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PROGRESSING CAVITY PUMP AS A SOLUTION TO INCREASE PRODUCTIVITY OF HIGHLY VISCOUS OIL WELLS WITH SAND PRODUCTION: A CASE STUDY OF FIELD X

(Progressing Cavity Pump sebagai Solusi untuk Meningkatkan Produktivitas Sumur Minyak Sangat Berat dengan Produksi Pasir: Studi Kasus Lapangan X di Indonesia)

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ABSTRAK

Lapangan minyak utama di Indonesia telah mengalami penurunan besar-besaran dalam produksi, disertai dengan produksi pasir berlebih yang merugikan bagi integritas sistem produksi. Produksi pasir telah dikenal untuk meningkatkan potensi erosi, mengurangi masa pakai peralatan sumur, dan juga dikenal menutup sepenuhnya sumur karena penumpukan pasir di sumur. Progressive Cavity Pump telah diusulkan sebagai solusi untuk menjawab masalah ini, karena sifatnya yang dapat menangani banyak jenis cairan dan bahkan padatan. Idenya kemudian diuji ke bidang Alabaster dewasa di mana sebagian besar sumur telah ditutup karena masalah pasir yang berlebihan dan produktivitas yang rendah. Perlu dicatat bahwa setelah memasang PCP, pemodelan produksi menunjukkan kemungkinan mempertahankan produksi melalui aplikasi PCP, di mana produksi meningkat sekitar 120 STB / hari. Meskipun PCP telah membuktikan keefektifannya, penting untuk dicatat bahwa teknik mitigasi pasir tambahan diperlukan untuk menjaga integritas fasilitas setelah beberapa tahun produksi.

Kata Kunci: *Progressing Cavity Pump, pengangkatan buatan, minyak berat*

ABSTRACT

Major oil fields in Indonesia have been experiencing massive decline in production, accompanied by excessive sand production that is not beneficial to the integrity of the production system. Sand production has been known to increase the potential of corrosion, reducing lifetime of well equipment, and also known to shut in wells completely due to sand buildup in wellbore. Progressive Cavity Pump has been proposed as a solution to withstand these complications, due to its nature that can handle many types of fluids and even produced solid. The idea is then tested to a mature Alabaster field where the majority of the wells have been shut in due to excessive sand problem and low productivity. It is worth nothing that after installing the PCP, production modeling indicates possibility of sustaining production through the application of PCP, where the production increases around 120 STB/ day. Although PCP has proven its effectiveness, it is important to note that auxiliary sand mitigation techniques is required to maintain facilities integrity after several years of production.

Keywords: Progressing Cavity Pump, Pengangkatan Buatan, heavy oil

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I. INTRODUCTION

In the oil and gas industry, there are two methods commonly used to produce reservoir fluids to the surface, namely the method of natural flow and the artificial lift method. Wells can produce naturally flow if the reservoir pressure in formation is higher than the base hydrostatic well so that it can push the reservoir fluid to the surface. But over time the reservoir pressure will decrease so that it is no longer able to lift the reservoir fluid naturally to the surface and eventually the natural spray production will stop. In this condition, an artificial lift method is needed to push the fluid and optimize production again.

Artificial lifting methods that are widely used in the petroleum industry are sucker rod pump (SRP), hydraulic pumping units (HPU), electric submersible pumps (ESP), progressive cavity pumps (PCP), gas lifts and elevator plungers. In choosing the type of artificial lift must be seen from the condition of the reservoir, the condition of the borehole, conditions on the surface and others. The lifting method that will be discussed in this final project is progressive cavity pump. This method of lifting using PCP uses a screw type pump consisting of a spiral shaped rotor and a stator which is also spiral in it, but is designed to have a spiral pitch distance that is 2 times greater than the rotor pitch. PCP works by providing additional pressure on the reservoir fluid so that it can flow to the surface.

In PCP planning (Echavaria et al, 2015 & Bratu et al, 2005) well productivity is very influential because the rate of production of the fluid will have an impact on the selection of the type and size of the pump. This is because each pump has a different production capacity depending on the type and size of the pump. So from that the goal to be achieved in this final project is to calculate the optimization of the PCP production rate in well X.

