Optimation Pressure Loss to Oil Production System with Electrical Submersible Pump (ESP) at the Well A SW Field Bojonegoro, East Java

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Abstract. Study about oil and gas well A and SW fields have been conducted in Bojonegoro area, East Java Province. From the research, it is known that one of the constrain in oil and gas production process is a pressure drop, so that is necessary to set Electrical Submersible Pump (ESP) as an artificial lift pump at low pressure wells. It is needed to analyze the production well pressure as an effort to optimize the fluid production. It is in describe to relations between IPR (Inflow Performance Relationship) curve with TPR (Tubing Performance Relationship), are getting down point cut TPR curve with IPR curve, fluid rate its optimal, so need tubing's diameter variation and the number of stage pump ESP variation to can the most optimal fluid rate. Produced that to tubing variation are 2,441 ID is 876,729 bpd , 2,991 is 961,197 bpd , 3,476 id is 996 , 26 Bpd , while on the number of stage pump esp variation The most high is stage 400 with fluid rate 961,197 by comparison stage 338 it has value fluid rate 921,165 bpd , stage 200 it has fluid rate 827,889 bpd , and stage 169 has fluid rate 774,646 bpd .Of some variation tubing and stage pumps that has the most influence to fluid rate optimalize is the change number of stage pump..

1. Introduction

Bojonegoro is one of the cities located in the east java, which are production sites of oil and gas. One is in the SW field, which in the field there are several wells, one of which is well A. wells production in the field are generally scattered throughout the field. Each well has a production value of diverse circumstances which very good affect oil production. So the company perform a method that petroleum can be produced optimally By using a physical approach.

Formation fluid flow from the reservoir to the surface of the well passes through two stages, namely the flow of fluid from the reservoir to the bottom of the well through porous rock and then the flow of fluid from the surface to the bottom of a well past the vertical pipe media. Analyzes the relationship between fluid flow from the formation to the bottom of the well and the fluid flow from the bottom of the well to the surface of the well can be used to forecast oil production at a well.

Basically the fluid flow in oil production to make it to the surface pass through two phases: initial is the flow of fluid from the formation to bottom of well through porous media one of which is the reservoir rock , and continued with fluida flowing from the bottom of the well to the surface of the well through the media vertical pipes called tubing.

1.1. Fluid Flow of Formation To Basics wells

The ability of a well to produce can be described with IPR curve is represented as the relationship between the production rate of fluid flow to the bottom hole flow pressure (PWF) (Mahenda , 2014). Productivity Index Index is used to denote the ability of a well that is producing at certain conditions . It is expressed as the ratio between the production rate of the well in the bottomhole flowing pressure (PWF) certain differences bottomhole pressure at static state (Pr) and the well pressure during a flow (PWF) is expressed in equation (1)

$$q_0 = (\text{Pr} - pwf)PI = \frac{KA}{\mu}(\text{Pr} - Pwf) \tag{1}$$

When found the flowing fluid is a combination of fluid one phase and fluid two-phase , there will be conditions of reservoir pressure (Pr) is greater than the pressure bubble point (Pb) and the pressure flowing bottomhole (PWF) will decrease to less than Pb (Vogel , 1967) , so it can be determined by equation (2) as follows .

$$q_0 = q_{max}\left(1 - 0{,}2\frac{pwf}{pr} - 0{,}8\left(\frac{pwf}{pr}\right)^2\right)$$

(2)

