive cavity pumps, electric submersible pumps, and hydraulic jet pumps. The most suitable technique depends on the specific reservoir conditions and production requirements. The electric submersible progressive cavity pump (ESPCP) is a hybrid pump that combines the advantages of electric submersible pumps and progressive cavity pumps, making it suitable for lifting viscous crude containing sand and high gas oil ratio oil extraction [2-4]. Progressive cavity pumps (PCP has been successful in Colombian oil fields, but wells with severe deviations and high failure rates require alternative solutions to reduce repetitive failure [5, 6]. A human-in-the-loop approach, using machine learning and streaming analytics, has been developed to assess real-time performance of artificial lift pumps, aiding in exception-based surveillance and improving pump management [7].

The importance of studying artificial lift methods has led to significant attention from researchers. This is due to the increasing need to develop artificial lift techniques to maintain production rates and meet the growing demand for oil. As shown in Figure 1, the number of research papers on artificial lift methods has increased directly with time. This can be attributed to the availability of more data and the great development of computer capabilities to handle multi-constraint problems and provide solutions in a reasonable amount of time.

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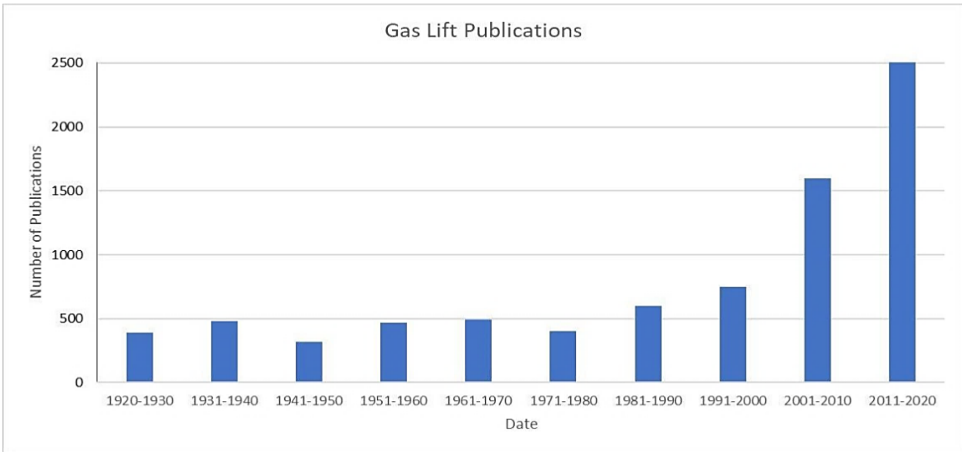

Fig. (1): Number of Gas Lift research published in the literature. [Adapted from Curtin University – Library Database]

The gas lift process involves injecting gas into the annulus between the casing and tubing to decrease the density of the fluid. This aeration of the fluid causes its density to decrease, resulting in the formation pressure becoming higher than the pressure exerted by the weight of the fluid column. As a result, the fluid is lifted to the surface [8-10]. The gas-lift method has a great role in maintaining oil production, especially from matured fields when the natural reservoirs' energy becomes inadequate[11]. Several giant fields employ gas lift techniques to increase the economic production levels [12]. The gas lift is being seen as the most economically effective artificial lift technique especially for a large field for the improvement of field productivity [13-15].

There are several constraints associated with gas lift operation, such as gas-injection rate, injection pressure, availability of lift gas, compressor capabilities, and water handling facilities, etc. These constraints must be considered during optimization. Considering these limitations to reach the optimum allocation of the injection rate of lift gas for every well in a network is a very demanding job [16]. Selecting the optimum volume of gas to inject in a set of wells to raise the oil production amount is a vital optimization problem in the gas lift process because the used gas is considered a rare and not cheap resource [17]. In a well, by raising the rate of injected gas the oil production rate increased however if it increases excessively high, production drops due to the additional intrusive limitations of friction, this phenomenon causes the curve shape of the oil rate against gas injection rate to be like a dome, which is known as the gas lift performance curve (GLPC) [18].

However, if the whole network is taken into consideration, the ideal gas-lift injection rate is not the same as maximizes individual well production because of the backpressure effects due to the connected wells in the downstream [19].

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Different optimization algorithms are applicable and have been used in the study of the gas lift optimization problem. These algorithms can be generally subdivided into two general groups, Numerical methods, and Meta-Heuristic-Methods [20]. Normally the numerical methods are considered the traditional ones such as the equal slope method, Newton Reduction Method, Mixed Integer Programing Method, and they are centered on some repetitive calculations or plots and their results are absolute, but their problem is that their degree of complexity increases as the number of parameters increases. On the other, there are the meta-heuristic-methods and algorithms such as the Genetic Algorithm, PSO Algorithm, Ant Colony Optimization Algorithm, Hybrid Algorithms. These techniques are random based, and their different runs reaches to different results and their advantage is their capability of dealing with complex problems much more efficiently than numerical methods, especially, in present problems in which the amount of input parameters is great [21],[22].

