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THE EFFECT OF CARBON STEEL PIPELINE DETERIORATION TO WATER INJECTION QUALITY AND PRESSURE DROP IN TANJUNG WATERFLOOD INJECTION PLANT

(Pengaruh Dari Pemburukan Pipa Carbon Steel Terhadap Kualitas Air Injeksi dan Penurunan Tekanan pada Plant Waterflood Injeksi)

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ABSTRAK

Di Tanjung, Kalimantan Selatan, PT Pertamina EP (PEP) menggunakan teknologi secondary recovery (injeksi waterflood) untuk mengambil minyak. Kondisi permeabiltias reservoir yang rendah membuat kualitas dari air injeksi harus cocok dengan persyaratan reservoir tersebut and tekanan injeksi harus diset sekitar 1400 psig. Pada umumnya di lapangan injeksi milik Pertamina EP, pipa carbon steel masih digunakan. Serpihan-serpihan yang terakumulasi dan minyak yang terjebak dapat terjadi seiring dengan pemburukan pipa carbon steel. Hal ini dapat menyebabkan kualitas dari air injeksi menjadi lebih buruk. Ada empat data yang dianalisis; Kandungan Minyak (Oil Content), Kandungan Padatan yang tersuspensi (Total Suspended Solid), Turbiditas dan Total Iron. Contoh yang diambil adalah pada keluaran pompa dan salah satu sumur injeksi selama 6 bulan. Secara umum hasil menunjukkan nilai dari Total Iron, Turbiditas dan Kandungan Minyak pada sumur injeksi lebih besar daripada di keluaran pompa sedangkan kandungan padatan tersuspensi lebih cenderung berfluktuasi. Secara kesimpulan, pemburukan pada pipa carbon steel mempunyai efek untuk mengurangi kualitas air injeksi menjadi lebih buruk dan efek dari kekasaran (roughness) pipa karena pemburukan pipa carbon steel bisa membuat penurunan tekanan menjadi lebih tinggi sesuai dengan panjangnya.

Kata Kunci:

ABSTRACT

In Tanjung, South Kalimantan, PT PertaminaEP (PEP) use secondary recovery (waterflood injection) for its technique for oil lifting. Low permeability reservoir condition make quality of water injection must be comply with low permeability reservoir requirement and the pressure injection must be around 1400 psig. In the common PEP injection plant, carbon steel pipeline is still used. Flakes accumulation and trapped oil could occur along with the deterioration of carbon steel pipeline. This matter can make the quality of requirements of injection water become worst. There were four data were analyzed; Oil content, TSS (Total Suspended Solid), Turbidity and Total Iron. The sample was taken at discharge pump and one of the injections well during 6 months. Averagely the result of value of total iron, turbidity and oil content in injection well are bigger than discharge pump while TSS has little fluctuation. In conclusion, deterioration carbon steel pipeline has effect to reduce quality water injection become worst and effect of roughness of pipeline due to carbon steel deterioration can make the pressure drop is higher in accordance with the length.

Keywords:

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I. INTRODUCTION

Water flooding method is one of method for increasing oil production use water injection. This method is also called secondary recovery which is applied in mature oilfield. There are some factors has to be concerned such as pressure, temperature and water quality. Usually parameters of water quality consist of TSS (Total Suspended Solids), Oil Content, RPI (Relative Plugging Index), pH, Dissolved Oxygen, Bacteria. The low permeability reservoir will be having strict value of parameters. According to Petrowiki Total Suspended Solids (Solids and Oil Droplets) in the injection water is one of the main properties that determine damage or the injectivity of water injection wells. Contaminated water frequently contains residual oil, chemical solute, fine grains, minerals, clays and other solid particles, which may significantly reduce the available porous spaces and degrade the formation permeability, thus reduce the injection efficiencies (Bai, 2012).