IPR curve will be found on a comparison between the flow rate at bottomhole flowing pressure as shown in Figure 1
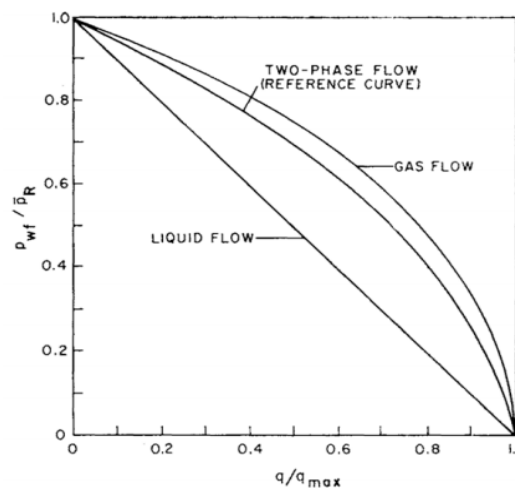

Figure 1. IPR Models (Vogel, 1968)

1.2. Flow in pipe

Fluid flows from the bottom of the well to the surface past the media pipeline , the vertical pipe is usually placed under the surface called tubing , in this case used the principle of a pressure gradient derived from the energy equation by using the principles of thermodynamics , analysis of pressure loss in vertical pipes can be approximated by the laws of thermodynamics which can be represented by Figure 2 .
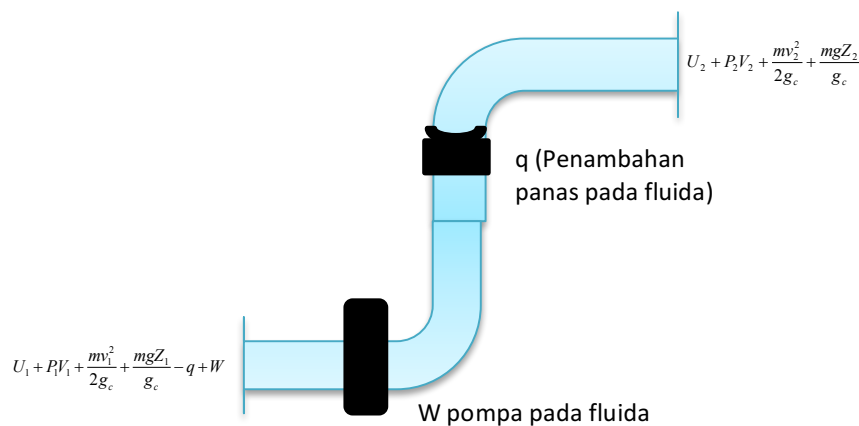

$$U_2 + P_2V_2 + \frac{mv_2^2}{2g_c} + \frac{mgZ_2}{g_c}$$

q (Penambahan panas pada fluida)

$$U_1 + P_1V_1 + \frac{mv_1^2}{2g_c} + \frac{mgZ_1}{g_c} - q + W$$

W pompa pada fluida

Figure 2. Equilibrium of energy

$$U_1 + P_1V_1 + \frac{mv_1^2}{2g_c} + \frac{mgZ_1}{g_c} - q - W_s = U_2 + P_2V_2 + \frac{mv_2^2}{2g_c} + \frac{mgZ_2}{g_c} \qquad (3)$$

And equation (3) lowered into the equation (4)

$$\frac{dP}{dZ} = -\left(\frac{g}{g_c}\right)\rho - \frac{\rho v dv}{g_c dZ} - \frac{\rho dLw}{dZ} \qquad (4)$$

and get the results of the analysis which can be seen in equation (4) , there are three components of the equation (4), namely :

a. Elevation component

$$\left(\frac{dP}{dZ}\right)_{eL} = \frac{g}{g_c}(\rho) \qquad (4.a)$$

b. Velocity Component

$$\left(\frac{dP}{dZ}\right)_{acc} = \frac{\rho v dv}{g_c dZ} \qquad (4.b)$$

velocity components are usually always ignored in the calculation of the pressure gradient.

c. Friction Component

$$\left(\frac{dP}{dZ}\right)_f = \frac{d.Lw}{dZ}(\rho) = \frac{f\rho v^2}{2g_c d} \qquad (4.c)$$

