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TECHNICAL AND ECONOMICAL EVALUATION FOR ELECTRICAL SUBMERCIBLE PUMP OPTIMAZATION USING VARIETY OF STAGES AND FREQUENCIES AT THE "INTB-12" WELL IN THE WIDURI FIELD

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ABSTRACT
Based on the analysis and calculations from daily production reports, there was a decrease in oil production of about 500 barrels of oil per year in the Widuri Field. The output of fluid produced occurred since drilling activities, completion of wells and production. In addition, other problems arise related to production optimization, namely excessive use of electrical energy in electrical submersible pumps, artificial lifts used to produce hydrocarbon fluids in Widuri Field with limited electrical energy capacity. ESP optimization can use VSD, because the ESP pump motor is an induction motor, where the speed is very proportional to the electric power supply. By adjusting the frequency of the ESP motor on the VSD, of course, you will be able to control the operation of the ESP in a wider range of capacity, head, and efficiency, so that you can determine the price of the desired optimum production rate based on 70% - 80% of Qmax. The optimization will be carried out in this research is to replace the ESP type with the number of stages and the number of new frequencies as well as calculating the lifting cost ratio. The purpose and objective of writing this research is to evaluate the volumetric efficiency of the pump that is being installed in the well so that optimization can be done in the study well by doing various ways and calculating the economic of each pump, that it gets the most economical lifting cost price. The method of this paper is the variation of stages and frequencies to get how much% volumetric efficiency, the Pump Discharge (P2) and Pump Intake (P3) methods to optimize the pump in the study well and Oil Lifting Cost for its economy. The conclusion is that you can determine which ESP pump to use based on the oil lifting cost.
Keywords: *production optimization, ESP, VSD, Nodal Analysis*

INTRODUCTION

PHE SES operations are located in areas off the coast of the Java Sea (South East Sumatra) including Pabelokan Island which is located 90 kilometers north of Jakarta and borders the Thousand Islands, within the contract area according to the PSC Offshore Southeast Sumatra (SES) design. After the handover of several areas, the total production area became 8281 km2, reduced from the initial 13,725 km2 with a production of around 75,000 BOPD. The OSES PSC facility is located in the Java Sea, Northeast of the Sunda Strait, 6o 430 'LS. Currently PHE SES Ltd operates 33 production fields, 80 active production facilities: 56 production platforms; 17 caissons and one tripod; 73 well platforms including 20 monopod platforms, 6 production or process platforms; and 1 water treatment platform, of which 16 are manned and 64 are unmanned production platforms.

INTB-12 well in Widuri Field is a well that has a high water cut of 99% with a 10000 bfpd production rate. This well has not been activated or shut in for a long time due to the loss of power system in Widuri Field. It is necessary to further evaluate the previously installed pumps in order to achieve optimum production by analyzing the production history of these wells with nodal analysis. Reservoir, well, production and pump data will affect the evaluation to be carried out with the main variables being the frequency of the motor and pump stages when restarting the well and controlling its performance on the surface, so that the final result will be obtained optimal production or at least minimizing the decrease in the production rate. drastic. In addition, with the help of VSD, technology that changes AC - DC currents and vice versa can also save the power needed to run pumps, so that the spare power system in the INTB-12 well in Widuri Field can be used to power other wells. So, the pump stage and motor frequency in the electrical submersible pump circuit affect the optimization of oil production and the installation of a variable speed drive affects the efficiency of the power used to run the electrical submersible pump.

In this research, the author tries to evaluate the electric submersible pump that is being installed with volumetric efficiency and pump efficiency in production wells, this is important in the development process of a production field, so with this evaluation it can be seen whether the pump installed is operating. If the volumetric efficiency is less than 50% and uptrust / downtrust occurs, optimization must be carried out by calculating the IPR (Inflow Performance Relationship) after which determine the maximum total production rate of the well and perform nodal calculations based on the variation of stages (the part consisting of rotating impellers and a fixed part diffuser) and frequency (number of cycles per second) (a simple technique used to determine the relationship between the Inflow Performance Relationship and the Tubing Intake, which can be used to determine the optimum production rate that occurs in a production system), Optimization method Electrical Submersible Pump. After calculating the pump type which is more profitable in terms of engineering and production can be selected. Then the SVC (surface voltage calculation) calculation will be carried out to determine the amount of electricity flow, voltage and HP of the pump, and the engineering optimization of this pump ends with a VSD (variable speed drive) calculation. After the technical analysis is carried out, an economic analysis will be carried out using selected pumps starting from the calculation of investment costs, net production value, internal rate of return, benefit to cost ratio, and pay out time.