1.1 Genetic Algorithm

Genetic algorithms (GAs) are a type of evolutionary algorithm that uses the principles of natural selection and genetic recombination to solve optimization problems. The algorithm is modeled after the process of biological evolution, where the fittest individuals in a population survive and pass on their genetic material to the next generation [23, 24]. In GAs, the population consists of a set of candidate solutions, and the fitness of each candidate solution is evaluated based on a fitness function. The algorithm then uses techniques such as selection, crossover, and mutation to recombine the genetic material of the fittest individuals and generate new candidate solutions. Selection involves choosing the fittest individuals in the population for reproduction [25-27]. Crossover involves combining the genetic material of two individuals to create a new solution, while mutation involves introducing random changes to a solution to explore the search space [28, 29]. The GA process continues until a satisfactory solution is found or a termination criterion is met. GAs are effective in solving both constrained and unconstrained optimization problems and have been applied in various fields, including engineering, finance, and biology.

The genetic algorithm can be categorized as the earliest and most vastly employed evolutionary algorithm, genetic algorithm is considered as one of the high-efficiency optimization tools for several real application problems, as for the engineering problems the GA is considered as a very robust technique for optimization and it also has a varied range of applications and has been largely used in a lot of fields for more than three decades [30], GA was considered and categorized with

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the modern techniques of optimization due to the difference in its main concept from the other traditional approaches GA uses a population of selected points which leads to avoiding the local optimum solution that's why most of the GA solutions are of the global optimums [31, 32]. The genetic algorithm could solve a real complex multi-objective problem in a few fields, discrete and integer problems are highly applicable to be resolved by GA since the GA represents the selected variables by utilizing a string of binary numbers (0,1) to simulate the chromosomes in genetics [33]

1.2 Genetic Algorithm Workflow and Procedure

The GA normally starts with the initialization step where a population of individuals with high and low quality are initiated randomly to start the first population, after the initialization the fitness function is starting to assess every candidate and asset its worth to choice the fittest individuals for the selection step based on the probability that is predefined by the user and the selection operator is the roulette wheel and as defined earlier the wheel will start to rotate and select from the different individuals but in a manner that the fittest individual will have higher probability of being selected for the next step while the poor individuals will have lower probability. After the selection step and identifying the two parents the crossover (swapping the genes of the selected pair) and mutation (changing some chromosomes randomly) processes starts and the probability of each step is previously regulated by the user so that the number of the new offspring is controlled and to reach some new solution areas and to help bring new and developed solution to the pool of selections. By the preceding steps, a new offspring (generation) is formed for the next recurrent iteration of optimization till reaching the optimal solution [34]. The steps of the GA process can be briefed in the next steps and as in Figure (2).

1. Generating the initial population and four chromosomes are created (A, B, C, and D) as shown in Figure (2) and each chromosome represents the (Gas injection rate).
2. Fitness function evaluation is based on evaluating the oil flow rate (a function of the injected gas) which is the fitness function in the gas lift problem.
3. Termination of the process if the results meet the optimization criteria.
4. If the results do not meet the criteria of optimization, then two more chromosomes are selected to modify the results.
5. Initiate the crossover for the individual pairs with probability lower than the pre-selected crossover priority.

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6. Conduct mutation if required for some individuals to create new generations.
7. Use the standard deviation to calculate the fitness value for the new offspring.
8. Keep iterating until reaching optimum results, unless the number of new offspring is limited.

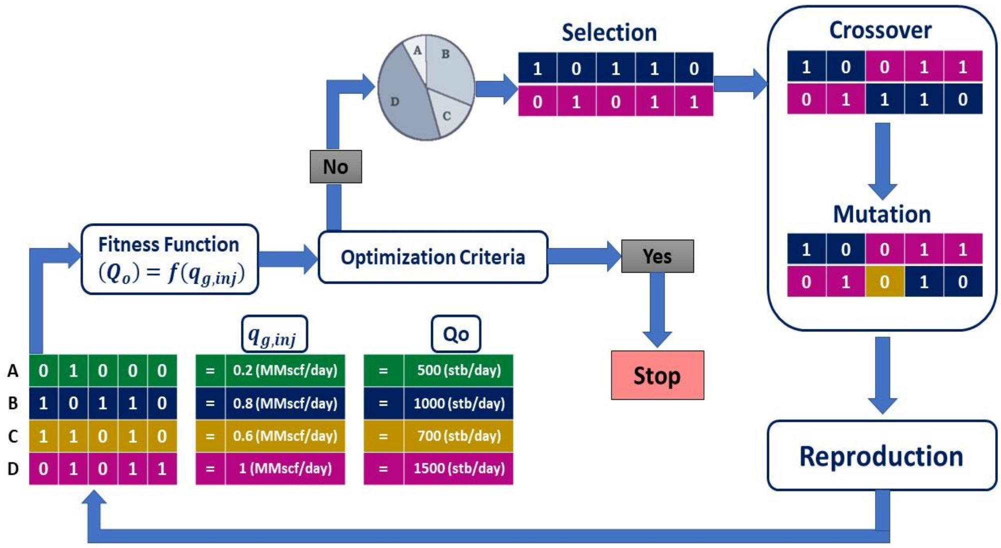

Fig. (2): Workflow of the Genetic Algorithm to reach optimal results.