Equation (4) can be expressed

$$dLw = \frac{P_1}{\rho} - \frac{P_2}{\rho} ;$$

with might be called due to friction . We can connect the equations (4.b) and (4.c) with dz we consider dL as assumptions vertical pipe, then becomes :

$$dp = \frac{fL\rho v^2}{2g_c d}$$

$$P_1 - P_2 = \frac{fL\rho v^2}{2g_c d}$$

$$\Delta p = \frac{fL\rho v^2}{2g_c d} \qquad (5)$$

Pressure loss due to elavasi is 0 because the sect is a vertical flow , as well as the speed is very small because the cross-sectional area is constant , so it can be expressed in the analysis of energy loss due to the friction is :

$$h_f = \frac{fLv^2}{2g_c d} \qquad (6)$$

With a conversion factor entered the equation to make it consistent dimensions.

Analysis of fluid flow in a vertical pipe can be represented by the TPR curve I Tubing Relathionship performance) .In the manufacture of TPR curve in need of equation (5)

• Where in the calculation of the pressure loss approximated by the equation (5)

• discharge pressure value can be approximated by the equation

$$P_1 = Pwh + \Delta P$$

In calculating the intake tubing pressure value can be approximated by

$$P_2 = P_1 - (\frac{\rho_{fsc} \times h}{808,314}) \times St$$

In calculating the intake bottomm of well can be approximated by

$$P_3 = P_2 + 0,433 \times Pwh$$

2. Methods

2.1 IPR and TPR Analysis

So from the relationship shown in Figure 2 is obtained that oil production in production wells can be predicted by a curve of intersection between the curves IPR with TPR curve. Basically the analysis of the relationship between TPR and IPR curve is often called nodal analysis, where the nodal analysis in this study is the connection between a porous medium with vertical media (tubing) with the connecting point is PWF.
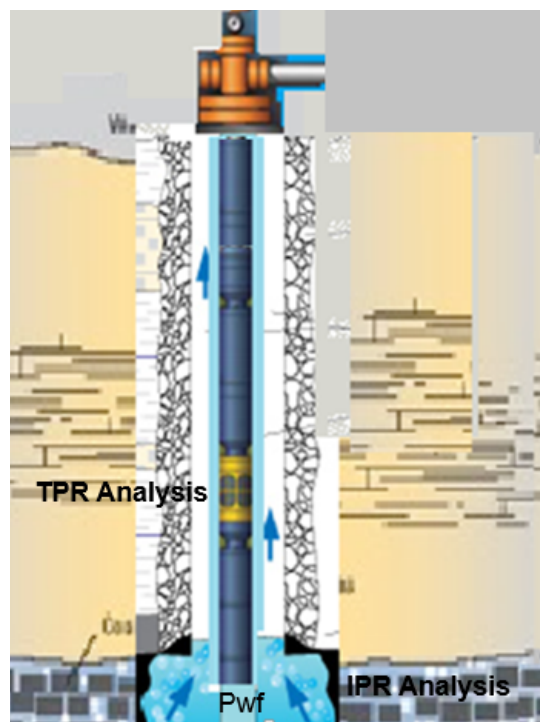

Figure 3. Analysis for Well Production

Nodal system analysis is required in order to:

1. Analyzing the behavior of the reservoir fluid flow at each well system components to determine the influence of each of these components of the well system as a whole.

2. Combine reservoir fluid flow behavior throughout the components so as to estimated production rate of the well.

In the analysis of the pressure loss in vertical pipes (tubing), the relationship between IPR and TPR important to do in the determination of oil production, caused by the intersection of the two curves can be seen the value of the rate of optimal fluid, the IPR curve called sebgai curve inflow derived from nature, ie the curve that is based with the ability reservoir rocks, while the TPR curve (outflow) is the curve that is constituted with human behavior untukk obtain optimal flow rate of a fluid. In determining the outflow curve in this case been a nodal system for submerged pump wells (ESP) where the dot is located nodalnya bottom wells (Yohana, 2010).

