Evaluation of Heavy Paraffin Solvent Injection in Langgak Oil Field

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Abstract. LGK 14 and LGK 25 wells are oil production wells with high paraffin levels. The presence of paraffin around well perforation causes many problems. One of which is a decrease in the rate of production. It solved with rig less workover / well service (WO/WS) is an injection of heavy paraffin solvent. LGK 14 well uses sucker rod pump and LGK 25 uses an electrical submersible pump. Main steps in LGK 14 are injecting heavy parasol, soaking, displacing and producing. The other wells have differences where before the heavy parasol injecting, pump washed first. The challenges are high static bottom hole pressure (SBHP) and fluid reactions. The results show for LGK 14 well decreased oil rate from 25 BOPD to 21.77 BOPD after the heavy parasol injection. LGK 25 well increased the production rate from 21 BOPD to 29.99 BOPD.

1. Introduction

Continuous oil production for a long time will experience a number of problems causing a natural decline in production. Problems that can be experienced are based on the characteristics of fluids, one of which is inorganic or organic deposits, or a combination of both. Organic deposits are formed when hydrocarbon liquids are being produced and undergo changes in their conditions. The types of organic precipitates that are traditionally formed are paraffin or wax. Paraffin often settles as a result of falling temperature or pressure [1]. Physical changes that occur in crude oil are basically caused by changes in thermodynamics that affect chemical equilibrium that usually occurs during drilling, stimulation, and workover, which causes paraffin deposits to stick around the formation [2].

The issue of paraffin deposits is an important issue for oil companies because paraffin depositions cost oil companies are eliminating costs and more in lost production. Therefore, a treatment is carried out to eliminate the paraffin. The treatment of paraffin is handled by two methods: solvency and/or dispersion. Solvents used to dissolve paraffin by breaking down the crystal lattice, dispersants prevent their agglomeration [3].

The concept of paraffin treatment uses heavy solvent injection on LGK 14 well and LGK 25 because the two wells have a high paraffin content problem. The job aims to reduce the skin factor around the
perforation area so as to facilitate the flow of fluid from the formation to the wellbore, removing/cleaning the scale on the casing wall, tubing and around the tubing pump, and minimizing cost.

The problem of paraffin formed at the time of production and transportation makes quite a lot of work to find the solubility of paraffin in hydrocarbon solvents. The loss of low molecular weight hydrocarbons can affect paraffin solubility to some extent, but water cannot change paraffin solubility [4]. A number of factors can affect the removal of paraffin from the production system using solvents. Some important factors in removing paraffin are the solvents used, the paraffin type, the paraffin amount, temperature and contact time. Any or all of this can help determine the success or failure of paraffin removal treatment. The best paraffin solvents applied for a long time Chain paraffin at low temperatures for too short a time will fail to provide a clean system.

LGK 14 and LGK 25 wells have production problems due to paraffin deposits around perforations and pumps. Production history and well data need to be known to be able to do the right treatment and find out the comparison of future production. The production data of LGK 14 well data is shown where the production of wells before treatment of 25 BOPD with 95.7% water cut. Whereas LGK 25 well of the production of the well 21 BOPD with a very high water cut of 99%.

From figure 1 LGK 14 Well production data which began in 2009, the peak of production at this well occurred in 2011 with a production of 47.3 BOPD. This well uses an Artificial Lift Sucked Rod Pump (SRP). After reaching the peak of its production, this well then decreased. It can be seen from figure 1 that the decline curve starts from 2013 to 2015 with a fixed amount of production in the range of 15-18 BOPD. Before reaching the deadline for production, treatment is carried out to deal with the production decline that occurs, namely by injecting heavy parasols.

In LGK 25 with the same problems, from figure 2 the production history data, the peak of production occurred in September 2010 with a total production of 75.88 BOPD. At this well Artificial lift is used differently from LGK 14, LGK 25 uses Electric Submersible Pumps (ESP). So the amount of production in LGK 25 is bigger than LGK 14. But the decline curve looks very sharp until 2017 with production remaining at 20.5 BOPD.

2. Methods
The method used in the job of a rig less with main equipment such as a pump, tank and vacuum truck. The injection activity was carried out by LGK 14 well and LGK 25 had different activities when LGK 25 the injection activity was divided into two stages while the LGK 14 only used one stage because it did not use stage-1 (wash pump). This is due to the type of pump used too, on LGK 14 using SRP pumps and LGK 25 using ESP.

