PROCEEDINGS
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PRODUCTION OPTIMIZATION OF FLUMPING AND SANDY WELL USING TUNGSTEN MATERIAL IN BALL & SEAT OF SUCKER ROD PUMP IN WELL P-335 PERTAMINA EP ASSET 1 RANTAU FIELD

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Abstract

Rantau Field has applied full scale waterflood on the Z-600 layer since 2011. Over time the VRR (Voidage Replacement Ratio) for the Z-600 layer especially for D1 block has reached the value of ± 2. This causes the monitor wells experiencing sand problem and flumping condition (there is a flow through the annulus when it is produced by artificial lift). At the time of flumping, standing valve or traveling valve cannot close properly as it gets large enough pressure. Whereas when the well experiences sand problem, the ball on the standing or traveling valve is easily eroded and blocked by the produced sand. This paper presents ball and seat material replacement for standing valve (STV) and traveling valve (TV) by using a material that is heavier and harder than stainless stee that is commonly used. The replacement of ball and seat material on the standing valve and traveling valve expected to overcome both of these problems and could optimize the lifetime of the well and also the production.

Introduction

Rantau Field is part of PT. Pertamina EP whose operational area is located in Aceh Tamiang Regency - Aceh Special Region and Langkat Regency - North Sumatra. The first well in the Rantau field was drilled in 1928 under the name well R-001. Rantau Field consists of nine structures: Rantau, Kuala Simpang Barat, Kuala Simpang Timur, Serang Jaya, Prapen, Kuala Dalam, Sungai Buluh, Bukit Tiram, and Pematang Panjang. Waterflood pilots in the Rantau Field were conducted in 1984-1992 with a peripheral pattern in Z-560 layer block A1 of the Rantau structure. At present Rantau structure has 628 wells, consisting of R-001 to R-175 (drilled by the Dutch), and P-001 to P-453 (drilled by Pertamina from 1961 to the present). Rantau structure has applied waterflood in full scale in 2011 on the Z-600 layer. At present the Z-600 layer, especially in the block D1, has a Voidage Replacement Ratio (VRR) value of ± 2. This indicates that the Z-600 layer has reached water breaktrough and caused flumping condition in some of monitor wells, where it is a flow through the annulus when it is produced with artificial lifts, this condition makes the monitor wells that use SRP (Sucker Rod Pump) lifting do not produce optimally. Problems that lead to suboptimal production of monitor wells that produce with SRP lifting with flumping conditions are as follows:

1. Sand problem
   Excessive injection rates cause unconsolidated sandstone to collapse and the grains are produced along with the production fluid.
2. Production string problem
   The up stroke and down stroke movements of SRP result in friction between the sucker rod and tubing so that the thickness of the tubing becomes thinner and thinner until it leaks.
3. Downhole pump problem
   Low pump efficiency results in the production of monitor wells with artificial elevator SRP not reaching its potential.

The first well that uses tungsten ball & seat on the standing valve and traveling valve is well P-335. This well is experiencing sand and flumping problems, currently producing at the Z-600b layer and is a monitor well for the P-340 and P-440 injection wells.

Data and Method

The dynagraph of well P-335 showed an indication of leakage on the TV and STV. This caused the pump fillage not optimal so that the well production performance did not reach its potential.

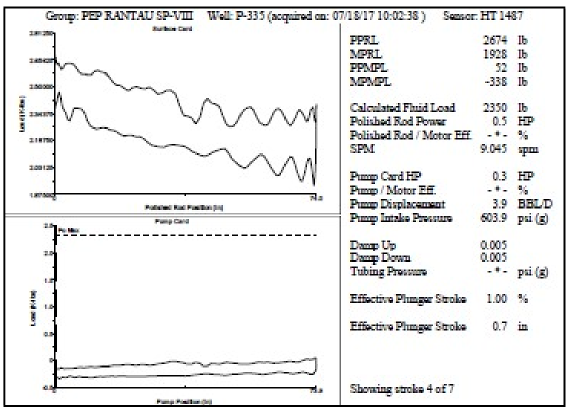

Figure 1: Well P-335 Dynamometer Measurement Results with Stainless Steel Ball & Seat

Based on the dynagraph results in Figure 1, an analysis and evaluation were carried out to optimize the P-335 well with the following steps:

1. Step I – Detection
   Production performance analysis, pump parameters monitoring, and dynagraph measurements to determine the problems experienced by the pump.
2. Step II – Screening
   To choose the right ball & seat material, criteria screening is needed. The following is the table of material screening criteria.

