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Analysis of the Use of Sand Pump Control Pumps in Overcoming Sand Problem in Sucker Rod Pump (SRP) in Sp Wells in the Kawengan Field

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ABSTRACT

The sand problem is a common challenge in the oil and gas industry. PT Pertamina EP Asset 4 Cepu Field in the Kawengan Field has rock which is a ngrayoung formation and the type of sandstone can cause sand to enter into the well bour when oil is produced for a long time. Therefore, we need the right tool to be able to overcome the problem of sandiness. In this case PT Pertamina EP Asset 4 Cepu Field in the Kawengan Field uses a sand control pump in an effort to overcome the sand problem. Thus, this research was conducted by analyzing the appropriate pump size from the sand rate calculation, fluid flow rate before and after using the sand control pump, as well as economic analysis. The results of the pump size analysis show that the right pump size to use is 2 joint mud anchors. The results of the subsequent analysis show an increase in the rate of fluid production after using a sand control pump. The results of the economic analysis show that the use of a sand control pump on a sucker rod pump (SRP) in the SP well is feasible because it has economic value with an oil price of 45 US$ / bbl, an NPV of 221,709 USD is obtained, and project success (IRR) reaches 106 %, as well as the value of pay out time for 1.83 years.
Keywords: Economy, Flow Rate, Sand Problem, Sand Control Pump, Sand Rate.

I. INTRODUCTION

The sand problem is one of the main challenges for the oil and gas industry, especially in the upstream sector (Roslan, et al., 2010). In the oil world, especially in wells using the sucker-rod pump lifting method in SP wells, various problems are often encountered which can disrupt the fluid production process from the well. These problems include sand which can arise due to the age of the well, the production process being carried out continuously over a long period of time causes the quality of the oil to decrease, the presence of frictional forces and collisions by the fluid flow causing the flow rate to exceed the maximum limit of the critical flow rate. These problems also cause the tubing to leak and become an obstacle to oil flow, blockage at the bottom of the well, and disrupt pump performance until the pump stops producing. PT Pertamina EP Asset 4 Cepu Field in the Kawengan field also has fluid / crude oil characteristics which are HPPO (High Pour Point Oil) which is paraffinic, meaning it contains wax, which has a low octane value and straight chain alkanes. Kawengan Field itself, the rock is the ngrayoung formation with a type of sandstone. Therefore, if an oil well is produced for a long period of time, it will cause the sand layer to fall on the oil layer so that sand can also enter the wellbore. If this sand is allowed to enter the pump, it will disrupt the performance of the pump itself and cause the pump to get stuck. Apart from that, the large amount of sand that is produced at various depths of certain wells in the Kawengan Field will cause a high frequency of well service. So to resolve sand in oil wells that contain a lot of sand and to increase the efficiency of the most effective pump, use low energy, and have low costs, a sand control pump can be used. Sand control pump is a process for removing sand contained in a well, in the form of a barrel and installed on tubing and then inserted into the well. This research was conducted to analyze the use of sand control pumps in overcoming sand problems in sucker rod pumps (SRP) in SP wells in the field Kawengan, by analyzing the right pump size from sand rate calculations, fluid flow rates before and after using the sand control pump, as well as economic analysis.

II. METHODS

The research method used was field research. The author collects the necessary data by requesting data or information from the petroleum engineer and discussing matters directly with the field supervisor regarding matters related to the research. The data required includes well profile data and sandrate data to explain the height of the sand falling on the liner. Well production data is needed to see usage before and after using sand pump control. Economic data is used to assess whether the investment made is feasible or not.

III. RESULTS AND DISCUSSION

Sand which is produced at the same time as oil is a problem that is often experienced in the world of oil. This can result in a decrease in the quality of production carried out. In addition, the production of sand can cause damage to well production equipment such as pumps. Therefore, choosing the right pump to use can minimize sand problems. In the process of selecting the right pump, it is necessary to analyze the right size to be used. Apart from that, it is also necessary to look at the comparison before and after using the pump, as well as the feasibility of using the pump from an economic perspective. PT Pertamina EP Asset 4 Cepu Field in Kawengan Field uses a sand control pump in an effort to overcome the sand problem.

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Field Data Preparation

The data collection stage is a very vital activity to ensure the output that will be obtained as well. The most appropriate technique for obtaining results that are similar to actual field conditions. The data required includes well profile and sand rate data, well production data before and after using the sand control pump, as well as economic data by looking at NPV (Net Present Value), IRR (Internal Rate of Return), and POT (Pay out Time).