Based on review of technologies for oil and gas produced water treatment (Ahmadun, et al., 2009) There are many produced water treatments such as, Corrugated Plate Separator, Centrifuge, Hydrocyclone, Gas Floatation, Extraction, Ozone, Adsorption, Lime Softening, Ion Exchange, Evaporation, Filtration, Reverse Osmosis, Activated Sludge and Constructed wetland treatment. The selection of these water treatments equipment based on water quality requirement. Meanwhile, there are some water treatment plant has a long distance from injection well. Usually water from water injection plant is sent by pipe to injection well.

Many of plants of water treatment injection still used carbon steel as piping and pipeline. Based on the experiences carbon steel can make flakes of scale and product of corrosion. Corrosion in carbon steel can increase roughness of the line, this will make a slit for oil or TSS trap in one of the points of pipeline.

Therefore, the longer injection carbon steel pipeline can make high possibility accumulation of TSS (Total Suspended Solid) and oil in the pipeline. Also, the increasing roughness can increase pressure drop, one the impact of high- pressure drop is high discharge pressure of pump and certainly have impact to the power.

Based on that cases, the material of piping or pipeline in water treatment injection plant have to be changed. There are some technical evaluation and justification must be considered of choosing the material pipeline for water treatment plant. Usually, there are two objectives for a water treatment plant, good quality water injection and pressure water injection. In this paper, there are two evaluation for checking quality of water injection to deterioration carbon steel of pipeline and pressure drop due to roughness of carbon steel pipeline.

II. DATA AND METHODE

Lab analysis was used for checking quality of water injection and simulation of PIPESIM 2017 was used to determine effect of carbon steel deterioration to pressure drop of pipeline, the simulation of carbon steel was compared with Fiber Reinforced Plastic (FRP) Pipe

A. Quality of Water Injection

There were four data analysis consist of oil content, turbidity, Total Iron and TSS (Total Suspended Solid).

- Data were taken from range January - June 2019 as can be seen in the Figure 2 - Figure 5.
- Two sample were taken, sample after discharge pump and sample near injection well. Schematic of pipeline can be seen in Figure 1.

Figure 1
Schematic of Pipeline.

- Oil content and total iron is measured with ultraviolet-visible spectrometer, turbidity is with turbidity meter and total suspended solid used filter paper 0.45 micron.

B. Pressure Drop

PIPESIM simulation is used for determination of roughness effect of carbon steel to pressure drop. FRP pipeline is will be used for the comparison to carbon steel because FRP pipeline has smooth roughness than Carbon Steel. Assumption for Simulation data for the PIPESIM could be seen in Table 1.

III. RESULT AND DISCUSSION

There are 5 results which identified. These are Total Iron, Turbidity, Oil Content , Total Suspended Solid and Pressure Drop pipeline.

A. Result

1. Total Iron

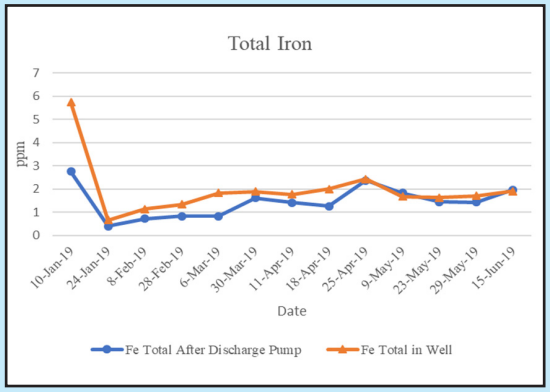

Figure 2
Total iron.

2. Turbidity

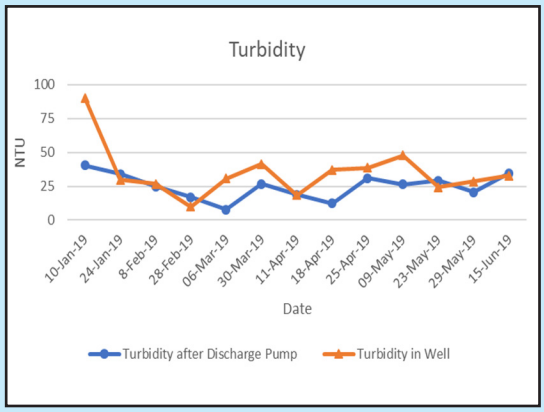

Figure 3
Turbidity result.