Material	Hardness	Density	Strength
Stainless Steel	52-56	7.98	Medium wear, mild corrosion
Cobalt Alloy Cast	53-63	8.8	Good wear, good corrosion resistance
Tungsten Carbide	88-89	19.6	Good wear, corrosive & abrasive resistance
Nickel Carbide	89-90.5	8.8	Good wear, corrosive & abrasive resistance
Titanium Carbide	89-90.5	4.5	Medium wear, mild corrosive & high abrasive resistance

To find out whether the selected ball & seat material is floating (opened STV/TV) or sinking (closed STV/TV), we used Archimedes' law:

1. $W > Fa$ the object will sink
2. $W = Fa$ the object will be fly in the middle
3. $W < Fa$ the object will float

To get the value of the Fa (floating force), we used the following equation:

$$Fa = \rho_{fluida} \times V \times g \quad (1)$$

Where:
Fa : floating force, N
ρ_{fluida} : liquid density, kg/m^3
g : standard gravity, 9.8 m/s^2
V : volume of the object, m^3

W : weight of the object, N

With the data from the field below, the calculation is done using equations (1).

ρ_{fluida} : 770 kg/m^3
g : 9.8 m/s^2
V : 0.00003112 m^3

$Fa = 770 \times 0.00003112 \times 9.8$
$Fa = 0.235\ N$

Tungsten ball valve mass is 610 gram, then:

$$W = m \times g \qquad (2)$$
$$W = 0.61 \times 9.8$$
$$W = 5.978\ N$$

Based on the calculation above, for ball valve with tungsten material obtained the value of W > Fa, which means the valve with tungsten material can sink in the flumping well condition.

3. Step III – Installation
After selecting the suitable ball & seat material, the ball & seat installed on the pump and a high-pressure test is carried out to determine the STV/TV leakage, if there is no leakage the pump can be installed to the selected well.
4. Tahap IV – Monitor & Evaluasi
Production performance, pump efficiency, and dynagraph results monitoring to see the effectiveness of tungsten material uses in well P-335.

Result and Discussion

The results of the evaluation and monitoring after the installation of tungsten ball & seat showed better performance compared to stainless steel ball & seat that commonly used in Rantau Field. Pump performance increased by 98%, which previously had displacement of only 3.9 BBL (Figure 1) to 335.5 BBL (Figure 2). This shows the tungsten ball & seat can work well, and the pump performance is more effective. Increased pump efficiency contributed to an increase in well production by more than 100%, from an average production of 12 BBL/D to 30 BBL/D (Figure 3 & Figure 4).

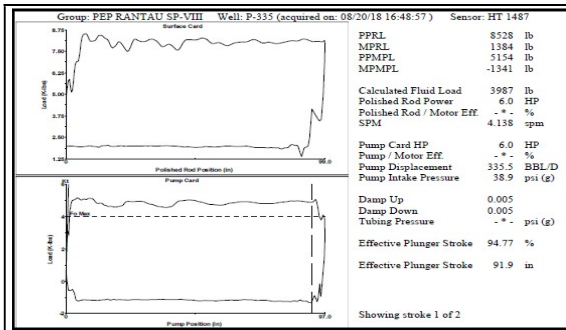

Figure 2: Well P-335 Dynamometer Measurement Results with Tungsten *Ball & seat*

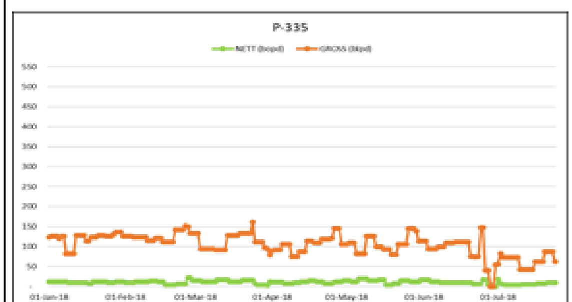

Figure 3: Well P-335 Production Performance Before Using Tungsten *Ball & seat*

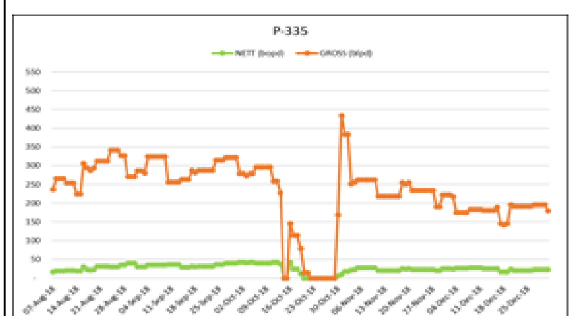

Figure 4: Well P-335 Production Performance After Using Tungsten *Ball & seat*

Conclusions

The use of tungsten ball & seat on TV or STV of sucker rod pump can reduce the effects of flumping and sandiness problems in P-335 wells, as evidenced by an increase in well production by more than 100%. The success of using tungsten ball & seat in P-335 well can be considered for use in other wells, especially injection monitoring wells that use an artifical lift sucker rod pump that has the possibility of experiencing flumping conditions and wells that are experiencing sand problem.

References

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