Sandrate Calculation Data

Produksi		Lama Produksi	Gross Total	Gross	Kedalaman	Kedalaman	Volume pasir pada	Debit pasir	Volume
Awal	Akhir	(t)	(TG)	(G)	Akhir PPS	Akhir PPS	liner 5,5"	(Qpasir)	pasir/m^3 fluida
		days	m^3	m^3/day	m		m^3	m^3/day	
06-Jan-19	15-Mar-19	69	1086	15,739	622	596	0,330774912	0,004793839	0,0003046
22-Mar-19	24-May-19	64	923,2	14,425	620	600	0,25444224	0,00397566	0,0002756
28-May-19	06-Aug-19	71	1093,4	15,400	608	603	0,06361056	0,000895923	0,0000582
11-Aug-19	27-Jan-20	170	2621,3	15,419	609,5	593,3	0,206098214	0,001212342	0,0000786
03-Feb-20	31-Mar-20	58	960,8	16,566	621	595	0,330774912	0,005703016	0,0003443
06-Apr-20	05-Jun-20	61	1225,9	20,097	620	600	0,25444224	0,004171184	0,0002076
11-Jun-20	11-Aug-20	62	1187,7	19,156	622	598,5	0,298969632	0,004822091	0,0002517
15-Aug-20	20-Oct-20	67	1320,9	19,715	622	595	0,343497024	0,005126821	0,0002600
26-Oct-20	07-Jan-21	74	1431,5	19,345	620	597	0,292608576	0,00395417	0,0002044
14-Jan-21	16-Mar-21	62	1102,5	17,782	622	604	0,228998016	0,003693516	0,0002077
18-Mar-21	19-Apr-21	33	562,4	17,042	616,5	596,5	0,25444224	0,007710371	0,0004524
23-Apr-21	09-May-21	17	326,9	19,229	609,5	591	0,235359072	0,013844651	0,0007200
13-May-21	05-Jul-21	54	900,9	16,683	622	598,5	0,298969632	0,005536475	0,0003319
12-Jul-21	08-Oct-21	89	1156,7	12,997	620	596	0,305330688	0,003430682	0,0002640
12-Oct-21	25-Nov-21	45	739	16,422	622	595,5	0,337135968	0,00749191	0,0004562
Total		996	16639,1	256,018			4,035453926	0,076362653	0,0044171
rata - rata				17,1				0,005090844	

Figure 1. Well Production Data (Before Using the Sand Control Pump

The sand height at the MA is assumed to be on January 11, 2022

- Volume of sand sucked in by the pump
  = Volume of sand/m^3 of fluid × TG until January 11^{th}. 2022 × %puff……………………………..……………..(1)
  = 0.00024 x 790 x 55,88%
  = 0.10707 m³

- Efficiency of pump filters

Because the Sand Control Pump has a filter in the intake channel, which functions to prevent the amount of sand being sucked in by the pump. So the filter efficiency is obtained at :

$$L_{penampang} = \pi \times d_{in} \times filter\ length \quad (2)$$

$$L_{hole} = \frac{\pi}{4} \times d_{mm} \times \text{number of holes} \quad (3)$$

$$\text{Eff filter} = \frac{L_{penampang} - L_{hole}}{L_{penampang}} \times 100\% \quad (4)$$

$$\text{Eff filter} = \frac{((\pi \times 4'' \times 25{,}4 \times 260) - (\frac{\pi}{4} \times 5^2 \times 1026))}{\pi \times 4'' \times 25{,}4 \times 260} \times 100\%$$

Eff filter = 76%

- Volume of sand entering as of January 11th. 2022
  Vsand entering MA = Vsand sucked in by the pump x (1-Eff filter) ……..…………… …………………………..(5)
  Vsand entering MA = 0,10707 x (1-76%)
  Vsand entering MA = 0,02599 m^3

- Sand height at MA as of January 11th. 2022

$$\text{Sand height at MA} = \frac{V_{sand\ entering\ MA}}{L_{penampang\ MA}} \quad (6)$$

$$\text{Sand height at MA} = \frac{0{,}2599}{\frac{\pi}{4} \times d_{in}^2}$$

$$\text{Sand height at MA} = \frac{0{,}2599}{\frac{\pi}{4} \times (2{,}441 \times 0{,}0254)^2}$$

Sand height at MA = 8,61 m

The height of sand that can enter the MA until January 11^{th}. 2022 is 8,61 meters