The treatment between LGK 14 and LGK 25 wells is different because the well uses a different type of artificial lift in its production, where LGK 14 uses sucker rod pump and LGK 25 uses the electrical submersible pump. LGK 14 injected as much as 264 gallons of heavy parasol, then soaking for 12 hours, and then injected water from GS as much as 20 bbls. The stages of LGK 25 were more complex, there are step 1 aimed at cleaning the pump by injecting 106 gallons of diesel oil, dissolver 55 gallons, and parasol 55 gallons. The second stage is the main injection work, injection of parasol 253 gall then reverses out with GS water 82 bbls and displacement 78 bbls. After the main stage, the well was soaking for 24 hours.

3. Results and Discussion
Solvent-based methods have been recommended as an alternative to heavy oils and bitumen recovery. However, the cost of the solvent injection process is high and therefore requiring careful design of field scale applications [5]. In the case of LGK 14 well and LGK 25 which had production problems in the form of paraffin deposit and high paraffin levels, therefore the use of paraffin solvent injection was highly recommended to overcome the problem of the paraffin exposure.
In this activity, there are several challenges that inhibit the process of injection of the parasol. Among them are high Static Bottom Hole Pressure (SBHP) and fluid reactions. From table 1 & 2, the SBHP condition is around 500 psi with 900 ft FAP and 1045 ft FAP, this will cause flowing when shutting down well. This condition makes the well require greater pressure to be injected by the parasol. Besides that, the fluid properties of parasols that become constraints are density, where the density state of the chemical parasol will be reduced when mixed with the oil contained in the annulus. Because The composition and strength of the paraffin depend primarily on the composition and properties of reservoir fluid, geology and physical properties [7]. Then, when the density of the chemical parasol decreases, the chemical parasol process in pushing the oil into the perforation hole does not work optimally and the target is not achieved. Then these problems will be overcome by several stages of the process when injecting parasols.

The first step is to do LGK 14 shut down well for 2 hours so that flowing conditions occur, this is done to reduce the pressure in the annulus and make flowing in LGK 14 smaller. After that to avoid the flowing process, heavy parasol injection was carried out with the LGK 14 well condition in ON status, this was done to avoid chemical heavy parasols coming out through the annular casing. To overcome the reduced density of chemical parasol after injection, because paraffin normally consists of high molecular weight hydrocarbons which may be both straight chained and branched with carbon numbers ranging from 18-60 [8]. Then soaking process is carried out for 24 hours so that the parasol can reach the target perforation, results from process soaking time suggest also improve well performance [9] and final step is displacement process uses water GS at pressures of 250 - 300 psi.

In addition to using parasol as the main ingredient, this injection also uses additives to improve parasol work. As well as the displacement material needed to help parasol injection work more perfectly, because when only the parasol is injected it cannot push the fluid completely out towards the perforation target. Displacement material is also needed to replace the oil position in the rock when it is produced.

Injection volume and zone thickness greatly affect the success rate of this heavy parasol injection process, because numerical studies have been conducted to analyze the effect of several operational parameters (injection rate, volume of solvent injected and type of solvent) on oil recovery [6]. In the well LGK 14 and LGK 25 the total volume of each well injected was 264 galls for LGK 14 well and 253 galls for LGK 25 well. The thickness of the injected zone is also different. From figure 3 and 4, in LGK 14 the thickness of the injected zone is 18 ft, while in LGK 25 the thickness of the injected zone is 5 ft. injected on the LGK 14 well, there was no increase while the LGK 25 well increased. In addition to the factor of injection volume, zone thickness, and type of solvent there are other factors that influence the success rate of parasol injection on LGK 14 well and LGK 25 well, namely the injection process activity that has been carried out.

In LGK 25 injection activity which was divided into 2 stages was slightly different from LGK 14 which did not use stage-1 (wash pump) because at LGK 14 it used an SRP pump. Where the pumping concept uses a sucker rod and a subsurface pump that is driven down and up by equipment on the surface to lift fluid from the well into the surface [10]. Unlike ESP when the liquid enters the well, it must pass through the motor and enter the pump. This fluid flow through the motor helps in cooling the motor. The liquid then enters the intake and is fed into the pump. Because of the viscous oil, the pumps present a reduced lift performance and higher power consumption when compared with water. The modeling of the reduced performance requires appropriate factors to produce an accurate prediction of the oil viscosity at pump intake conditions [11]. So, it is necessary to do a pump wash step to clean the paraffin deposited around the pump and motor to help increase oil production later.