METHODOLOGY

Evaluating and Optimazig ESP

The principle of planning or design electric submersible pump unit for wells with high WC is the same as an ordinary electric submersible pump unit, where with the maximum desired production rate. The control is by calculating the critical rate where the desired oil production rate is greater than the critical rate so that water coning occurs. This production continues because it is still economically valuable and the occurrence of water coning is normal for old wells that have a water cut greater than 90%.

1. Estimated Maximum Production Rate

The maximum production rate of a well must be in accordance with the productivity of the well. In general, the fluid flowing from the formation to the wellbore should be more than one phase. As explained in the previous section, for two-phase fluid flow, Vogel graphs the fluid flow performance from the formation to the wellbore based on production test data. As for the three-phase flow, namely gas, oil and water, in developing the three-phase flow behavior from the formation to the wellbore, you can use the regression analysis of the Pudjo Sukarno method as previously described.

2. Selection of Pump Size

the selection of the pump type is based on the amount of the expected production rate at the appropriate lift rate and casing size (Check clearances). The production of gas with the liquid has an influence in the pump, because of the high compressibility of the gas, which causes a fairly large difference in fluid volume between the intake pump and the discharge pump. This will affect the efficiency of the ESP pump.

3. Estimated Pump Setting Depth

Estimated pump setting depth is a depth limitation for determining the location of the pump depth in a well, which is that the pump must be immersed in the well fluid. Before calculating the estimated setting depth, the parameters that determine it are first known, namely the Static Fluid Level (SFL) and the Working Fluid Level (WFL) which sonologists use or wireline operations to determine if the well does not use a packer.

4. Static Fluid Level

The static fluid level in the well is in a inactive (not produced), so there is no flow, so the pressure in front of the perforation is equal to the static pressure of the well. So that the depth of the fluid surface in the annulus (SFL, ft.) is:

$$SFL = D_{midperf} - \left(\frac{Ps}{Gf} + \frac{Pc}{Gf}\right) \quad (1)$$

5. Working Fluid Level

If a well is produced with a production rate of q (bbl / D, and the bottom well flow pressure is Pwf (Psi), then the height (depth when measured from the surface) of fluid in the annulus is:

$$WFL = D_{midperf} - \left(\frac{Pwf}{Gf}\right) \quad (2)$$

6. Suction Head

The suction head is a cylinder or piston which is originally on the surface of the liquid (in the tub), the water will rise following the piston until it reaches a height of Hs, where

$$Hs = \frac{144 \times P}{\rho} \quad (3)$$

7. Cavitation and Net Positive Suction Head (NPHS)

The absolute pressure on the liquid at a point in the pump is below the saturation pressure (Pb) at the liquid temperature, so the gas originally dissolved in the liquid is liberated. These gas bubbles will flow together with the liquid until an area of high pressure is reached where the bubbles will shrink. This phenomenon is known as cavitation which can reduce efficiency and damage the pump. This incident is related to the suction condition and if the suction condition is above Pb, then cavitation does not occur. The minimum condition required to prevent cavitation in a pump is called the Net Positive Suction Head (NPHS). NPHS is the absolute pressure above the saturation pressure needed to move the fluid into the fluid.

8. Minimum Pump Setting Depth

The minimum pump setting depth is a condition shown in **Figure 1**. The minimum position in a short time will be pump-off, because the fluid level above the pump is relatively small or short so that only gas will be pumped. In this condition the Pump Intake Pressure (PIP) will be small. PIP reaches below the Pb value, so there will be a decrease in the volumetric efficiency of the pump (due to the release of gas from the solution). The minimum PSD can be written with the equation bellow:

$$PSD_{min} = WFL + \frac{Pb}{Gf} + \frac{P}{Gf} \quad (4)$$

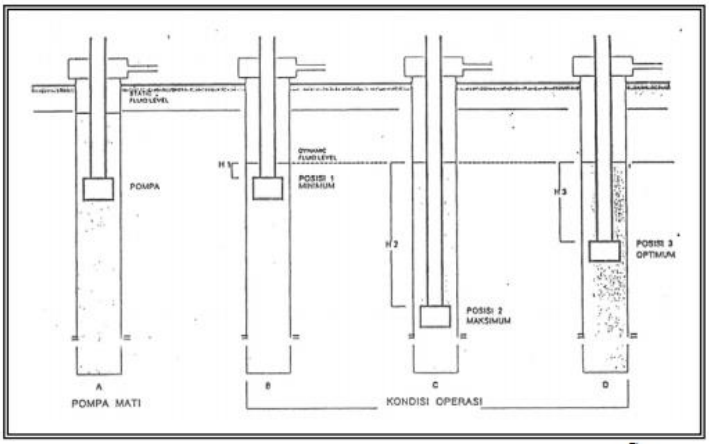

Figure 1. Pump Position at the Depth of the Well

9. Maximum Pump Setting Depth

This situation allows for overload, the lifting of the fluid column load that is too heavy. The maximum PSD can be defined:

$$PSD_{max} = D - \left(\frac{Pb}{Gf} - \frac{Pc}{Gf}\right) \quad (5)$$

10. Optimum Pump Setting Depth

The expected planning position of electric submersible pump (the pump is in its optimum state) to determine the optimum depth (so that pump-off and overload do not occur and according to the desired rate conditions), then the pump capacity used must be adjusted to the productivity of the well. Determination of the optimum PSD is influenced by the opening and closing of the casing head which will affect the casing pressure or the pressure acting on the surface of the fluid in the annulus. This incident affects the size of the pump suction head.
For a closed head casing, defined:

$$\text{Optimum pump setting depth} = \text{WFL} + \frac{PIP - P_c}{Gf} \quad (6)$$

For an open head casing defined:

$$\text{Optimum pump setting depth} = \text{WFL} + \frac{PIP - P_{atm}}{Gf} \quad (7)$$

11. Calculation of Total Dynamic Head (TDH)

a. Determining of Fluid Gradients

$$Fluid\ Gradient\ (Gf) = \ SG_{Fluid} \times 0.433 \quad (8)$$

b. Determining of Pump intake presssure

$$Depth\ Deferences = Mid.Perforasi - PSD \quad (9)$$
$$Pressure\ Deferences = Perb\ Kedalaman\ \times Gf \quad (10)$$
$$Pump\ Intake\ Pressure\ (PIP) = \text{Pwf} - \text{Perbedaan Tekanan} \quad (11)$$

c. Determining of Vertical lift (HD)

$$Fluid\ Over\ Pump = \frac{PIP}{Gf} \quad (12)$$
$$Vertical\ Lift\ (H_D) = Pump\ Setting\ Depth\ (PSD) - FOP \quad (13)$$

d. Determining of Tubing Friction lost (Hf)

$$Friction\ Loss = \frac{2.0830 \times \left[\frac{100}{C}\right]^{1.85} \left[\frac{Qt}{34.3}\right]^{1.85}}{ID^{4.8655}} \quad (14)$$
$$Tubing\ Friction\ Loss\ (H_F) = Friction\ Loss \times PSD \quad (15)$$

e. Determining of Head Tubing (HT)

$$Tubing\ Head\ (H_T) = \frac{Tubing\ Pressure}{Gf} \quad (16)$$

f. Determing of Total Dynamic Head (TDH)

$$TDH = \ H_D + H_F + H_T \quad (17)$$

12. Estimated Number of Pump Stage

To calculate the number of pump stages (stages), the Total Dynamic Head (TDH, ft) is used divided by the head / stage value obtained from plotting Q on the IPR Curve

$$Number\ of\ pump\ stages = \frac{TDH}{Head/Stage} \quad (18)$$

After getting the results of the number of stages with the formula above, then we choose the tandem pump in the available pump catalog. If the number of calculated stages is not available in one tandem in the pump catalog, then choose the number of stages that is closest to the number of stages calculated. And if the number of stages is too much and it is not available at that amount in one tandem, then we can use two tandem pumps with the consequence of higher budgets.

13. Selection of Motor and Horse Power

Brake horse power is a unit indicating the power of an engine before it is reduced by losses due to system design or other losses. The HP required by the pump can be obtained using the formula:

$$\text{HP } required\ by\ pump = Jumlah\ Stage\ \times Hp/Stage \qquad (19)$$

The HP / Stage value is obtained from the Pump Curve. Meanwhile, to determine the HP needed by our motor, we use the formula:

$$\text{HP } required\ by\ Motor = \frac{HP\ required\ by\ pump}{80\%} \qquad (20)$$

After getting the HP results needed by the motor, then we look at the motor catalog. Just like the number of stages, if there is no HP available on one motor then use the nearest higher HP or use two motors.