Sand level on the liner as of January 11th. 2022

- Volume of filtered sand = Volume of sand sucked in by the pump x Eff filter…………………… ………………..(7)
  Volume of filtered sand = 0,10707 m^3 x 76%
  Volume of filtered sand = 0,08108 m^3
- Vsand is not sucked in = Vsand / m^3 of fluid x TG until 11-01-22 x % not sucked in……… …………………………(8)
  Vsand is not sucked in = 0.00024 m^3 x790 x 44.12%
  Vsand is not sucked in = 0.08452 m^3
- Vsand falls to the bottom of the liner =Volume of filtered sand+Vsand is not sucked in……… ……………………..(9)
  Vsand falls to the bottom of the liner = 0,08108 m^3 + 0,08452 m^3
  Vsand falls to the bottom of the liner = 0,16561 m^3
- Sand level on the liner as of January 11 2022
  $$\text{Height of sand on liner} = \frac{V_{\text{sand falls to the bottom of the liner}}}{L_{\text{penampang liner}}} \quad \ldots(10)$$
  $$\text{Height of sand on liner} = \frac{0{,}16561\text{m}^3}{\frac{\pi}{4}\times d_{in}^2}$$
  $$\text{Height of sand on liner} = \frac{0{,}16561\text{m}^3}{\frac{\pi}{4}\times(5{,}012\times0{,}0254)^2}$$
  Height of sand on liner =13,02 m

The height of the sand falling to the bottom of the liner until January 11 2022 is 13.02 meters. Based on this data, we can further analyze the right pump size to use.

Sand forecast meets MA

- Volume MA 3 joint
  $$V_{MA} = \frac{\pi}{4} d_{in}^2 \times h \quad \ldots(11)$$
  $$V_{MA} = \frac{\pi}{4}(2{,}441 \times 0{,}0254)^2 \times 25{,}8$$
  V_{MA} = 0,077856 m^3
- Sand forecast meets MA (tMA)
  $$t_{MA} = \frac{V_{MA}}{Q_{sand}\times\%_{puff}\times(1-Eff\ filter)} \quad \ldots(12)$$
  $$t_{MA} = \frac{0{,}077856}{0{,}00509084 \times 55{,}88\% \times (1-76\%)}$$
  $$t_{MA} = 112{,}7\ day$$

The volume of sand sucked in by the pump is 0.077856 m3 and falls into the MA, which will fill the MA joint on the 113th day after the well is produced again. Namely on May 4, 2022, to be precise.

Estimate sand that fills the liner to the end of the concatenation

- Volume of liner to end of concatenation
  $$V_{liner} = \frac{\pi}{4} d_{in}^2 \times h \quad \ldots(13)$$
  $$V_{liner} = \frac{\pi}{4}(5{,}012 \times 0{,}0254)^2 \times (620-594{,}3)$$
  $$V_{liner} = 0{,}326958\ m^3$$
- Estimated that the sand in the liner will be accommodated up to the end of the concatenation
  $$t_{liner} = \frac{V_{liner}}{(Q_{sand}\times\%_{falling\ sand})+(Q_{sand}\times\%_{puff}\times Eff\ filter)} \quad \ldots(14)$$
  $$t_{liner} = \frac{0{,}326958}{(0{,}00509084\times44{,}12\%)+(0{,}00509084\times55{,}88\%\times76\%)}$$
  $$t_{liner} = 74{,}3\ days$$

The volume of sand accommodated in the liner is 0.326958 m3 where the height can reach the end of the pump series on the 74th day after the well is produced. That is exactly March 26, 2022.

Sand forecast meet MA

- Volume MA 2 joint
  $$V_{MA} = \frac{\pi}{4} d_{in}^2 \times h$$
  $$V_{MA} = \frac{\pi}{4}(2{,}441 \times 0{,}0254)^2 \times 17{,}2$$
  V_{MA} = 0,051904 m^3

- Sand forecast meets MA (tMA)

  $t_{MA} = \frac{V_{MA}}{Q_{sand} \times \%_{puff} \times (1 - Eff\ filter)}$

  $t_{MA} = \frac{0{,}051904}{0{,}00509084 \times 55{,}88\% \times (1 - 76\%)}$

  t_{MA} = 75,2 days

  So the sand that is sucked in by the pump and falls into the MA will fill the MA joint on the 75th day after the well is produced again. Namely on March 27, 2022, to be precise.