The Genetic Algorithm differs from the conventional methods in some major points and as was explained by as the conventional methods uses single point to point solution and a derivative based objective function that will lead the optimization to concave at local optimum results While GA uses the bases of population and multiple points in the search for the results and it evaluated the individuals based on their fitness value and select the fittest survival individual these will lead the genetic algorithm to terminate at the global optimum solutions most of the time [35].

The genetic algorithm (GA) is often selected to solve gas lift optimization problems due to its ability to handle multi-objective problems and consider several gas lift constraints such as gas injection rate, water treatment system, and bottom well flowing pressure [36].

In the oil field, it is essential to have flexibility in decision-making to achieve optimal results. The GA's ability to provide multi-point solutions is particularly useful in situations where the best solution may not necessarily align with the decision-making goals. This feature is especially important in the gas lift optimization process in the oil field [35, 37]. In the oil field, the field and wells data are constantly varying, especially the data of production for every well like water cut, gas oil ratio, and the flow rate of oil which requires updating the objective function. GA can easily

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handle this change and keep on providing the optimum solution [38]. The GA's ability to generate a starting solution randomly without the need for any method to find an answer solution is a significant advantage. This feature saves time and effort compared to traditional methods. Several studies have employed the genetic algorithm (GA) in petroleum engineering. For instance, Solanki et al. (2022 [39] discussed the application of artificial intelligence in the petroleum upstream industry, including the use of GA. Mohammadi et al. (2021) [40] utilized GA-based support vector machine regression for predicting SARA analysis in crude oil samples using ATR-FTIR spectroscopy. Kumar Pandey & Kumar (2023)[41] optimized deep structured classifier-predictor models for pressure transient analysis using GA. Other studies have used GA for predicting single well production in high water cut reservoir (Zhang et al., 2021)[42] and optimizing workover rig scheduling (Popa et al., 2023)[43].

2. Field Modeling and Optimization Simulation

The modeling of the field and the installation of gas lift to each well of the field is a process of many steps that will be elaborated in this paper to reach the goal of the production of the network in both scenarios of natural flow and the gas lifted wells.

2.1 Field Background

The studied oil field is situated in the Middle East and comprises several production wells. The field has a substantial reserve of oil, estimated to be approximately 2.7 billion STB with a relatively low API of around 23 degrees. The average reservoir pressure in the field ranges from 4250 psi to 4700 psi, with the Southern dome having the lowest reservoir pressure. The production formation is located at a depth of approximately 4000 m. The field drive mechanism is depletion due to the weak support of the aquifer, and therefore, several water injection wells have been activated to maintain pressure and sustain production [34, 35].

2.2 Well Flow Modeling

Developing a fluid model for the entire field is a crucial step that requires special attention, particularly when the available data is insufficient for all the wells used [44-47]. For the field in this study the user will be faced with the problem of having to deal with the availability of the PVT data for only for 5 wells in the field, luckily the 5 wells are in the same formation of the other wells and the depth of the production zone is nearly the same in the wells so to overcome this type of problems the user should solve this problem by averaging the available wells by applying the

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method of curve fitting to reach the field average model of PVT. The PVT data for the wells needs to be calibrated with the available PVT correlations in the software and select the best fit correlation for prediction and calculations with the lowest error percentage. The PVT data matched with Standing correlation [48] except the viscosity which was matched with Elsharkawy correlation [49].

2.4 Gas Lift Design and Data

To model the gas lift technique using the PIPESIM simulator, a number of assumptions must be made for the field in study, since it does not have any application of gas lift technique. The first assumption is that the gas to be injected will be provided from the associated gas that is produced with the oil from the wells of the field. This gas must be treated after being separated from the oil and then collected for reuse and injection into the well. Other assumptions will relate to the completion of each well, such as the depth and tubing size, so that the best-fit valve can be selected. Additionally, some design conditions and regulations must be enforced, such as the requirement that the operation valve be at least 100 ft. above the packer for wells that are installed with packers [1], and for the operating company regulations that the minimum allowable P_{wf} is only to be above the pressure of the bubble point Pb by 50 psi. As for the available data of production, the produced associated gas in the field is around 36.255 (MMscf/day).

The PIPESIM software offers a flexible safety feature called the Valve Bracketing feature or (Error Envelope) that can be implemented in the gas lift design. This feature accounts for any mistakes in the current or future design and can cope with any errors or uncertainties in the productivity index of a well. Additionally, it corrects misinterpretations in the multiphase flow correlation in vertical or horizontal directions. Figure (3) shows the proposed design for a well with gas lift and activated bracketing feature.