14. Switchboard and Transformer Selection

To determining the switchboard, we should know how much voltage will work on the switchboard. The amount of working voltage can be calculated from the following equation:

Vs = Vm + Vc, Volt (21)

Vc = (L/100) x Voltage , Volt (22)

Determining the required transformer voltage is calculated by the following equation:

$$T = \frac{Vs \times Im \times 1{,}73}{1000}, KVA \qquad (23)$$

Variable Speed Drive (VSD)

The electric submersible pump system can be modified by entering a Variable Speed Drive (VSD) frequency so that it can operate a higher range of capacities, heads and efficiency. Since the submersible pump motor is an induction motor, its speed is very proportional to the mains power supply. By adjusting the frequency, the VSD system offers more potential to increase production and generate profits. VSDs can increase efficiency in many cases, including wells with high viscosity, waterflood wells, and others. VSD can extend the range from ESP-made removal of less than 100 BPD to 100,000 BPD. Determining the amount of the output frequency of the VSD, which will be the frequency of the pump rotation, can be determined through several types of controllers (control mode), namely:

1. Speed Mode, which is a setting based on speed as a fixed price. For example, with Speed Mode at 52 Hz, it means that the motor will remain at 52 Hz.
2. Current Mode, which is a setting based on the running amperage as a set value. For example, with the Current Mode at 40 Amp, it means that the VSD will adjust the rotation (frequency) to adjust the running ampere (40 Amp).
3. Pressure Mode, which is a setting based on the subsurface pressure (Pressure Intake Pump) as a set price. For example, the Pressure Mode is at 1000 psi, meaning that the VSD will adjust the rotation to adjust the pressure at 1000 psi.

Nodal System Analysis for Electric Submersible Pump Production Methods

Specifically, for pumping liquids (oil or oil-water). The procedure for creating a tubing intake (node outflow) curve for liquids only with Nodal at the bottom of the well is as follows:

1. Select a suitable pump according to the casing size and production capacity of the well.
2. Calculate ρfsc using the following equation:

$$\rho fsc = 350 \text{ wc } T_{wsc} + 350 \text{ (1- wc) } T_{osc} \quad (24)$$

and Tfsc using the following equation:

$$T_f \text{ (V)} = \frac{qsc\ \rho fsc}{350\,V} \quad (25)$$

3. Assume various production rates and for each of these production rates do the following:
   a. Read the head / stage from the pump performance curve and calculate the quantity (ρfsc h / 808,3141) using Figure 2.
   b. Determine the pump output pressure from the correlation pressure gradient.
   c. Assume various numbers of stages and for each of these numbers calculate the intake pressure with the following equation:

$$P_3 = P_2 - (\rho fsc\ h / 808{,}3141)\ St \quad (26)$$

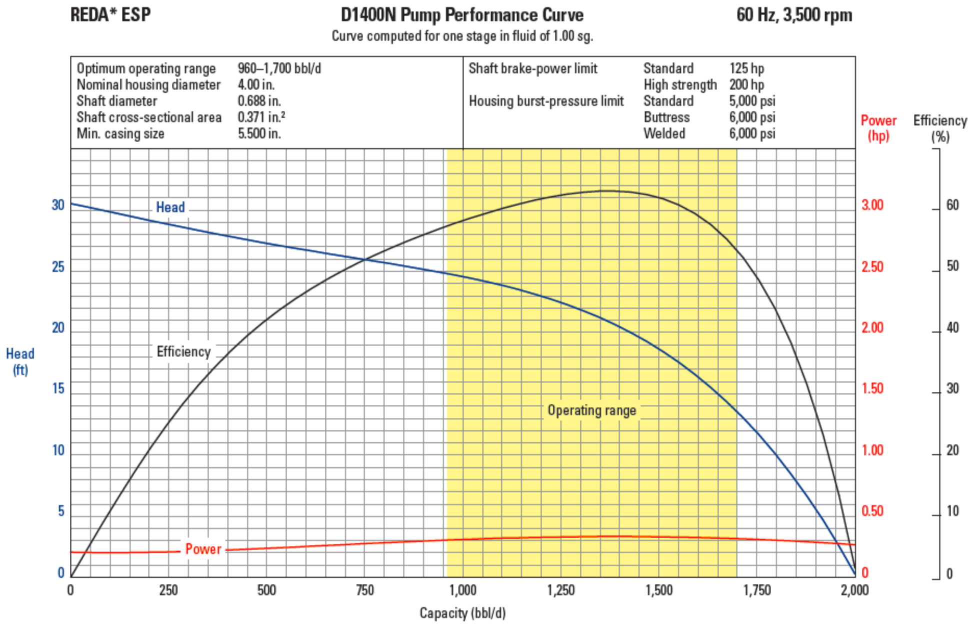

Figure 2. ESP Performance Curve (Powerlift, 2019)