II. DATA AND METHOD

Alabaster Field is located in the territory of Jambi Province which has a fairly extensive operating area. The production field in the Jambi Province area is divided into 2 (two), namely the South Jambi Production Field and North Jambi Production Field. Field X is included in the North Jambi Production Field area. Field X has 43 wells to date. Well Y is then used as a prototype for PCP installation and design with the following data (Tabel 1).

The following table provides an insight well completion data (Table 2).

III. RESULT AND DISCUSSION

Nodal system analysis is done by checking at the intersection between the curve of IPR and TPR to determine the ability of flow of a well. Inflow Performance Relationship curve to determine the ability of the optimum production rate in well Y using the Vogel method because this well only produces 2 fluid phases, namely oil and water. While the curve of Tubing Performance Relationship as a determination of the ability of the fluid reservoir to flow from the bottom of the well to the surface using the Hagedorn Brown method (Wanfu et al, 2012). In well Alabaster-1 known reservoir pressure (P_r) is 487,127 psia, well bottom flow pressure (P_{wf}) is 143,775 psia and the production rate is 119.5 BFPD.

Based on the results of the Inflow Performance Relationship curve, the maximum production rate of well Y is 138.1 BFPD at the bottom well flow pressure is zero. But in Figure 1 the IPR and TPR curves do not intersect, so the fluid cannot flow to the surface. This happens because the pump X will be replaced by the well so that it is assumed that at that time the SRP pump was being removed where well X was not using artificial lift which resulted in the fluid not being able to flow to the surface.

Table 1
Reservoir fluid parameters of well Y

No	Parameters	Value	Unit
1	Reservoir Pressure	487.127	psi
2	Flowing Bottom Hole Pressure	143.775	psi
3	Temperature (T)	114.6	°F
4	Water Cut	48	%
5	Basic Sediment	0.25	%
6	API *gravity*	21.6	°API
7	Gas SG	0.64	
8	Water SG	1	
9	Oil SG	0.9315	
10	Oil Viscosity	5.2	cP