3. Oil Content

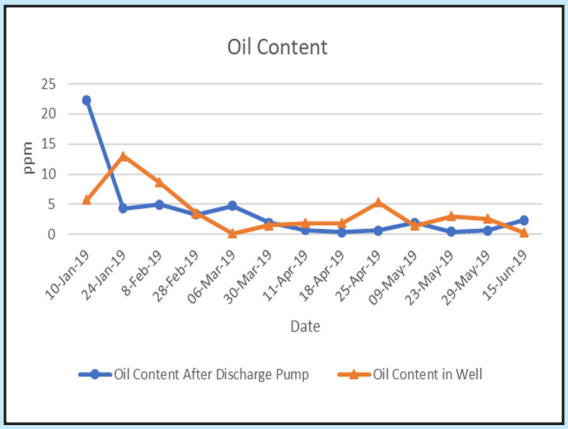

Figure 4
Total oil content.

4. Total Suspended Solid

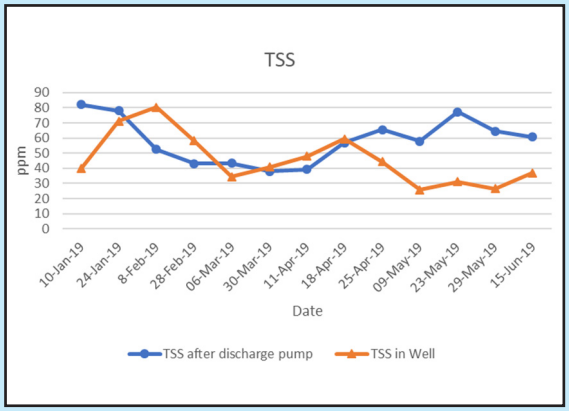

Figure 5
Total suspended solid.

Table 1
Simulation data for PIPESIM

Simulation Data	Value	Unit
Flowrate	75000	Bpd
Destination Pressure	1400	psig
Nominal Diameter	10	inch
Length	±15	km
Flow Correlation	Moody	-
Roughness	Carbon Steel: 0,000164 ft FRP: 0,000017 ft	

5. Pressure Drop

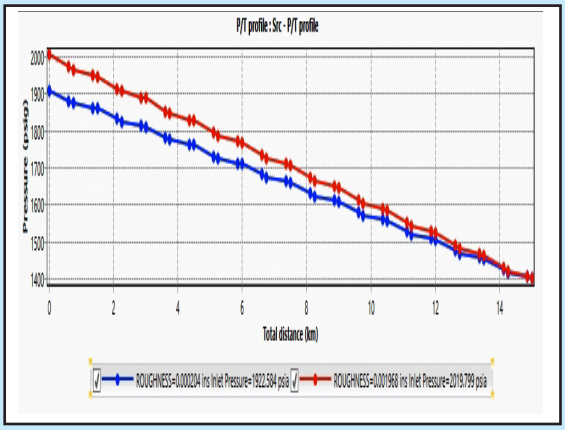

Figure 6
Pressure drop.

B. Discussion

1. Total Iron

Based on Figure 2 total iron in produced water increase after through the pipe. This case is shown by total iron is higher in discharge pump than total iron in well. Increasing of Total Iron show there is corrosion tendency in pipeline. Corrosion is one of the important concerns in carbon steel pipeline. Based on definition of NACE (National Association of Corrosion Engineer), corrosion is deterioration of material (usually metal) that result from electro-chemical reaction. Electrochemical corrosion reaction requires four elements: an anode, a cathode, a metallic conductor, and electrolytic conductor (Papavinasam, 2014). Deterioration of materials can make loss of amount metal which will mix with the produced water. The loss of metal due to corrosion will have influence to other parameters.