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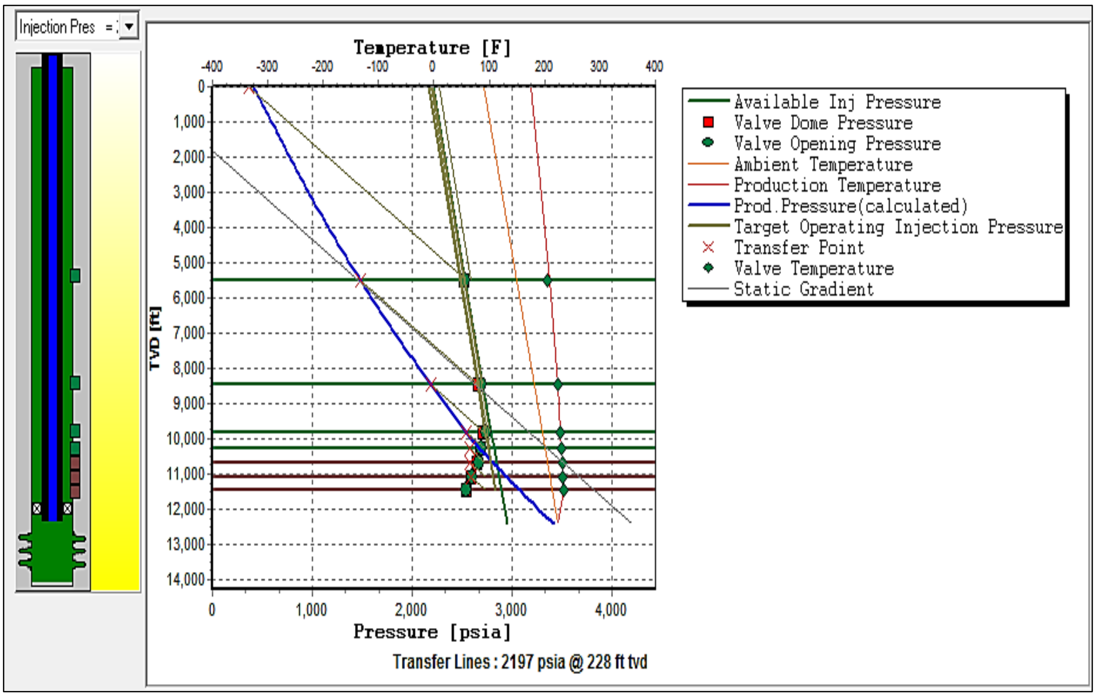

Fig. (3): Gas lift design with activated bracketing feature

2.5 Building Field Model

Following the establishment of the single-well model, the construction of a full-field model is now possible. This model can be created using the surface network feature available in PIPESIM, as illustrated in Figure 4. The model comprises 43 production wells, each of which will be equipped with gas lift to investigate the impact on production and assess the sensitivity of the wells' performance to water cut and reservoir pressure analysis. The full-field model is designed based on the locations of the wells and their distribution among the separation stations [34, 35].

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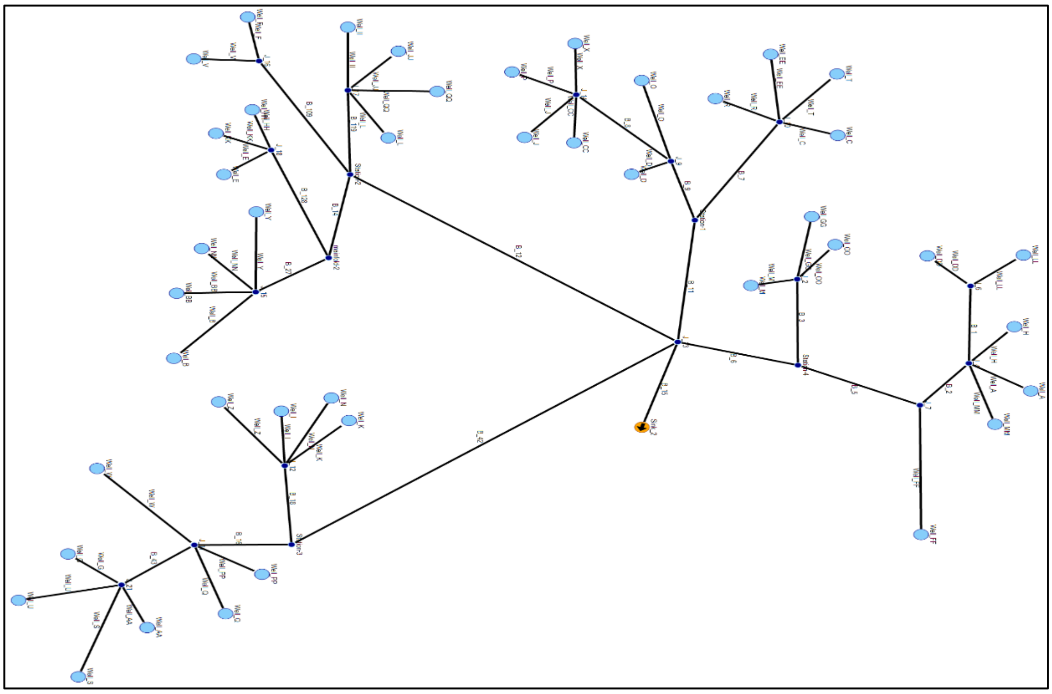

Fig. (4): The whole field network model

2.5 Optimize the Gas Injection Rates Using Genetic Algorithm

After installing all the wells with the designed gas lift one of the main goals of this study is to utilize the optimization of the gas lift using the genetic algorithm [23] as an artificial intelligence algorithm.