4. Plot the intake pressure against the production rate for each assumed stage number on the same graph as the IPR curve with the same scale.
5. Read the production rate price at each point of intersection between the intake pump curve and the IPR curve.
6. For each production rate, read the required HP / stage from the pump performance curve, then calculate the total HP with the equation HP = hp Tfsc St.
7. Plot the production rate against the required stage number and Hp.

STUDY CASE

Evaluation of Electric Submercible Pump Type RD-26

"INTB-12" well in the "Widuri" field, the actual current flow rate is 2739 BFPD with a Pwf of 1665.47 Psi, the number of stages 80 and the type of pump installed is RD-26. From the evaluation results of the installed pump evaluation with Total Dynamic Head (TDH) 3178.56 ft and divided by the number of installed stages, it is obtained the head / stages value of 40 ft / stages, then we get a theoretical flow rate of 2950 BFPD, so that the Volumetric Efficiency is obtained 92.85%. Judging from the pump performance curve there is no upthrust or downthrust. And seen from the pump performance curve, the pump efficiency is 64%, so from this the pump needs to be optimized in order to get the results according to the desired target. In this study, the authors optimized the ESP by replacing the old pump from the RD-26 to a new pump available in the field, namely the QN-70 with nodal analysis using various stages and frequencies.

Table 1. Pump Efficiency Data on the ESP RD-26

Pompa Terpasang	Pwf (psi)	Pip (psi)	Head/ Stage	Qaktual (BFPD)	Qteori (BFPD)	EV (%)	EP (%)
RD-26	1665.47	654.03	40	2739	2950	92.85	64

Before optimizing ESP with nodal analysis using various stages and frequencies, first determine the formation productivity which can be presented in the form of an IPR curve. Inflow Performance Relationship (IPR) is a Productivity Index (PI) statement that graphically depicts changes in flow pressure values. Pressure well flowing (Pwf) versus flow rate (q) generated due to changes in the bottom well flow pressure. Meanwhile, the Productivity Index (PI) is the index of measurement of a well's ability to produce at a certain pressure. With Ps of 2224.45 psi and Pwf of 1665 psi, the ability of the reservoir well "INTB-12" has a Productivity Index of 4.9 BFPD / psi with a maximum flow rate of 8613.093 BFPD. The following is the calculation result of the production rate shown in Table II below,

Tabel 2. Result of Calculation of Production Rate (Q) at Various Prices of Pwf

Pwf, psi	Q, bfpd
2224,45	0
2000	1100
1950	1345
1800	2080
1665	2741
1500	3550
1350	4285
1200	5020
1050	5755
992,7	6029
750	7038
600	7540
450	7948
300	8263
150	8485
0	8613

Explenation : Red color = primier data
Blue color = q target

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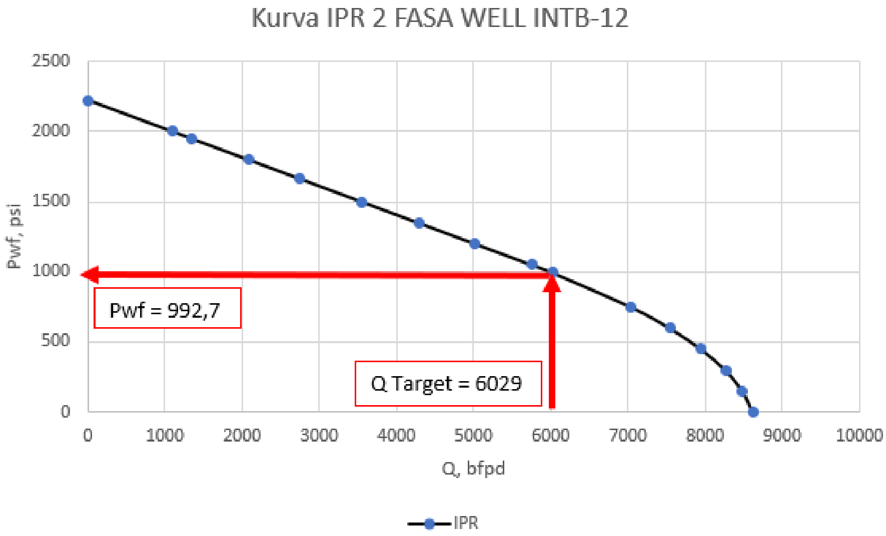

Figure 3. INTB 12 Well's IPR Curve

The optimal production rate targeted at 70% of the maximum production rate is obtained at 6000 BFPD with a Pwf of 1241 Psi.