• In determining the outflow curve can be influenced by several aspects, and aspects of the possible in influencing the productivity of wells that need to be further analyzed one of which will be discussed in this case is

a. Diameter Tubing influence on TPR

b. Stage Pumps influence on the curve TPR

3. Analysis and Discussion

Tabel 1. Well A Data

Parameter	
Depth *(Ft)*	6218
SFL (Ft)	1000
WFL(Ft)	3900
Sg oil	0,8592
Sg water	1,125
WC (water Cut)(%)	0,24
API	33
Q liquid(Bpd)	836
Sg Oil	0,8592
T (Temperatur)(^{0}F)	180
Pb (Bubble Point) (psi)	683
tekanan Atmosfer (psi)	14,7
Densitas gas (lbm/cu ft) ρ	8,25
Viskositas liquid (cp) μ_{liquid}	0,34
Viskositas gas (cp) μ_{gas}	0,02
Surface strain	24
mid perforasi	5160
Pump Setting Depth	4900

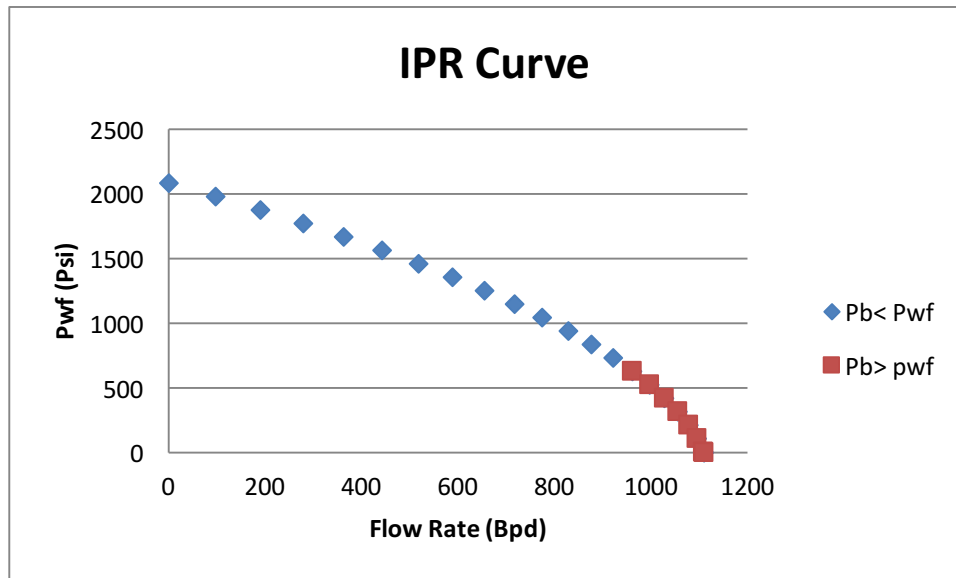| *Stage* | 400 |
Pwh	300
h(Feet/stage)	10
gc	32,2

Analysis of IPR

Figure 4. IPR Curve Well A

In this analysis it was found that there is a phase change from one phase into two phases , where the curve is red there is a phase change from one phase into two phases , namely phases of oil and gas this can result in fluid viscosity will change while the viscosity is very influential in the production fluid ,
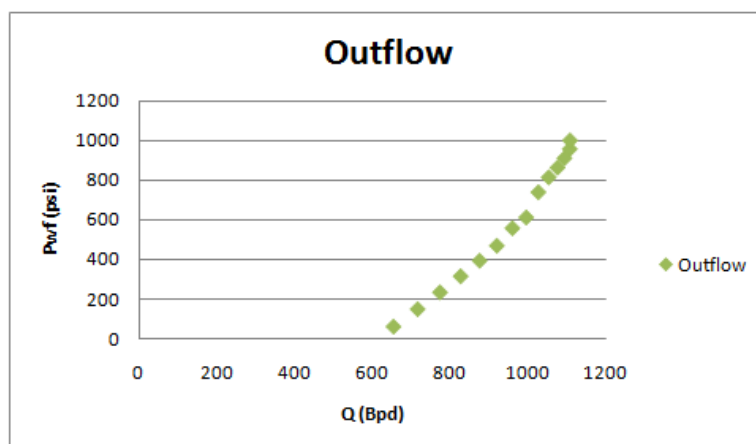
TPR analysis