The Inputs that were applied in the application of the Genetic Algorithm and the whole optimization process were selected after the process of trial and error and as mentioned in Table (1).

Prior to initiating the optimization process, it is essential to select the algorithm to be employed, along with its constraints such as the number of iterations and other relevant values. Moreover, before running the optimization, it is imperative to perform a final step and adjust the advanced settings of the algorithm. This ensures that the optimum area is selected where the algorithm will take a reasonable amount of time to converge while providing accurate results.

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Table (1) The optimization operation variables and values.

Category	Variable	Value
Local Constrains	Min. bubble point pressure margin	50 (psi)
	Min. and Max. gas injection rate	N/A
Global Constrains	Maximum Injection gas rate	37.4 (MMscf/day)
Optimization Opt.	Optimization Type	Max. Oil Rate
	Control Variable	Gas Lift Rate
	Solver	Genetic Algorithm
	Initial Wellhead Pressure	250 (psi)
Genetic Algorithm	Population Size	5000
	Max. Generations	250
	Max. Generations without change	5
	Random Number Seed	0.25
Convergence	Number of Iterations	50
	Convergence Tolerance	1%
	Damping Threshold	25

2.6 Sensitivity Analysis

Sensitivity analyses were conducted to investigate the impact of reservoir pressure and water cut changes on the performance of natural flowing and gas lift wells. The water cut percentage evaluated in this study were ranged between 10% – 50 % to study the performance of the well in each case and to prevent and bias to a case over the other the same well head pressure will be used to analysis each case scenario. The reservoir pressure sensitivity for each well to study the well performance in the case of natural flow and gas lift wells were conducted in a range 800 psi – 4700 psi the reservoir pressure is quite important to evaluate the potential performance of the wells in case of decreasing reservoir pressure and to identify the effect of the gas lift on the performance of the wells, in order to have a fair study a suitable wellhead pressure should be selected and stabled for all the wells and in all the cases and the wellhead pressure should be suitable enough to operate the surface facilities (separators and process units) in this study the wellhead pressure was selected to be (250 psi).

3. Optimization Problem Formulation

To optimize the gas lift allocation problem, a mathematical model must be established. The genetic algorithm is one of the metaheuristic optimization algorithms that can be used to solve this problem. In the genetic algorithm, the set of genes to create a chromosome (individual) represents the gas lift rate, and the set of all chromosomes to generate the population represents the number of gas lift rates available. The oil flow rate (Q_o) resulting from gas lift injection ($Q_{gi,inj}$) in the whole oil field can be represented by the sum of the produced oil of each well (q_{oi}) as in Equation (1) [50]. Several papers have been published on gas lift optimization using mathematical models and metaheuristic algorithms, including the genetic algorithm[51, 52]. For example, Al-Janabi et al. (2021) [35] used numerical simulation and artificial intelligence for gas lift optimization, while Zanbouri et al. (2022) [53] proposed a new method for gas lift allocation using a chemical reaction-based optimization algorithm.

$$Q_o = \sum_{i=1}^{n} q_{oi}(\text{fitnessfunction}) = \sum_{i=1}^{n} f(Q_{gi,inj})(\text{Variable function}) = f(Q_{g1,inj}),(Q_{g2,inj}),(Q_{gn,inj}) \quad 1$$

The objective function for the gas lift optimization problem can be expressed as maximizing the oil flow rate (oil production) or minimizing the injected gas [34] and can be expressed in (2) or the equation could be arranged to be as (3).

$$\max f(x) = Q_o \quad 2$$

$$\min f(x) = \frac{1}{Q_o} = \frac{1}{\sum_{i=1}^{n} q_{oi}} \quad 3$$

Since the field under study has a limited volume of gas to be used for the gas lift of the field then the previous equation of the optimal gas injection to maximize oil production can be rearranged as suggested by [54, 55] and as in (4) and (5).

$$Q_o = \max f(Q_{gi,inj}) \quad 4$$

$$\sum_{i=1}^{n} Q_{gi,inj} \leq \text{Available limited gas} \quad 5$$

Also the equation for the minimum and maximum gas injection rate are as shown in (6) where the minimum gas injection rate ($Q_{gi,inj}(\max)$) stand for the smallest needed amount of gas to unload a dead well or maintain a production, as for the maximum gas injection rate ($Q_{gi,inj}(\min)$) represents the best and highest volume of gas required to achieve the maximum oil production and

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above it the production will decrease.

$$Q_{gi,inj}(\min) \le Q_i \le Q_{gi,inj}(\max) \qquad i = 1,2,3,\dots,n \qquad 6$$

Gas lift allocation problem is subjected not only to the subsurface constrains but facility constrains play a vital role in the numerical formulation of the gas lift optimization problem and as was modelled by Camponogara and Nakashima [56] the facility constrains of production rate of the fluid (q_p^n), the separator capacity (q_p^{max}), and constraints of handling gas, oil and water (q_g^{max}, q_w^{max}, q_o^{max}) are represented in (7), (8), (9), and (10) where (γ_w, γ_g, γ_o) are the water, gas, and oil fractions of the produced fluid.