Furthermore, ESP optimization is carried out by nodal analysis with variations of Stages on the new INTB-12 pump. Based on the plot results between the IPR Curve and the Pump Intake Pressure, the optimal production rate is 6000 BFPD and Pwf is 992.7 Psi at 150 stages.

Table 3. Pump Intake Pressure Calculation Results with Various Stages QN-70 ARC

Q asumsi (BFPD)	Pwf	PIP	PBHP	HD	Ft	HF	HT	TDH	ΔP	arge Press P2 (psi)	Head/ stage	Pump Intake Pressure/P3 (psi)				
												100	120	146	160	180
5000	1194.48	430.53	1308.60	1299.40	72.31	296.26	1519.74	3115.40	1028.08	1458.62	31	1011.08	921.57	805.21	742.56	653.05
5500	1100.31	336.36	1022.35	1585.65	86.26	353.39	1519.74	3458.78	1141.40	1477.75	29	1059.09	975.36	866.51	807.89	724.16
6000	998.31	234.36	712.32	1895.68	101.32	415.11	1519.74	3830.53	1264.08	1498.43	26	1123.08	1048.01	950.41	897.87	822.79
6500	886.13	122.18	371.35	2236.65	117.49	481.36	1519.74	4237.75	1398.46	1520.63	22	1203.03	1139.51	1056.93	1012.46	948.94
6800	812.44	48.49	147.39	2460.61	127.72	523.27	1519.74	4503.62	1486.19	1534.69	20	1245.95	1188.21	1113.13	1072.71	1014.97

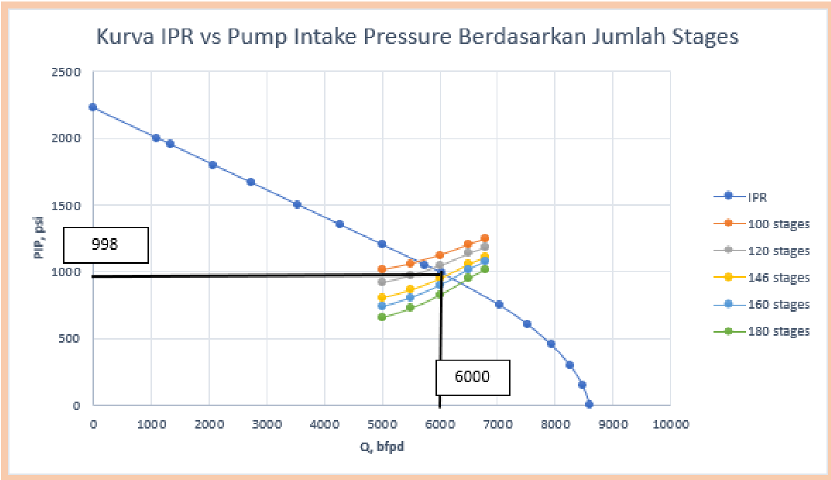

Figure 4. IPR Curve vs Pump Intake Pressure Variation Stages

Furthermore, the ESP optimizer with nodal frequency variations on the new pump QN-70. Based on the plot results between the IPR Curve and the Pump Intake Pressure, the optimal production rate is 6000 BFPD and a Pwf of 998 Psi at 146 stages and a frequency of 60 Hz.