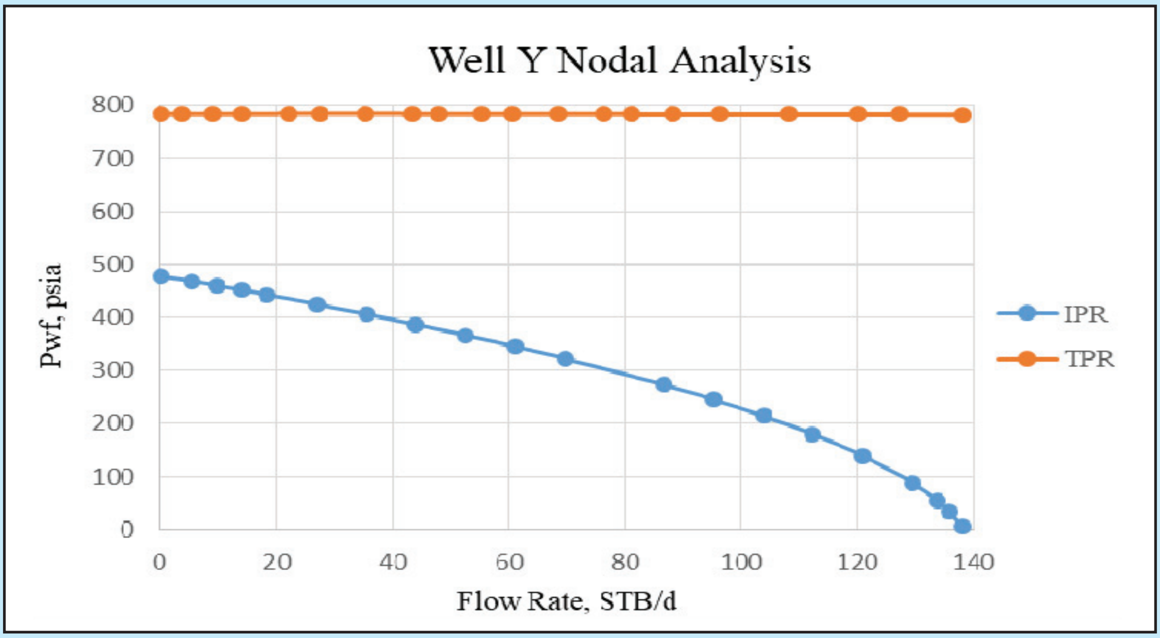

Figure 1
Nodal analysis of well Y pre-PCP installation.

The choice of pump type is based on the expected production rate, which is equal to or exceeds the maximum production rate of 138.1 BFPD. From Figure 2 the type of PCM 312-24E2000 pump is selected with a diameter size of 3.875 “, the nominal rate is 149.81 bbl/d, and the pump rotation speed is 100 rpm.

In Figure 3 it can be seen the depiction of the results of the calculation of the IPR and TPR curves of well X after the installation of the PCP pump. After the PCP pump is installed the IPR and TPR curves intersect at a production rate of 126.2 STB / d with a pressure of 111.7 psia. Due to modeling complexity, sand production is not modelled even though normal consensus would assume that as fluid production increases, sand production would increase notably in unconsolidated reservoir.

Pump lifetime predictions are carried out by calculating the future IPR curve. In Figure 4.5 the future IPR curve of well X is assumed to be a pressure drop of 3 (three) percent in each year based on historical data from the well. This decrease in pressure is influenced by the drive mechanism of the reservoir in this well, namely the water drive. Based on the results of the calculation of the future IPR curve, the optimum production rate of wells in each year can be seen as shown in Table 3.

Table 2
Well Completion Properties of Well Y

No	Parameter	Value	Unit
1	Well Depth	3615.66	ft
2	Perforation Top	1516	ft
3	Perforation Bottom	1522.38	ft
4	Mid Perfo	1519.1	ft
5	Static Fluid Level (SFL)	533.1	ft
6	Dynamic Fluid Level (DFL)	1143.3	ft
7	ID Tubing	2.441	inch
8	OD Tubing	2.875	inch
9	ID Casing	8.775	inch
10	OD Casing	9.625	inch
11	Fluid Production Before Cease Production	119.5	BFPD