$$\sum_{i=1}^{n} q_p^n = q_p^{max} \qquad 7$$

$$\sum_{i=1}^{n} q_w^n = \gamma_w^n \times q_p^n \le q_w^{max} \qquad 8$$

$$\sum_{i=1}^{n} q_o^n = \gamma_o^n \times q_p^n \le q_o^{max} \qquad 9$$

$$\sum_{i=1}^{n} q_g^n = \gamma_g^n \times q_p^n \le q_g^{max} \qquad 10$$

The previous part represents the used equation in the mathematical modeling and formulating of the gas lift optimization problem utilizing the genetic algorithm [23] for the limited amount of gas case and with facility constrains.

4. Results and Discussion

The results of the network after installing all the 43 production wells with gas lift shown a significant increase in the production rate of the whole field, the oil production rate has increased from 73,380 STB/day in the case of natural production to 187,559 STB/day after using the gas lift as an artificial lift method and as shown in Figure (5) which shows the comparison between the production in the two cases of natural flow and the gas lifted wells and also shows the percentage on increase in production which was around an average of 155.5%.

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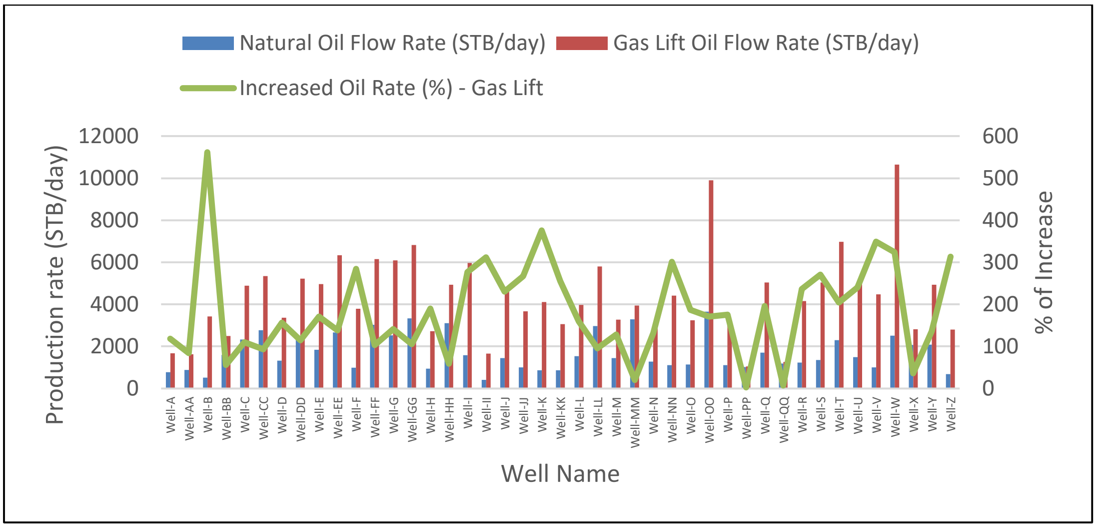

Fig. (5): Comparison between production of natural flow and Gas Lift.

In order to compare the effect of the optimization technique Figure (6) will provide a comparison between the two cases before and after the optimization to show the difference in the distribution of the gas injection rate for each well and the effect that increased the oil production from 184,591 STB/day in the case of before optimization to 187,759 STB/day after the use of the optimization algorithm while maintaining the same stable and limited gas injection rate of 82 MMscf/day to be distributed among the 43 production wells of the field. The results will show the importance of applying the optimization technique to the gas lift process and using a multi-constrains algorithm is highly important to be able to handle all the different constrains and specially when working with large number of wells and for the case of limited amount of injection gas in order to achieve the best production rate.

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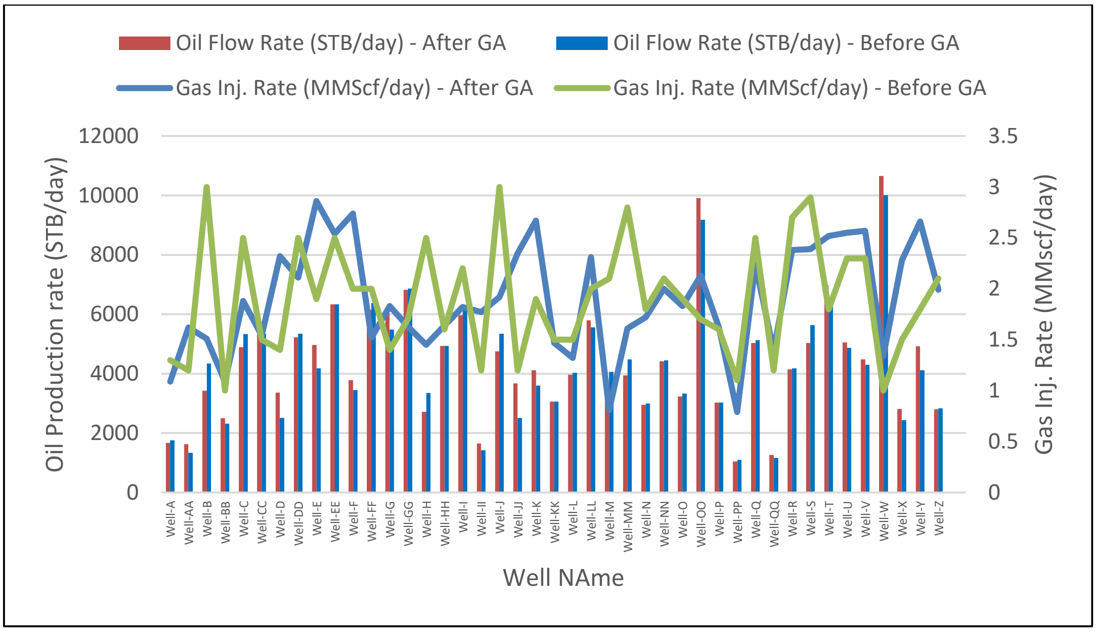