Table 4.
Pump Intake Pressure Calculation Results for Various Frequencies of QN-70

Q asumsi (BFPD)	Discharge Pressure/ P2 (Psi)	Head/ stage	Pump Intake Pressure/P3 (psi)			
			45 Hz	50 Hz	55 Hz	60 Hz
5000	1458,62	31,2	1205,69	1079,22	952,76	801,00
5500	1477,75	28	1300,70	1174,24	1022,48	870,72
6000	1498,43	26	1397,26	1245,50	1093,74	950,41
6500	1520,63	22,8	1520,63	1368,88	1217,12	1040,07
6800	1534,69	19,2	1585,27	1433,51	1281,76	1130

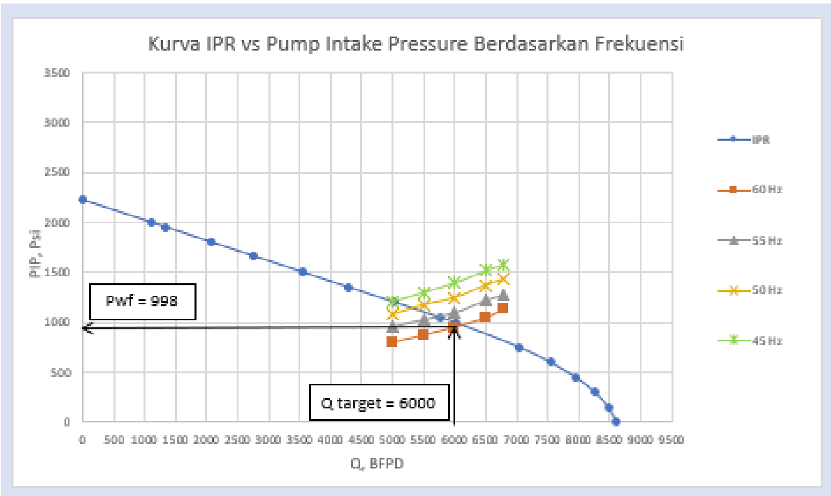

Figure 5. IPR vs Pump Intake Pressure Curve Based on Frequency

After optimization, the calculation of the electrical voltage on the surface, in this plan the calculation of the amount of electricity, voltage and HP at the QN-70, here is the data for calculating KVA at 60 Hz;

Table 5. KVA @ 60Hz Calculation Data

PSD	4097	Ft
Pump Type	QN-70	
Num of stages	146	Stages
HP motor	273	HP
Nameplate Amps	58	A
Nameplate Volts	2688	V
HP/Stages	1.62	HP
Protector	2	HP
Intake	3	HP
MLE	82	FT
Cable lenght	5097	FT

From the data above, HP pump is 236.52 HP, then the selection of the selected motor is based on the HP required in the HP specification catalog of 273 HP, a voltage of 2688 volts and an Ampere of 58 A. Furthermore, the recommended carrier current is Powerlift. Round Cable Series AWG # 1 (Series 17044C) with a cable length of 5097 ft & Motor Load Extension / MLE AWG cable # 4 (Series YR1911021) 82 ft, with a volt drop on MLE of 2.56 volts and a volt drop on the cable of 85, 05 volts. For the selection of transformers, which is calculated from the power needed by the transformers obtained is 2775.61 volts, for the total voltage required by the transformers to be 2845 volts (including safety factors), then the estimated power loss in the transformers is obtained at 69.39 volts, for KVA at 60 Hz it takes 314.38 KVA. So that the Horse Power (HP) motor is 273 HP, the motor power is 352.74 KVA, so the selection of the transformer capacity to be used is TR500 KVA and the ampare capacity of the transformer is 96.6 ampare. The selection of the VSD that will be used in operations is based on the calculation of the total electric voltage on the surface (surface voltage calculation) and the electrical power required for the transformers. Based on the calculation of the transformer power capacity (KVA) required in the ESP Sumur INTB-12 circuit is 314.38 KVA, so that the VSD catalog based on KVA capacity and amps output is VSD Cap 390 KVA. From the maximum calculation of the frequency that can be controlled by VSD, the max drive Hz is 64.5 Hz and the max motor Hz is 64.06 Hz.

The results of the calculation of production optimization with ESP using a new pump type QN-70 and VSD Cap 390 KVA in the well "INTB-12", "Widuri" field are shown in Table VI;

Table 6. Comparative Results of Evaluation and Optimization of Electric Submersible Pump Using Variations of Frequency and Stages in the "INTB-12" Well "Widuri" Field