The injection process carried out in LGK 25 is more complex, in LGK 25 before the injection of the good parasol is done first reverse out 1 & 2 using water GS. This stage is useful for fully filling the annulus volume to the pump set limit. This process is carried out in the ON well state, then stage-1 is carried out, namely the injection of parasols and other materials to clean the pump parts. After injection of the material, then fill up annulus is used using water GS before continuing the stage-2 activity. At stage-2, the injection process is done to clean the paraffin attached to the perforation hole. This injection process is carried out in the OFF-well state. The parasol used to clean the perforation hole in LGK 25 is
the same as that used in the injection in LGK 14. However, the aspiration to maintain oil recovery on the design level leads to an increase of equipment deterioration and an increase of electricity consumption [12].

The depth of LGK 14 and LGK 25 is one of the things that influence the success of this injection. The LGK 14 well depth is 1181 ft with treatment target intervals of 1082-1088 ft and 1100-1112 ft. Whereas the LGK 25 well depth is 1332 ft with a target treatment interval of 1173-1178 ft. The LGK 25 well, which is more than 151 ft compared to the LGK 14, makes it possible for the LGK 25 well to have a higher temperature than the LGK 14 so that when the paraffin is treated in the 25 LGK it can be more easily produced. Because behavior of paraffin is affecting by difference temperature parameter [13].

The LGK 14 well is shown on figure 1. The product obtained after the injection of parasol drops from 25 BOPD to 21.77 BOPD. Whereas the LGK 25 well is shown on figure 2. Production increases after injection from 21 BOPD to 29.99 BOPD. This is influenced by one of them, the steps taken between the two wells are different, where at LGK 25 the steps are more complex, such as the pump wash process and then parasol injection for washing performance. While in LGK 14 there is no washing pump process, the possibility of this activity also reduces the performance of the pump, because paraffin can also be attached to iron equipment.

The high flow rate of ESP production which reaches 16000 BOPD and resistant of any kind environment makes ESP can produce more oil than SRP [14]. On the other hand, SRP offers certain benefits with regard to heavy oil production within permissible limits, in terms of operating range, run life and operational flexibility. As regard to its capital and operating cost for heavy oil application, it is often comparable with PCP for given set of operating condition [15]. So the factor of the selection of the use of the pump for parasol injection which explains the difference in the level of production obtained

4. Conclusion
The results show that heavy parasol injection in oil wells with high paraffin content varies. In the well of LGK 25 oil production experienced an increase, while for LGK 14 well oil after treatment was decreased. This can be caused by the condition of the well and the stages of the injection carried out. Several factors that influence the success of parasol injection in two wells in Langgak field are the job stage, pump type, formation thickness, and injection volume.

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Table 1. Data of LGK 14 well

| FORMATION DATA | PRODUCTION DATA |
|----------------|-----------------|
| Name           | Sihapas         | Gross (Sep 2, 2017) | 566 | BFPD |
| Type / Layer   | Sandstone       | Oil Nett            | 25  | BOPD |
| Temperature    | 135 Deg F       | Water Cut           | 95.7% |
| Est. BHP       | - PSI           | Lifting Type        | TP 973.5 FT |
| Porosity       | 31 %            | WFL, Ft             | 49 FAP 921 |
| Permeability   | 500 mD          | Oil Gravity         | 30 API |
| BHFP@ 0 Ft     | 0 PSI           | **Prod Problem**    | Paraffin deposit |
| Frac. Gradient | 0.8 PSI / FT    | **Paraffinic**      | Viscous crude |

Table 2. Data of LGK 14 well

| FORMATION DATA | PRODUCTION DATA |
|----------------|-----------------|
| Name           | Sihapas         | Gross (Dec 16, 2016) | 1850 | BFPD |
| Type / Layer   | Sandstone       | Oil Nett            | 21  | BOPD |
| Temperature    | 135 Deg F       | Water Cut           | 99%  |
| Est. BHP       | -37 PSI         | Lifting Type        | ESP1129 FT |
| Porosity       | 31 %            | WFL, Ft             | 85 FAP 1045 |
| Permeability   | 500 Md          | Oil Gravity         | 30 API |
| BHFP@ 0 Ft     | 0 PSI           | **Prod Problem**    | Paraffin deposit |
| Frac. Gradient | 0.8 PSI / FT    | **Paraffinic**      | Viscous crude |
Figure 1. Production history of LGK 14

Figure 2. Production history of LGK 25
Figure 3. LGK 14 well schematic

Figure 4. LGK 25 well schematic