Fig. (6): Comparison between the gas lift results before and after GA optimization

The results can clearly locate the importance of applying the gas lift optimization technique in order to achieve the best injection rate distribution among a number of wells and as shown in Figure (7) which show the gas lift curves for all the network wells.

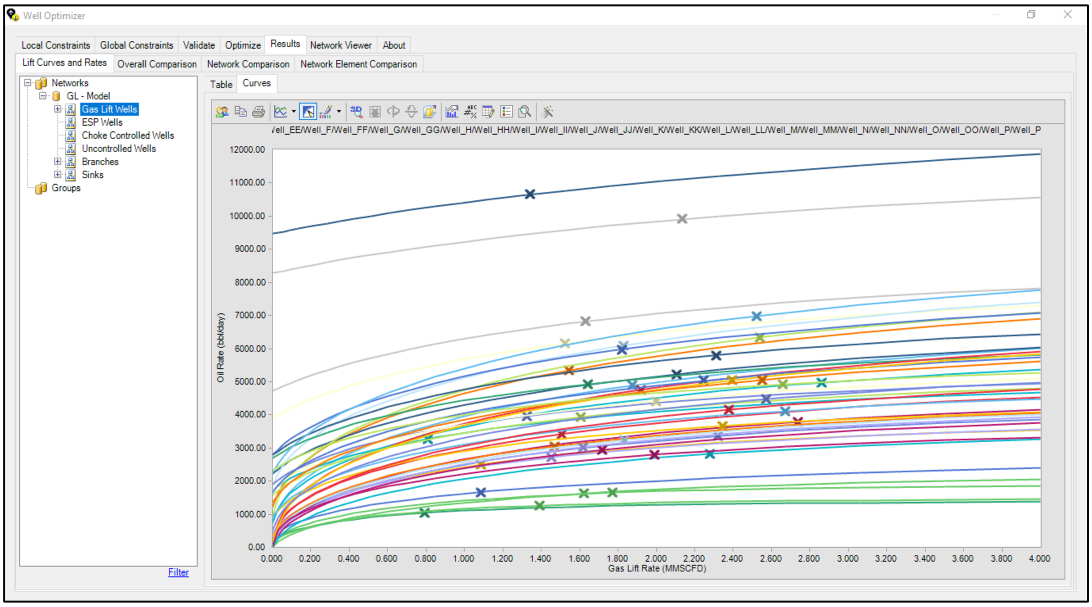

Fig. (7): The Optimal gas injection rate for all the wells of the network.

4.1 Water Cut Sensitivity

A water cut sensitivity analysis was conducted to fully understand the impact of gas lift on the production rate of the entire network. The results showed that the gas lift method can maintain the

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production rate of the field after increasing the water cut to a certain amount of stability. Specifically, the production rate decreased from 174,660 STB/day at the 10% water cut case to 88,492 STB/day at the 50% water cut case. It is worth noting that all sensitivity studies were conducted under the same current wellhead pressure to ensure the accuracy of the results and enable unbiased comparison. Figure (8) was designed to visualize and compare the effect of water cut percentage on the different cases of production.

