Tubing Optimization based on Simulation Tubing Size Sensitivity to Reservoir Pressure Drop

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Abstract— **Tubing is an important piece of equipment in natural flow production operations. The aim of this research is to select the optimum tubing diameter based on flow rate and usage period using nodal system analysis at well X. Inflow performance relationship (IPR) and tubing performance relation (TPR) analysis are the main factors in tubing optimization. The tool used for data processing uses Pipesim software. Based on the results of the simulation, processing and analysis, the researchers selected tubing with a size of 2.375 "to be used as production tubing at well X.**

Keyword: **Natural flow, nodal system analysis, tubing, inflow performance relationship, tubing optimization.**

I. INTRODUCTION

Natural flow well is a well that produces with driving force derived from reservoir pressure. Tubing is an important equipment in natural flow production operations. Oil and gas production forecasting is a very important application of the TPR model. With the knowledge of nodal analysis and material balance, it is possible to forecast future oil and gas production rates and cumulative production. In forecasting production, a series of average reservoir pressures, assumed between the bubble point and the voiding pressure[1]. A fundamental production issue for natural flow wells is the determination of tubing size. Tubing size, especially its diameter, is a factor that affects the flow of reservoir fluid from the hole to the surface. Variations in tubing size will be studied to assess their impact on well performance[2]. The inflow performance relationship (IPR) of an oil well is the ability of the well to flow fluid from the reservoir or the relationship between the flow rate and the bottom flow pressure of the well. IPR is also used to evaluate reservoir performance in production activities[3]. IPR correlations addressed the curvature of the inflow performance curves in case of solution gas drive oil reservoirs in which Pb is the initial reservoir pressure. Based on the literature survey, the most known IPR correlations can be subdivided into empirically and analytically derived correlations. Some of the most known empirical correlations are Vogel, Fetkovich, Kilns and Majcher, Wiggins, and Sukarno and Wisnogroho. Some of the most known analytical correlations are Wiggins and Archer and Del Castillo[4]. IPR is divided into several types including IPR single-phase, IPR two-phase, and IPR three-phase[5].

Some of the critical parameters that play an important role in determining well performance include tubing size, water cut, reservoir pressure, and wellhead pressure[2].

II. RESEARCH METHOD

The data used in this study are field data on the well X. This field data is divided into two parts of data, namely well integrity data and well test data.

The tool used for data processing is the Pipesim software. Data analysis based on simulation results and theoretical basis related to the topic and purpose of this study to obtain optimum tubing diameter for natural flow production[6].
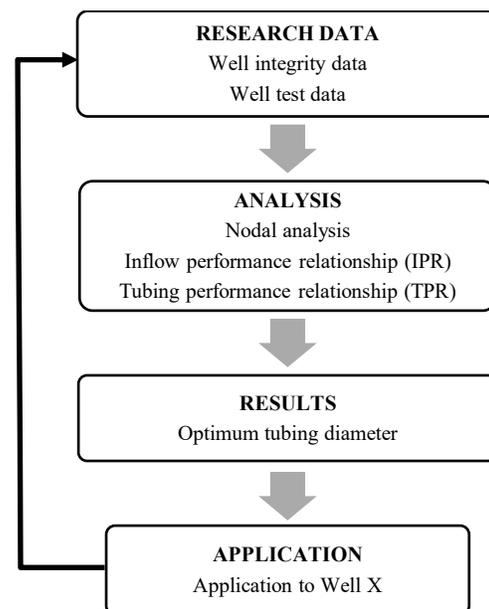

Fig. 1. Tubing optimization research diagram.

Analysis of well integrity data and well test data on the well X can be used as temporary results for the selection of tubing that will be used in the well X. The data obtained from the field

is analyzed with software to obtain analytical results, and the results of the analysis can be implemented in the field. Implementation of the results in the field will also result in data sustainability, this is the research cycle we can see in Diagram.

III. RESULT

1. Inflow Performance Relationship

The well test data needed to make the IPR curve include reservoir pressure (Pr) 4800 psi data, bubble point pressure (Pb) 4735 psi, bottom hole pressure (Pwf) 3692 psi and flow rate (q) = 6273 bbl/d. The AOFP or qmax value of the well is a theoretical condition in which the well can flow fluid with maximum discharge at flowing bottom hole pressure (Pwf) = 0 psi. For AOFP well FeyFurak is 6696 bbl/d which can be seen in Figure 4.1. The amount of AOFP is determined by the reservoir pressure value (Pr). The greater the value of reservoir pressure (Pr), a well will have a greater AOFP, which means that the well will have the potential to drain fluid better.
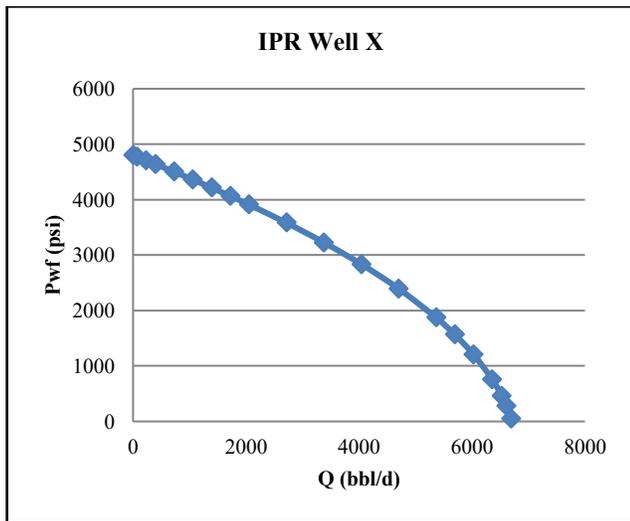

Fig. 2. IPR Well X.

