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Water Injection in Tight Formation with Sensitive Minerals: Lessons Learned From "F" Field

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Abstract

Telisa Formation is the second productive reservoir in "F" Field beside Baturaja. The formation, which is familiar as TF, is considered as a tight sandstone containing sensitive minerals. Hydraulic fracturing needs to be done before producing the wells. Producing initially since 2001, TF has been implemented water injection since late 2009. Before its initial implementation, the feasibility study recommends that water injection was feasible to be performed and targeted to increase its reservoir pressure. However, after almost ten years of injection, the cumulative voidage ratio is still low and reservoir pressure could not reach its expected value. Nevertheless, water injection is critical to maintaining reservoir pressure. So, it was decided to conduct another study to evaluate the water injection performance and recommend for further improvement.

The following paper elaborates the evaluation phases and the lessons learned derived from the study. The evaluation phase consists of historical data gathering; mapping the problems; performing the field and laboratory measurement and parallel conduct the analysis. The study covers rock characteristics, surface facilities and geomechanics evaluation.

The result shows that all factors have their contribution to the permeability impairment which creates poor injectivity performance. Main factors, in this case, explain the criticality of reliable separation facilities. As the other eye-opener, the formation also contributes to the loss of strength due to exposure to water injected. When it is weakened, it may multiply the damage in the formation. The study shows that an integrated study gives a comprehensive result and give the options to the management for selecting the desirable outcome.

Introduction

F Field, located in Sumatra, has three productive reservoirs. Baturaja Formation is the primary objective of this field. The scenario to develop this formation drives the implemented strategy to develop the field. In early 2001, Telisa Formation (TF) is started to be produced and considered as the second productive reservoir. The least productive one is Talang Akar Formation.

The reservoir pressure for TF was started to decline since its initial production. Nevertheless, some area were already loss 70% from its initial pressure after four years of production. Material balance analysis shows that there is no aquifer support and a pressure maintenance program were urgently required.

In 2009, the reservoir was injected water to encounter its pressure depletion. Nevertheless, before the injection, a study and a pilot injection were commenced. The study consists of a series of Laboratory testing that shows that water injection is feasible to be done in this formation. It comprises Compatibility Test; Scaling Tendency Analysis; Return Permeability Test, Plugging Tendency Analysis. The laboratory result was continued with a pilot water injection from 2 wells. Both wells showed a positive result indicated from a reservoir pressure increment from adjacent wells.

However, after almost ten years of water injection, cumulative voidage reservoir ratio (VRR) of TF still exist below 0.3 which indicate the water injection performance still needs to be improved. Almost 50% of the water injection wells also do not inject as expected. It is mandatory to investigate the cause and find the doable solution.

The Updated Study

The updated study should be completed at the soonest to ensure that the current operation mode is already meet the requirement. The study started with data gathering. Data from any related study was gathered. The investigation began by defining the aspects that may cause the low performance of the water injection rate.

Three aspects were assumed to contribute to the water injection low performance. It may be caused by reservoir aspect (formation mineralogy); surface facilities aspect or geomechanic aspect. Furthermore, the investigation was performed based on the assumption.

The objective of surface facilities investigation is to analyze the results of data collected and corresponding observations about the quality of water injected. It also studies the impact of a complex operation and infrastructure on the performance. The key areas are:

1. Water composition
2. Oil content
3. Solids loading
4. Microbiology

The objective of formation mineralogy aspect evaluation is to know the contribution of the mineralogy to the damage and knowing how sensitive the formation to the injected fluid. It tries to quantify the formation mineralogy and potential sensitivity. It measured the critical velocity to avoid any propagation of fine migration. Lastly, this part also evaluated the compatibility between the core and fluid.

The geomechanic aspect needs to be studied as the hydraulic fracturing stimulation is implemented since the beginning of the field life. The well requires the stimulation to be produced, and this part of the study search for any possibility of sand production to the surfaces.

Result and Discussion

The scope of the surface facilities aspect is covered by taking representative samples. The result shows that the average TDS number is around 14,000 – 15,800 ppm with a considerably high amount of Oil in Water (OIW) content. TSS also indicated high figures within the system. However, microbiology activities check shows a reasonable amount of numbers and no further issue.

The formation mineralogy evaluation shows some water sensitive minerals exist within the clay. Their existence should be consider but no further action could be done so far to avoid the excess since these minerals are naturally exist and distributed randomly. Telisa Kaji shows that it is sensitive to water from water sensitivity test. It shows a continuous reduction in permeability as the number of injection water increases.

The lab result that shows indications of TSS and OIW gives a good input to the formation mineralogy phase. Flow tests were conducted to know the effect of these high figures of TSS and OIW to the formation. The result shows that as the number of solid in the injected water increases, the differential pressure also increases. However, when the injected water contains more oil in water content with the same number of solid content, the differential pressure grows rapidly. This may illustrate the condition that exists in the reservoir. The water injection performance was altered when the injected water was exposed to a high solid content which may originated from corrosion products or loose grains from any of the formations. It was indicated by the increase of differential pressure, as illustrated in Figure 1. The effect multiplies even more when the injected water contains the coagulated solid with the carried-over oil. The effect is shown in the rapid increase of differential pressure in Figure 2.

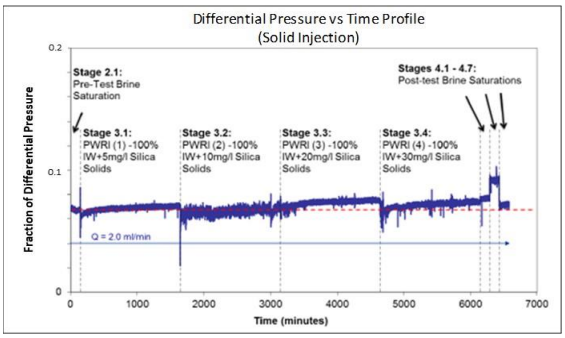

Figure 1: Differential Pressure vs. Time Profile for Water Injection Containing Various Solid Content

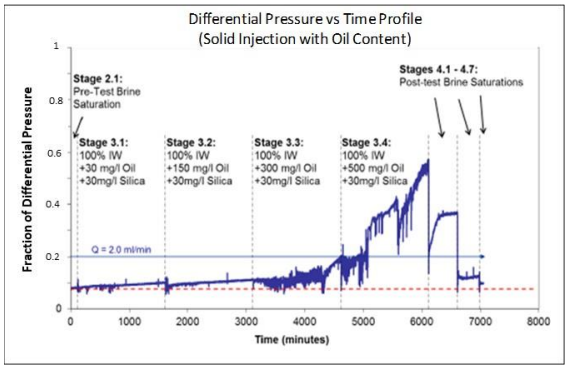

Figure 2: Differential Pressure vs. Time Profile for Water Injection Containing Solid and Various OIW

The last phase is checking the potential effect of sand production to the surface. A model of UCS was build by using a correlation. This correlation is used to build the performance curve of the well. The result shows that the reservoir does not tend to produce the sand.

Conclusion

Based on the abovementioned description, the study shows that an integrated study gives a comprehensive result from all possible aspects that may contribute to the formation damage. The finding provides a more convergence conclusion that the cause was mainly caused by the poor separation quality between injected water and its impurities. By knowing the origin comes from the high values of TSS and OIW, the study could give a straight recommendation to the management for selecting the desirable outcome.

References

Ariessita, F., et al., 2014, Telisa Kaji Pressure Maintenance: Water Injection in Tight Shaly Sandstone Formation. Proceedings, IPA.

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