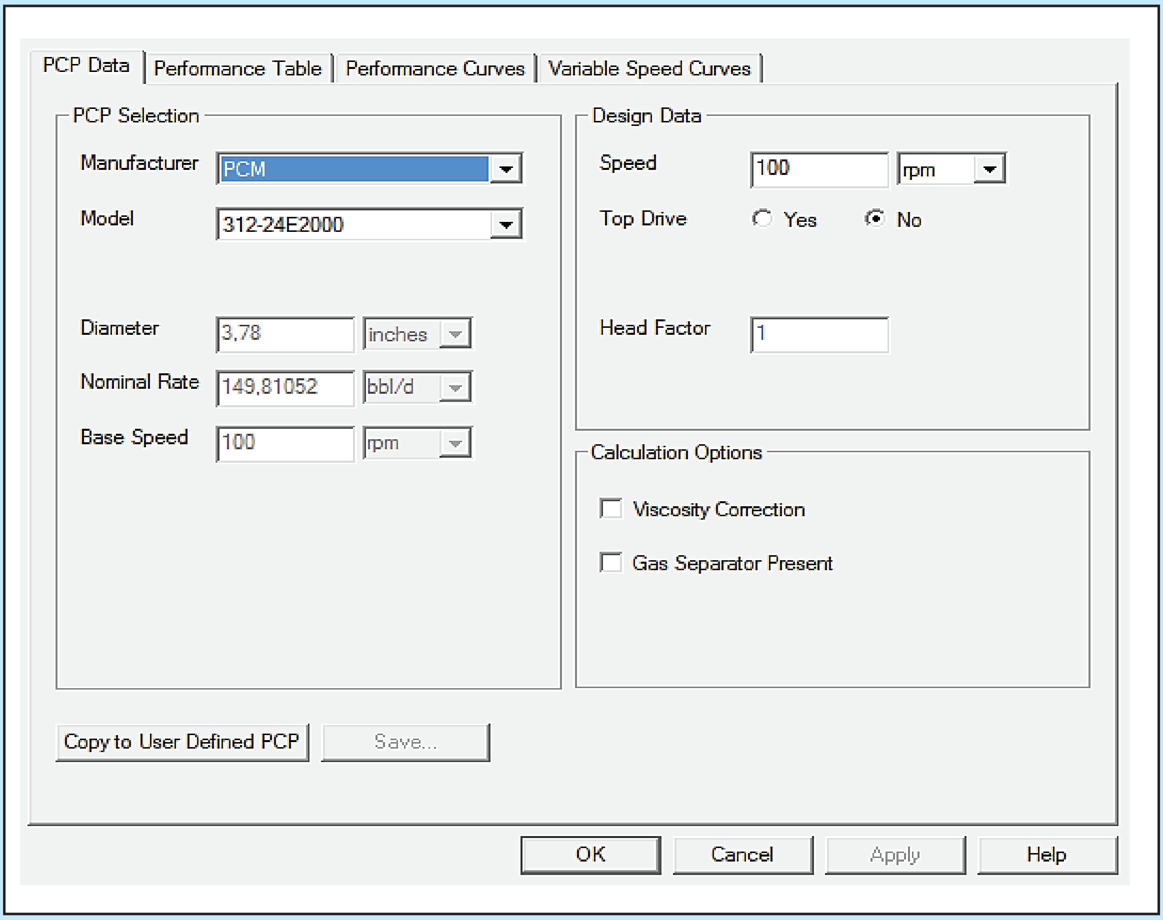

Figure 2
PCP selection of well Y.

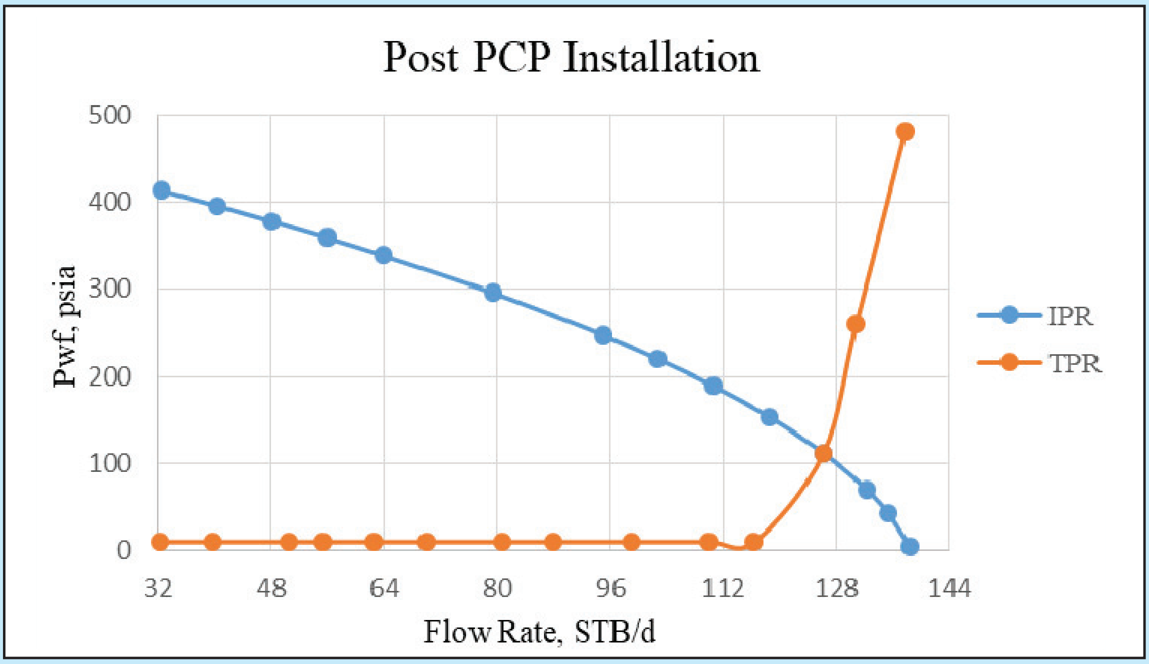

Figure 3
Nodal analysis of well Y post PCP installation.