Averagely, value of total iron is increased during 6 months. Figure 2 show at 10 January 2019, total iron has highest value and at 24 January 2019 total iron decrease. Started at 24 January 2019 until 15 January 2019, total iron is increased averagely. Figure 2 also show Total Iron in well is higher than after discharge pump averagely.

The increasing of value of total iron show there was serious corrosion in pipe-line. Dong et al (2011) showed data iron ion contents from 0.590 mg/l to 1.752 mg/l proved serious corrosion in pipeline. Iron oxide and Iron Carbonate are the example of products of corrosion (Stewart & Arnold, 2011). This solid matter can reduce injection efficiencies. Corrosion products can increase the friction along pipe walls and decrease carrying capacity and may also contribute to plugging of injection wells (Thakur & Satter, 1998).

2. Turbidity

Turbidity is a reduction in water clarity because of the presence of suspended matter absorbing or scattering downwelling light. (Grobbelaar, 2009).

Based on figure 3, averagely, the data show produced water turbidity from well is higher than after discharge pump. Even though both of data from 10 January 2019 until 15 June 2019 have fluctuation. There are some factors make turbid in water such as oil content and solid particle (sand, clay, wax, iron). The fluctuation of these data can be influenced by velocity of liquid, the flow regime in pipeline. High velocity could cause increased turbidity in water distribution system (Shamsei, et al., 2013).

3.Total Oil Content

Figure 4 show oil content in well increase averagely after through the pipeline. Even though, there are some data show oil content in well decrease. This problem can be caused by trapped oil content in pipeline due to formed pit. Figure 7 show typical shape of pits and Figure 8 is one of example oil trap in pit inside part of spool of pipeline in Tanjung.

In Tanjung field, the characteristic of oil is waxy. Oil become waxy because the wax appearance

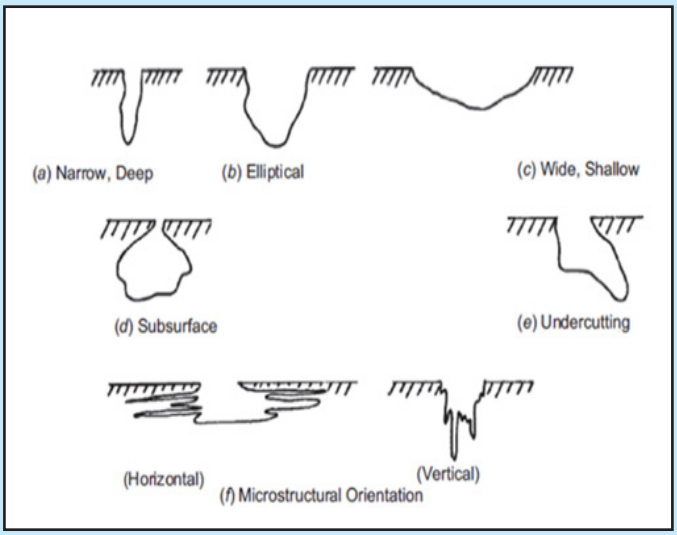

Figure 7
Typical shape of fits (Papavinasam, 2014).

temperature point is reached. Rainy and Cold Weather can decrease ambient temperature, therefore fluid temperature is drop and wax appearance temperature is reached. Waxy is very easy to trap when there are many pits in the pipeline and the fluid velocity is low. Therefore, wax deposition will form in the pipeline. The turbulent flow and high velocity flow will be carried partial wax away. In Figure 4 indicate thatoil content decline is caused due to trapped wax. Consequently, in the same time sample was checked, there was no many oils carried away in the sample. Figure 8 show one of the inside parts of spool pipeline in area of injection pump Tanjung Field.

