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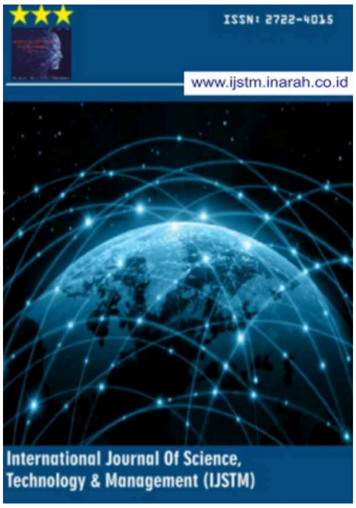

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Prayang Sunny Yulia[1]*, Herdiansyah[2], Sigit Rahmawan[3], Samsol[4]

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Abstract.

This study evaluates the performance of Sucker Rod Pump (SRP) systems in depleted oil wells at X Field, specifically Wells H1, H2, and H3, which are characterized by low production rates and high water cut values of 85–93%. Declining reservoir conditions may reduce SRP performance and require optimization to improve production efficiency. The study utilized well characteristics, production data, and pump specifications to construct Inflow Performance Relationship (IPR) curves using the Composite method. SRP performance was evaluated through parameters including Peak Polished Rod Load (PPRL), Minimum Polished Rod Load (MPRL), rod stress, pump displacement, volumetric efficiency (Ev), and power requirements. Optimization was performed using nodal analysis by varying Stroke Length (S) and Stroke Per Minute (N). The results show that actual production rates were below the wells' potential. Optimum flow rates for H1, H2, and H3 were 156.94, 331.95, and 229.34 BFPD, respectively. Volumetric efficiencies were 47%, 54%, and 82%, indicating significant optimization potential for H1 and H2. After optimization, production increased to 360 BFPD for H1, 525 BFPD for H2, and 249.5 BFPD for H3. The study concludes that SRP optimization effectively improved production performance and recommends expanding optimization variables and applying the method to other wells.

Keywords: *Sucker Rod Pump (SRP); Optimization; Inflow Performance Relationship (IPR); volumetric efficiency and composite method.*

I. INTRODUCTION

Artificial lift systems play an important role in maintaining hydrocarbon production, especially in mature oil fields where reservoir pressure has declined and natural flow can no longer sustain production [1], [2], [3]. One of the most widely used artificial lift methods in the petroleum industry is the Sucker Rod Pump (SRP) system due to its simple operating mechanism, ease of maintenance, and relatively low operational cost [4]. SRP systems are considered effective for lifting fluids in onshore oil wells because of their operational reliability and adaptability to various production conditions [5] . However, SRP performance may decrease over time as reservoir conditions and well inflow capabilities change, causing the installed pump configuration to become less efficient and resulting in reduced production performance.

Several studies have emphasized the importance of evaluating and optimizing SRP systems to improve production efficiency [6]. The periodic monitoring, maintenance, and optimization of SRP operating parameters are necessary to maintain optimal pump performance and maximize production rates [7]. Optimization is commonly performed through nodal analysis by matching the Inflow Performance Relationship (IPR) curve with the pump performance curve to determine the optimum production operating point [8]. This study focuses on wells H1, H2, and H3 in the X field, located in Sumatera. These wells are categorized as mature wells with high water cut values of 85%; 91%; and 93%, respectively, and relatively low production rates of 140, 200, and 124 BFPD. Preliminary analysis using the Composite IPR method indicates that the current production rates are still below the wells' production potential. Therefore, optimization of the installed SRP systems is required to improve well productivity.

The objectives of this study are to evaluate the performance of the installed SRP systems based on optimum flow rate and volumetric efficiency, determine whether optimization is necessary, and identify the optimum operating parameters through variations of Stroke Length (S) and Stroke Per Minute (N). The final results are expected to demonstrate the production increase achieved after optimization and provide recommendations for field implementation and future development.

II. METHODS

Field data collected in this study included well characteristics, production data, reservoir pressure, fluid properties, and technical specifications of the installed SRP systems. The installed pumping unit evaluated was a conventional SRP type C-228-246-120. The main parameters analysed were Stroke Length (S), Stroke Per Minute (N), Peak Polished Rod Load (PPRL), Minimum Polished Rod Load (MPRL), rod stress, pump displacement, volumetric efficiency (Ev), and power requirements. This research are using three wells, H1, H2, and H3.