Table 3
Lifetime analysis of PCP in well Y

Tahun	P (psia)	Q (STB/d)	Operating Point (STB/d)	
			P (psia)	Q (STB/d)
2017	4.8	138.3	111.7	126.2
2018	4.7	129.8	64	124.6
2019	4.8	121.7	9.6	121.4

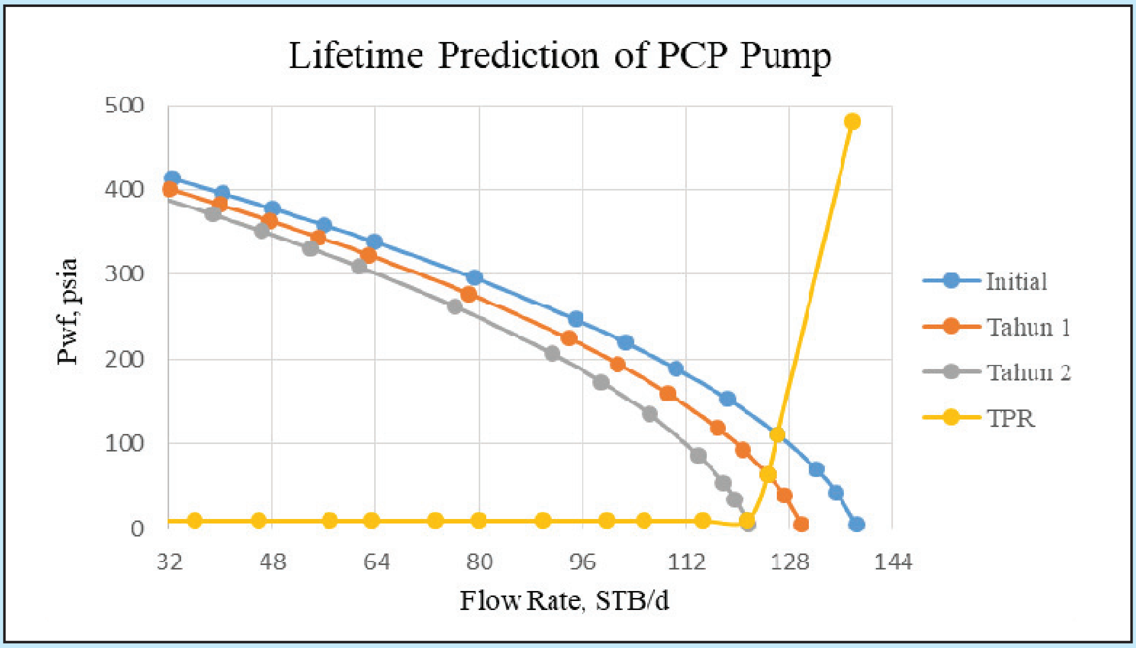

Figure 4
Nodal analysis for PCP lifetime in well Y.

IV. CONCLUSIONS

In well Y the main problem that occurs is sand where the sand content always increases with time. Artificial lifts on the X wells that are SRP can only hold sand content up to 0.25%, if it exceeds 0.25%, a replacement must be made because the SRP pump will be damaged and can inhibit the rate of production. Artificial appointments suitable for these conditions are Progressive Cavity Pump (PCP). The PCP pump can hold up to 0.5% of the sand. Therefore, in this final assignment the author made an optimization by designing the PCP pump for well X.

The PCP optimization design carried out for X wells is predicted to be able to produce only until the second year with 121.4 BFPD fluid production.

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