4. Total Suspended Solid

Produced water and oil contain very small particulate solid matter held suspension in the liquid phase by surface tension and electrostatic forces (Stewart & Arnold, 2011). This solid matter is referred to as a "suspended solid" and may consist of small particles of sand, clay, precipitated salts and flakes of scale, and products of corrosion such as iron oxide and iron carbonate. When suspended solids are measured by weight or volume, the composite measurement is referred to as the "total suspended solids" (TSS) content (Stewart & Arnold, 2011).

Based on Figure 5 TSS content have fluctuation, sometimes TSS is decline, in the other months TSS is incline. TSS will deposit in the pipeline when the flow has low velocity, if there is a pit TSS will trap. Solid will be carried away by water when water has enough velocity for it. Figure 9 give the illustration for deposition of solid and solid is carried by fluid.

5. Pressure Drop

Figure 6 show the comparison pressure drop between carbon steel and FRP. Based on figure 6 above, carbon steel backpressure higher than FRP. The destination pressure is 1400 psig. Carbon steel pipe has backpressure around 2005.1 psig and FRP is 1907.89 psig. The difference backpressure is around 97.2 psig (5%). This pressure will have impact to the power of injection pump. This mean if pipeline use carbon steel, the power pump will 5% above using FRP. According to GPSA (Gas Processor Supplier Association), formula of hydraulic horse power and brake horse power can be seen in equation 1 dan equation 2.

Figure 8
Inside part of the spool of pipeline in Tanjung.

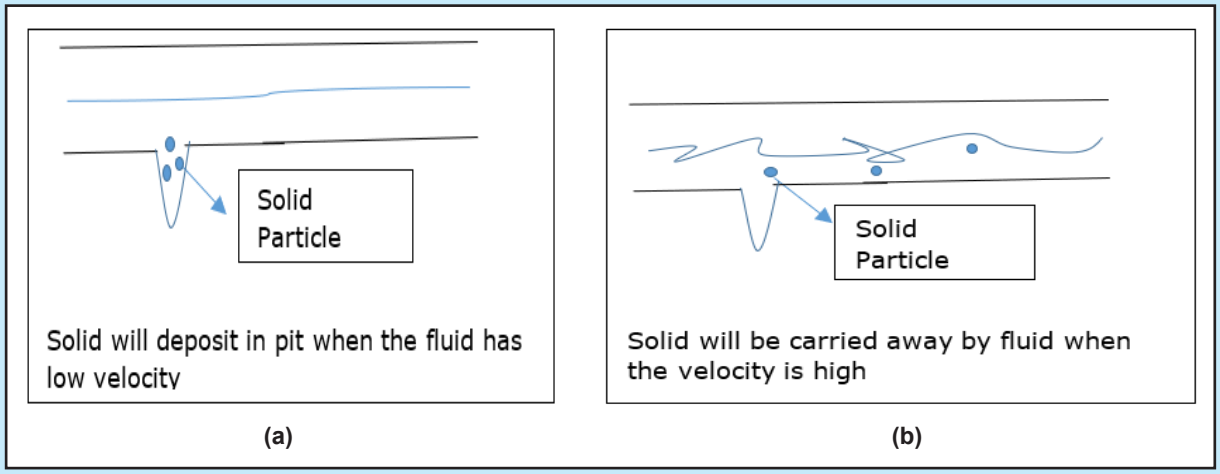

Figure 9
(a) Solid deposition (b) Solid rising.

IV. CONCLUSIONS

Based on result and discussion, metal deterioration has effect to reduce the quality of water injection become worst. If the quality water exceeds requirements such as high TSS, high oil content then wellbore is plugging. Wellbore plugging make well injection is not perform and has effect for decline of efficiency sweep. Therefore, oil production will decline. Moreover, roughness of carbon steel due to deterioration can make the pressure drop is higher in accordance with the length of pipeline. This case has an effect to power consumption in pump. In this case, nonmetallic pipeline is compared with the carbon steel pipeline. The nonmetallic pipeline which used as comparison is FRP (Fiber Reinforced Plastic) and the result is nonmetallic pipeline can have potency to reduce the power consumption of pump due to its smooth roughness.

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