2. Tubing Optimization

Optimization of tubing based on optimum flow rate. Tubing optimization can be done by simulating the sensitivity of the TPR curve to the IPR curve with a constant pwf of 3692 psi and wellhead pressure (pwh) of 300 psi. Grade tubing sizes include 1.05", 1.315", 1.660", 1.900", 2.063", 2.375", 2.875", 3.5" 4", and 4.5" (API 5CT, 2012). The simulation results of the sensitivity test between the TPR curve and tubing size to the IPR curve can be seen in table 1. The tubing size selected is based on the optimum flow rate with a production percentage of 40% - 60% of the AOFP value. Some of the selected tubing diameter sizes include: 1.66" tubing with a flow rate of 2713 bbl/d, 1.9" tubing with a flow rate of 3428 bbl/d, 2.063" tubing with a flow rate of 3880 and 2.375" tubing with a flow rate of 4636 bbl/d

Table 1.
Simulated Flow Rate

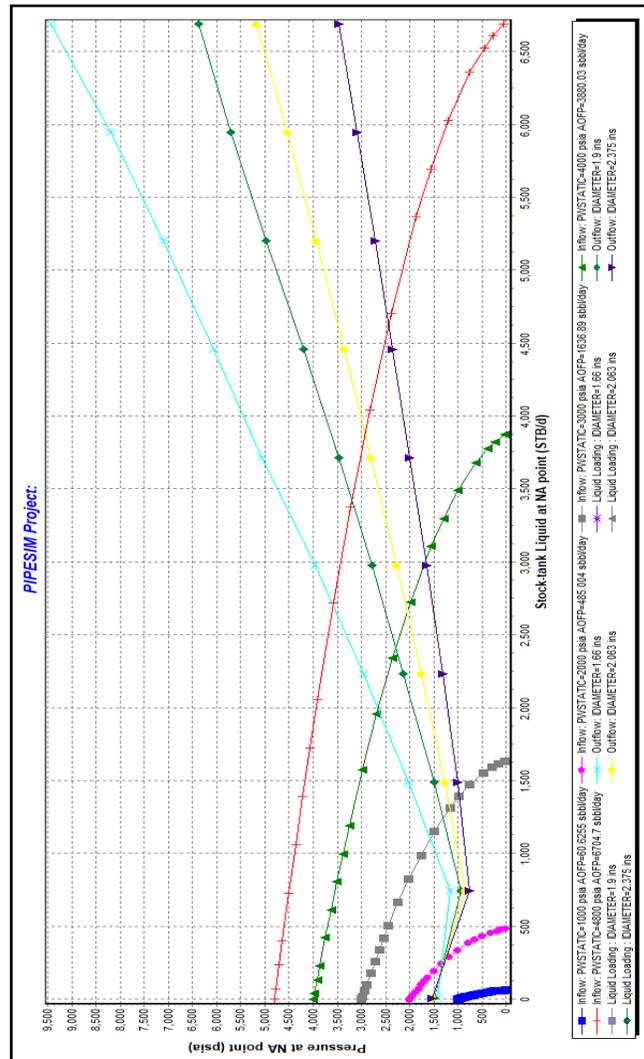| Well X			
Pwf (psi)	*Pwh (psi)*	*OD Tubing (in)*	*Q (bbl/d)*
3692	300	1.05	984
		1.315	1671
		1.66	2713
		1.9	3428
		2.063	3880
		2.375	4636
		2.875	5438
		3.5	5964
		4	6158
		4.5	6273

Fig. 3. Inflow performance relationship vs tubing performance relationship.

Table 2.
Simulation results of pressure drop to flow rate

Well X							
Pr (psi)	**Pwh (psi)**	**ID Tubing (in)**	**Reservoir Pressure Drop Simulation (psi)**				
			4800	**4000**	**3000**	**2000**	**1000**
4800	300	1.66	2713	1985	1087	257	0
		1.9	3428	2415	1236	280	0
		2.063	3880	2666	1316	291	0
		2.375	4636	3021	1402	297	0

3. Optimization of tubing based on usage period

The duration of use can be made based on the simulation of the reservoir pressure drop against the tubing. The tubing used in this study was selected based on the optimum flow rate including tubing with a diameter of 1.66", 1.9" tubing, 2.063" tubing, and 2.375" tubing. The simulation of decreasing reservoir pressure on the tubing can be seen in Figure 3 and the results of the flow rate (production) simulation can be seen in Table 2. Based on the simulation results in this study, tubing with a size of 2.375" was selected for use as production tubing because it fulfilled two criteria for tubing optimization, namely optimum flow rate and duration of use[7].

IV. CONCLUSION

Optimization of tubing production based on the optimum flow rate and usage period. Based on the optimum flow rate, the selected tubing includes 1.66" tubing, 1.9" tubing, 2.063" tubing, and 2.375" tubing. Continuing tubing optimization based on usage period and tubing selected for use is tubing with a diameter of 2.375" Tubing 2.375" is recommended for use in well X with the natural flow production method.

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