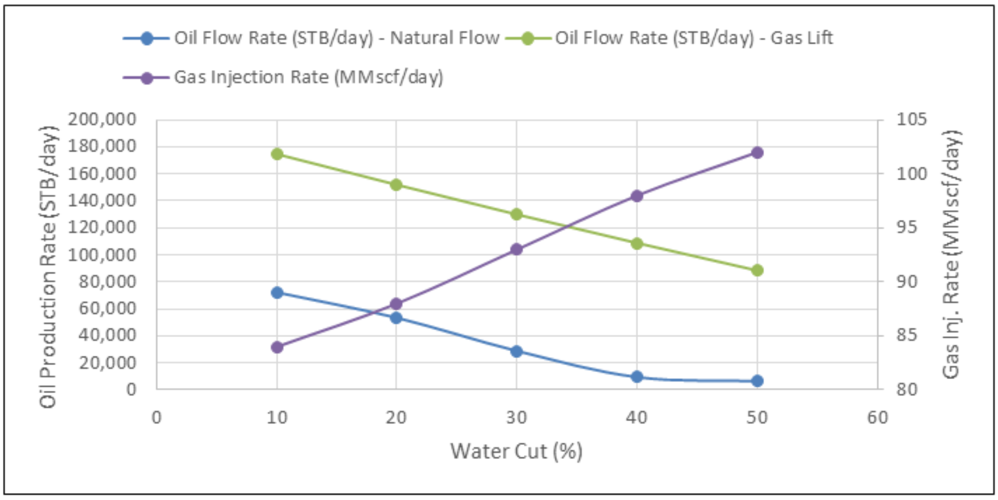

Fig. (8): Water Cut Sensitivity Analysis for Natural flow and Gas Lift.

4.2 Reservoir Pressure Sensitivity

The purpose of the sensitivity study was to determine the reservoir pressure at which the well would shut down and no longer be able to produce for natural flow and gas lift. All reservoir pressure sensitivities were conducted under a constant stable wellhead pressure of 250 psi. This wellhead pressure was chosen because it is appropriate for operating surface facilities and equipment and is capable of compensating for future adjustments in operations due to the expected reduction in reservoir pressure over time. The study aimed to simulate worst-case production scenarios and ensure that the wellhead pressure was sufficient to cover any potential losses in pressure and production.

Figure (9) shows the reservoir pressure at which the well will shut down for different cases of natural flow and gas lift. The results indicate that most wells shut down at an average reservoir pressure of 3500 psi under natural flow conditions, while the pressure at which the wells shut down under gas lift conditions averages at 550 psi. The gas lift method is useful in maintaining production potential at low pressures in case of reservoir pressure reduction, making it a suitable

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artificial lift technique to consider.

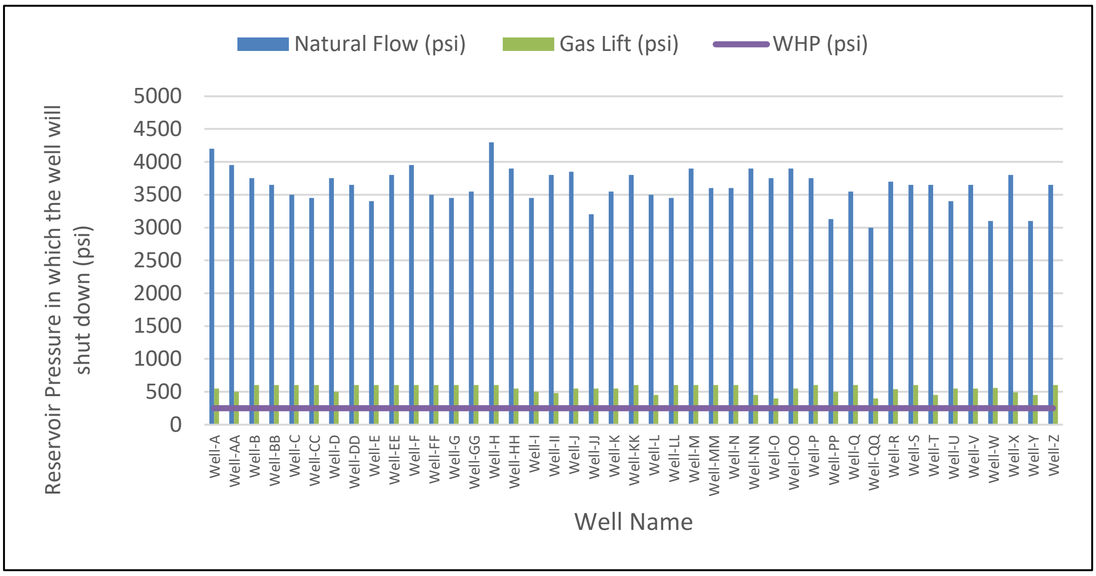

Fig. (9): Reservoir Pressure Sensitivity and WHP for all the wells.

5. Conclusions

The main goal of this study was to introduce the application of the gas lift optimization technique using the Genetic Algorithm based on real application in an actual large field with 43 production wells and study the effect of the optimization method while presenting an extensive numerical model to be followed as a guide for applying the gas lift optimization method based on genetic algorithm, the study also compared the results of the gas lift technique with the case of natural flow to have a full view on the abilities of the production from each case while comparing was not based only on the production rate the sensitivity analysis study were extended to include the two cases to be compared and fully assessed for future implementation of the Middle Eastern oil field. And based on the study results the following points of conclusion are made:

- The genetic algorithm [23] proved to be high efficient optimization technique that can handle large number of inputs and variable with ease and can maximize the oil production rate by optimally allocate the gas injection rates for the wells.
- The Gas lift method proves to be a good method to handle the water cut percentage increase and can withstand high values of water cut up to 50% for the wells in the network.
- Comparing the gas lift technique to Natural flow case the gas lift proved to have an advantage in maintaining the production from the wells in the case of reservoir pressure reduction to a low value.

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