Estimated sand filling the liner to the end of the concatenation

- Liner volume to the end of the concatenation

  $V_{liner} = \frac{\pi}{4} d_{in}^2 \times h$

  $V_{liner} = \frac{\pi}{4} (5{,}012 \times 0{,}0254)^2 \times (620 - 585{,}7)$

  $V_{liner} = 0{,}436368 m^3$

- Estimated that the sand in the liner will be accommodated up to the end of the concatenation

  $t_{liner} = \frac{V_{liner}}{(Q_{sand} \times \%_{falling\ sand}) + (Q_{sand} \times \%_{puff} \times Eff\ filter)}$

  $t_{liner} = \frac{0{,}436368}{(0{,}00509084 \times 44{,}12\%) + (0{,}00509084 \times 55{,}88\% \times 76\%)}$

  t_{liner} = 99,2 days

  So the sand collected in the liner can reach the end of the pump circuit on the 99th day after the well is produced. That is, to be precise, April 20 2022.

Based on the calculation results above, it can be seen that the estimated height of sand falling to the bottom of the liner until January 11 2022 is 13,02 meters. With a pump size, 2 joint mud anchors fill the liner in around 99 days, while 3 joint mud anchors take around 74 days. Judging from the large volume accommodated, 3 joint mud anchors > 2 joint mud anchors, but this has big consequences, because the installation of mud anchors with up to 3 joints is not correct. Because by installing long mud-anchors, the pump circuit can quickly become pinched by sand deposits that cannot be sucked up by the pump. Even if the pump circuit is forced to be unplugged, the pump circuit can break due to excessive tensile stress so that the pump will be damaged. Therefore, it is better to install 2 joints mud anchor.

Well Production Data

Table 2. Well Production Data Before and After using sand control pump

Production		Production Tme (t)	Before		After	
Start	End		Gross (BFPD)	Gross Total (BFPD)	Gross (BFPD)	Gross Total (BFPD)
06-Jan-19	15-Mar-19	69	98,7	6809,2	99,0	6834,2
22-Mar-19	25-May-19	64	90,4	5788,5	90,8	5809,7
28-May-19	06-Aug-19	71	97,8	6855,6	96,9	6880,8
11-Aug-19	27-Jan-20	170	98,4	16435,6	97,0	16495,8
03-Feb-20	31-Mar-20	58	105,7	6024,2	106,1	6046,3
06-Apr-20	05-Jun-20	61	126,0	7686,4	126,5	7714,6
11-Jun-20	11-Aug-20	62	120,1	7446,9	120,6	7474,2
15-Aug-20	20-Oct-20	67	123,6	8282,0	124,1	8312,4
26-Oct-20	7-Jan-21	74	123,0	8975,5	121,7	9008,4
14-Jan-21	16-Mar-21	62	109,7	6912,7	110,1	6938,0
18-Mar-21	19-Apr-21	33	106,9	3526,2	107,2	3539,2
23-Apr-21	09-May-21	17	120,6	2049,7	121,0	2057,2
13-May-21	05-Jul-21	54	104,6	5648,6	105,0	5669,4
12-Jul-21	08-Oct-21	89	81,5	7252,5	81,8	7279,1
12-Oct-21	25-nov-21	45	103,0	4633,5	103	4650,5

Based on the data above, it is known that before using the sand control pump the fluid flow rate produced was small, namely 1000 – 2000 m3/day, because it had a high amount of sand so blockages occurred in the pump, if this is left

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unchecked it will cause the production rate to decrease further and reduce quality. fluid. After the SP well uses a sand control pump, the fluid flow rate produced increases, namely 5000 - 16000 bfpd, so that production capacity increases because the amount of sand in the pump decreases and blockages do not occur. Reducing the amount of sand when production takes place can reduce the frequency of well service, while reducing the frequency of well service means that the lifetime of the well increases. Thus, the work of this well service activity can be said to be successful because there can be an increase in fluid.