No	Parameter	Installed Pump Evaluation	Pump Optimation
1	Type of Pump	RD-26 (Red-B)	QN-70 (Dqg)
2	Optimum Production Rate	2739 BFPD	6000 BFPD
3	PIP	654,03 psi	250 psi
4	PSD	4100	4097
5	TDH	3178,56 ft	3778 ft
6	Pwf	1665,47 psi	998.31 psi
7	Pump Capacity	1600 - 3200 BFPD	3500 - 7500 BFPD
8	Number of Stages	80 stages	146 stages
9	Volumetric effeciency	92.85%	-
10	Pump efficiency	64%	72%
11	Protector	456 Series – 66 L	NPBPBSLST-AR-CCR-PL3-RF-FD-E-INCH (Series ZNB200611R)
12	Type of Motor	Series 456	EMPHST-CCR-PL3-RF-HL (Series ZED1712Q01)
13	HP Motor	120 HP	273 HP
14	Motor Voltage	-	2688 volt
15	Electric Current	-	58 ampere
16	Type of Cable	-	Powerlift Round Cable Series AWG#1 (Series 17044C) with cable length 5097 ft & MLE Cable AWG#4 (Series YR1911021) 82 ft
17	Transformer	-	TR500 KVA
18	Variable Speed Drive (VSD)	-	VSD Cap 390 KVA

The results obtained are the evaluation of the RD-26 (Red-B) installed pump, with 80 stages, the actual flow rate of 2739 BFPD, the volumetric efficiency of 92.85%, the pump efficiency of 64%, and the optimization of the pump with the QN-70 type pump, with 146 stages with a frequency of 60 Hz, the optimal production rate is 6000 BFPD with a Pwf of 998.31 Psi and has a Pump Efficiency of 72%, then the better pump to use is the QN-70 pump.

From an economic point of view with an interest rate (i) of 5%, within 5 years for the RD-26 pump the NPV (net present value) price is US $ 109919 with an IRR (Internal Rate of Return) value of 11.74 %, for the benefit to cost ratio (B / C) where the sum of the Discounted Cash Flow (DCF) value from year 1 to year 5 is 713743, while the investment is in year 0 of 603824, obtained B / C is 1.18, and for Pay Out Time it is obtained in year 3.87. For the QN-70 pump, the NPV (net present value) price is obtained at US $ 154434 with an IRR (Internal Rate of Return) value of 14.38% for the benefit to cost ratio (B / C) where the sum of the Discounted Cash Flow (DCF) values) from year 1 to year 5, which amounted to 717519, while the investment was in year 0 of 566085, obtained B / C of 1.27 and for Pay Out Time was obtained in year 3.64. The comparison of the economic indicators for each pump can be seen in the following table,

Table 7. Comparison of Economic Indicators for Each Vendor

Benefit Indicators	Vendor of ESP Pump	
	RD-26	QN-70
Invest (US$)	603824	566085
NPV (US$)	109919	154434
IRR (%)	11.74	14.38
B/C	1.18	1.27
POT (Years)	3.87	3.64

CONCLUSION

1. Evaluation with an RD-26 installed pump of 2739 BFPD, with a Volumetric Efficiency of 92.85% and a Pump Efficiency of 64%, from these results the company wants a higher production so optimization must be done.
2. The ability of the well reservoir "H-12" has a Productivity Index of 4.9 BFPD / psi with a maximum flow rate of 8613.093 BFPD. Meanwhile, the optimal production rate is targeted at 70% of the maximum production rate, so that the target production rate is 6029 BFPD and Pwf of 992.7 Psi.
3. Optimization of ESP with nodal analysis with variations of Stages and Frequency on the new QN-70 pump. The optimal production rate is 6000 BFPD and Pwf of 992.7 Psi at 146 stages and a frequency of 60 Hz.
4. Comparison of the evaluation of an installed RD-26 pump, 80 stages with an actual flow rate of 2739 BFPD and a volumetric efficiency of 92.85% and optimization of pumps with QN-70 type, 146 stages with 60 Hz frequency with an optimal production rate of 6000 BFPD, then the better pump to use is the QN-70 pump.

5. With the selection of a new pump type QN-70 requires the selection of motor power (KVA) obtained from the Horse Power (HP) motor of 273 HP, obtained a motor power of 352.74 KVA, so the selection of the transformer capacity to be used is TR500 KVA. For the VSD catalog based on KVA capacity and amps output is VSD Cap 390 KVA.
6. From an economic perspective, the RD-26 pump incurs an investment cost of US $ 603824 with an NPV value of US $ 109919, an IRR value of 11.74%, B/C of 1.18 and a POT of 3.87 years. The QN-70 pump incurs an investment cost of 566085 US $ with an NPV value of 154434 US $, an IRR value of 14.38%, a B / C of 1.27 and a POT of 3.64 years.
7. In terms of production, the QN-70 pump is more optimal and gets better results than the RD-26 pump. As with the production point of view, from the economic point of view the QN-70 pump gets better results than the RD-26 pump.

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