The inflow performance of each well was analysed by constructing Inflow Performance Relationship (IPR) curves using the Composite method. The Productivity Index (J) was calculated using [1]:

$$PI = \frac{Q}{Fo\left[Pr - Pb + \frac{Pb\left(1 - 0.2\frac{Pwf}{Pb} - 0.8\left(\frac{Pwf}{Pb}\right)^2\right)}{1.8}\right] + Fw(Pr - Pwf)}$$

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$$PPRL = Wf + Wr \times (1 + \alpha)$$

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where Wf is fluid load, Wr is rod weight, α is acceleration factor, and G is fluid specific gravity.

Volumetric efficiency was used as the main indicator for pump performance evaluation. Wells with low volumetric efficiency values were identified as candidates for optimization.

Optimization was performed using nodal analysis by varying Stroke Length (S) and Stroke Per Minute (N) to determine the optimum operating point between the IPR curve and the Pump Intake Curve. The optimum parameters were selected based on the highest achievable production rate while maintaining acceptable operating conditions and pump efficiency.

III. RESULT AND DISCUSSION

The evaluation and optimization of the Sucker Rod Pump (SRP) systems were conducted for Wells H1, H2, and H3 in the X Field. These wells are categorized as mature wells with high water cut values ranging from 85% to 93%, causing the reservoir pressure and inflow performance to decline. The installed pumping unit in all wells was a conventional SRP type C-228-246-120.

The first stage of analysis involved constructing the Inflow Performance Relationship (IPR) curves using the Composite method. The IPR analysis indicated that the actual production rates were still below the optimum production potential of each well.

Table 1. Optimum Production Rate Based on Composite IPR Analysis

Well	Actual Production Rate (BFPD)	Optimum Production Rate (BFPD)
H1	140	156.94
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The results show that all wells still had production potential above the actual operating rates. Well H2 exhibited the largest production potential increase, indicating that the installed SRP operating conditions were not fully optimized.

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Optimization was then performed using nodal analysis by varying Stroke Length (S) and Stroke Per Minute (N) to determine the optimum operating point between the IPR curve and the Pump Intake Curve. Table 3 presents the optimized operating parameters and production improvements for each well.

Table 3. SRP Optimization Results

Well	Initial Production (BFPD)	Optimized Stroke Length, S (in)	Optimized Pump Speed, N (SPM)	Optimized Production (BFPD)
H1	140	50	10	360
H2	200	110	10	525
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The optimization results demonstrate significant production improvements in all wells. Well H2 experienced the highest production increase, from 200 BFPD to 525 BFPD, indicating that the previous pump operating conditions were substantially below optimum. Well H1 also showed a significant increase in production after adjusting Stroke Length and pump speed. Although Well H3 initially had better pump efficiency, optimization still improved production considerably.

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This study evaluated and optimized the performance of Sucker Rod Pump (SRP) systems in Wells H1, H2, and H3 in the X Field using the Composite IPR method and nodal analysis. The evaluation results showed that the actual production rates were below the wells' optimum potential, with optimum rates of 156.94 BFPD for H1, 331.95 BFPD for H2, and 229.34 BFPD for H3.

The volumetric efficiency values were 47% for H1, 54% for H2, and 82% for H3, indicating that Wells H1 and H2 required optimization. By optimizing Stroke Length (S) and Stroke Per Minute (N), production rates increased significantly. Production in H1 increased from 140 to 360 BFPD, H2 from 200 to 525 BFPD, and H3 from 124 to 249.5 BFPD.

The results confirm that optimization of SRP operating parameters effectively improves production performance in mature oil wells with high water cut conditions. Periodic evaluation and optimization are recommended to maintain pump efficiency and maximize production.

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V. ACKNOWLEDGMENTS

The authors dedicate this acknowledgment for Petroleum Engineering Department, Faculty of Earth Technology and Energy, Universitas Trisakti for supporting this research.

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Prayang Sunny Yulia

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