Parameter		Unit	Total	Pre-2019	2019	2020	2021	2022
Sales Oil		BBL	41.557,85	-	13.714,84	13.714,84	13.714,84	413,32
Oil Price		US$/BBL	180,00	-	45,00	45,00	45,00	45,00
Expenditure	Sunk Cost	US$	-	-	-	-	-	-
	Capex	US$	110.500,00	110.500,00	-	-	-	-
	Tangibel	US$	-	-	-	-	-	-
	Intangibel	US$	110.500,00	110.500,00	-	-	-	-
	Opex	US$	492.044,99	-	162.383,74	162.383,74	162.383,74	4.893,76
	ASR	US$	400,00	-	100,00	100,00	100,00	100,00
Total Expenditure		US$	492.444,99	-	162.483,74	162.483,74	162.483,74	4.993,76
Depresiasi		US$	-	-	-	-	-	-
Gross Revenue		US$	1.870.103,42	-	617.167,95	617.167,95	617.167,95	18.599,58
FTP	0,2	US$	374.020,68	-	123.433,59	123.433,59	123.433,59	3.719,92
Gross after FTP		US$	1.496.082,74	-	493.734,36	493.734,36	493.734,36	14.879,67
Cost Recovery Calculation								
	Depresiasi	US$	-	-	-	-	-	-
	Capex Intangible	US$	110.500,00	110.500,00	-	-	-	-
	Opex	US$	492.044,99	-	162.383,74	162.383,74	162.383,74	4.893,76
	ASR	US$	400,00	-	100,00	100,00	100,00	100,00
	Expense to be Recovered	US$	602.944,99	110.500,00	162.483,74	162.483,74	162.483,74	4.993,76
	Prev year Unrec Cost	US$	-	-	-	-	-	-
	total	US$	602.944,99	110.500,00	162.483,74	162.483,74	162.483,74	4.993,76
	Available Fund for CR	US$	1.496.082,74	-	493.734,36	493.734,36	493.734,36	14.879,67
Total Cost Recovery (paid this year)			492.444,99	-	162.483,74	162.483,74	162.483,74	4.993,76
Equity to be split			1.003.637,75	-	331.250,61	331.250,61	331.250,61	9.885,91
Contraktor								
	FTP	US$	-	-	-	-	-	-
	Equity	US$	716.884,11	-	236.607,58	236.607,58	236.607,58	7.061,36
	DMO Volume	US$	333.947,04	-	110.208,56	110.208,56	110.208,56	3.321,35
	DMO Free	US$	333.947,04	-	110.208,56	110.208,56	110.208,56	3.321,35
	DMO Loss	US$	-	-	-	-	-	-
	Taxable Income	US$	716.884,11	-	236.607,58	236.607,58	236.607,58	7.061,36
	Tax	US$	315.429,01	-	104.107,34	104.107,34	104.107,34	3.107,00
	Income after Tax	US$	401.455,10	-	132.500,25	132.500,25	132.500,25	3.954,36
Contractor Cash Flow Calculation								
	Cash in	US$	1.209.329,10	-	399.091,33	399.091,33	399.091,33	12.055,12
	Cash out	US$	918.374,00	110.500,00	266.591,08	266.591,08	266.591,08	8.100,76
Contractor Net Cash Flow		US$	290.955,10	- 110.500,00	132.500,25	132.500,25	132.500,25	3.954,36
Discount Factor		10%		1,10	1,10	1,21	1,33	1,46
Discounted Net Cash Flow		US$	231.754,84	- 100.454,55	120.454,77	109.504,33	99.549,40	2.700,88
Government Entitlement								
	FTP	US$	374.020,68	-	123.433,59	123.433,59	123.433,59	3.719,92
	Equity	US$	286.753,64	-	94.643,03	94.643,03	94.643,03	2.824,55
	Tax	US$	315.429,01	-	104.107,34	104.107,34	104.107,34	3.107,00
GOI Take		US$	976.203,33	-	322.183,96	322.183,96	322.183,96	9.651,46
GOI Take percentage,%			52%		52%	52%	52%	52%

Parameter Keekonomian		
NPV @10% Kontraktor	221.709	USD
IRR @10% Kontraktor	106,50 %	%
POT	1,83	Tahun
Contractor Take	290.955	USD
GOI Take	976.203	USD
GOI Take Percentage	52,13 %	%

Figure 2. Economic Parameter Data

Based on the table above, the discount rate used is 10%. This project is feasible. So the NPV is obtained at 221.709 USD. This value can be said to be feasible because the NPV value is greater than zero so that a project that will be carried out by the company is feasible to be implemented. With project success (IRR) reaching 106%, the IRR value is already greater than the discount factor of 10% so it is decided that the investment is worth implementing. The pay out time value or return on investment invested will return after 1,83 years, at the end of 2019.

IV. CONCLUSION

From the results of the research and discussion related to the title of the thesis, the author draws the following conclusions:

1. The sand rate that causes potential downhole problems in wells is around 13,02 meters. The size of the pump used is 2 joint mud anchors, so that the concatenation is not pinched by high sand deposits and does not damage the pump.
2. In the comparison table before and after using the sand control pump, it can be seen that there was an increase in production rate of 1 barrel after using the sand control pump. so that, well service activities are successful because fluid increases can occur.
3. Based on the results of economic indicators on the SP well with an oil price of 45 US$ / bbl, the NPV was obtained at 221.709 USD. With project success (IRR) reaching 106%. The payout time is 1,83 years. From the three economic indicators, it can be concluded that SP wells obtain positive NPV and high IRR from the discount rate. so that the use of a sand control pump on a sucker rod pump (SRP) in SP wells is feasible because it has economic value.

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