Figure 5. TPR Analysis

The image above is the calculation of outflows or vertical pipe analysis illustrated with TPR curve determination outflow curve can be influenced by several aspects , and aspects of the possible in influencing the productivity of wells that need to be further analyzed one of which will be discussed in this case is

a . Diameter Tubing influence on TPR

b . Stage Pumps influence on the curve TPR

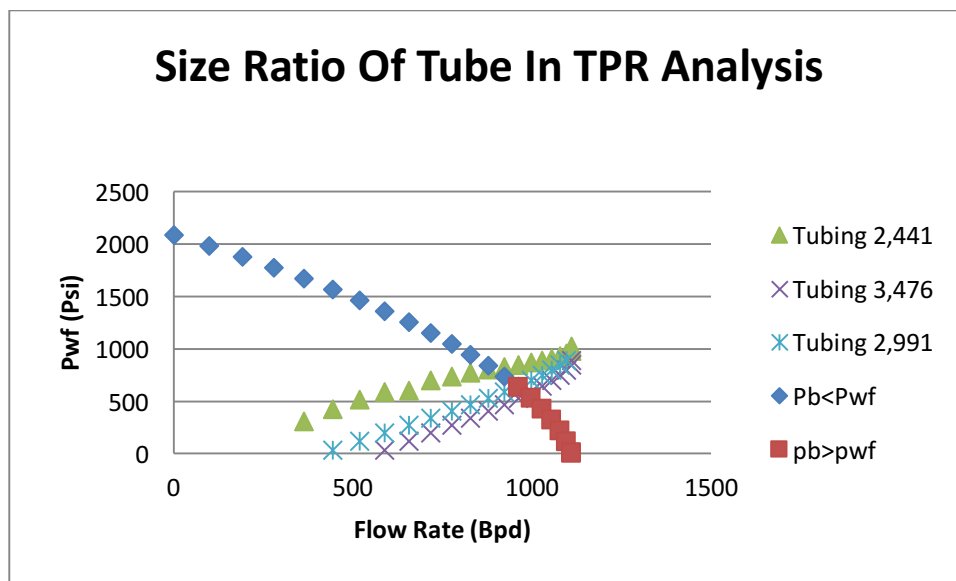   a.   Influence diameter tubing for the TPR

Figure 6. Size Ratio Of Tybe In TPR Analysis Curve

Table 2. Size Ratio Of Tube In TPR Analysis

tube size	Q (bpd)
2.441 ID	876,729
2,991 ID	961,197
3,476 ID	996,26

b . The influence of theTPR Analysis to stage pump

Figure 7. Influence Stage Number In TPR Analysis

Table 3. Influence Stage Number In TPR Analysis

Stage	Q (BPD)
400	961,1977
338	921,1655
200	827,889
169	774,646

4. Conclusion

So from this Analysis Based on the results of research conducted in wells A SW field and the description in previous chapters , it can be concluded that the ability of the rate of production at oil and gas wells A tubing can be optimized with its greatest diameter is 3.476 at 996.26 ID BPD , as well as the number of stages the ESP pumps were also crucial stage where an increasing number of more optimal production rates obtained namely by stage 400. in addition, the analysis also concluded that the pressure affects the friction pressure loss compared with the shape of the pipe cross-section (magnification) . At the appropriate type of pump ESP field characteristics obtained that initial pump installed in wells A far more optimal than the kind of pumps in others.

References

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