Plagiarism Checker X - Report

Originality Assessment

Overall Similarity: **14%**

Date: Oct 21, 2021

Statistics: 475 words Plagiarized / 3332 Total words

Remarks: Low similarity detected, check your supervisor if changes are required.

ESP Power Cable Screening Strategy Through Physical Band Test and Failure Record Evaluation to Reduce ESP Wells Failure in ASD Block PSC Area Nugroho Marsiyanto1 and Abdullah Rizky A.2 1PHE, Jl T.B. Simatupang Kav 99, PHE Tower, Jakarta Selatan 12520 2Petroleum Engineering Department, Engineering Faculty, Bhayangkara Jaya University Kampus II, Jl. Raya Perjuangan Kel. Marga Mulya, Bekasi Utara, Kota bekasi Jawa 17121 a)Corresponding author: nugroho.marsiyanto@pertamina.com Abstract. ASD Block PSC Area is located in South Sumatera, about 40 km south of Prabumulih, South Sumatera. The ASD-1 well is first exploration well and discovered 4oil at the end of 1988. Until May 2011, there were 24 exploration wells and 147 development wells drilled and produced. ASD block has been producing since November 1989. In 2011, the oil production was about 5800 BOPD, and 15 MMSCFD of producing gas and mostly the lifting equipment was dominated by 2Electric Submersible Pump (ESP) and the rest was Sucker Rod Pump (SRP). Total ESP was 667 oil producer wells meanwhile SRP was 4 oil producer wells. Since there were a lot of number and need of consumable parts of ESP units, the study is focusing on the impact of ESP power cable which is giving the significant impact 5on oil production if the wells down due to ESP power cable failure, such as shortage and also cost in purchasing the ESP power cable. This paper evaluated the well failures 1caused by the bad quality of ESP power cable. There were 3 ESP power cable brands used in 2011, namely X, Y Z where each of the brands had different quality. Through physical band test 4to the power cable and well failures caused by it, it would come up with the recommendation which ESP power cables had to be used in AS block. The ESP well failures data are taken from the year 2011-2015. Based on data shows improvement on reducing ESP well failures after followed the recommendation not to install X ESP power cable brand. From this study, it can avoid potentially lost about USD 1,786,562 due to well failures caused by X power cable and save actual cost about US$ 538,292 from procurement process to provide ESP power cable need for the year 2011-2015. Keywords: lifting, 2electric submersible pump, sucker rod pump, power cable, well failure introduction ASD Block is located 40 Km south of Prabumulih, South Sumatra, producing from Baturaja (BRF) and Talang Akar (TAF) Formation on the Kedaton Platform near the southeastern limit of the Sumatra Basin. Oil was discovered in late 1988 by drilling ASD-1 well with an initial rate of 2,504 BOPD from a fractured basement granodiorite that forms the core of this northeast-southwest trending structure. Oil was tested later from the Lower Baturaja and the Neutron-Density log indicated gas-bearing porous zones in the Middle and Upper BRF. In 1989, it continued drilling ASDJ-1 well, and was found a total flow rate of 1,064 BOPD (light oil) and 5.1 MMscfd of gas from 5 individual zones in the Baturaja Formation (BRF). The main hydrocarbon productive formation in ASD Block are Baturaja, and Talang Akar Formation. Figure 1 shows the location map of AS Block PSC Area. ASD block has been producing since November 1989. In 2011, the oil production was about 5800 BOPD and 15 MMSCFD of produced gas. Mostly the lifting equipment was dominated by Electric Submersible Pump (ESP), and the rest was Sucker Rod Pump (SRP). Total ESP were 67 oil producer wells meanwhile total SRP were 4 oil producer wells. ESP wells in ASD Block area has important role in keeping the oil production as targeted by the company. One important part in ESP lifting system is ESP power cable which transmits the electrical energy from surface to downhole ESP motor for rotating the pump to lift oil from wellbore to the surface. Its cost about 20% of total downhole ESP system and will influence high cost in maintenance the downhole ESP units cost and keeping the oil production in preventing the well failures due to the problem in the electrical power source. Figure 1: AS Block PSC Area location In 2011, 3 ESP downhole cable brands were operating, namely, X, Y, and Z. This X cable only has 27% of ESP cable population installed at ESP wells in ASD Block area. Although its population is smaller than 2 other brands, X ESP power cable gave most significant well failures population when 18 times failure wells using this X power cable was failures during 2011 and contributed 75% of well failures caused by electrical problem (ESP power cable failures) as shown in figure 2 and 5,907 barrels of oil was lost and USD 295,164 was spent to put back on the production those wells through well service. Figure 2: Number of well failures due to ESP power cable problems in 2011

MATERIAL AND METHODS Electric Submersible Pump Artificial lifts play an essential role during the oil field production process. The proper selection, acquisition, installation, evaluation, monitoring, and subsequent inspection of these systems involves not only reservoir conditions but also skilled worker of technicians, engineers in the company and manufactures. Based on the reservoir condition of ASD Block, Electric Submersible Pump (ESP) is the best and optimal elected artificial lift methods to lift the oil, thus the reason why mostly ESP is as primary artificial lift method being employed in the block. The ESP population is about 94% of total lifting method. Electric submersible pumps are multistage centrifugal pumps. The operating process is from electric power, which is travel from the surface to the downhole motor through ESP power cable. The motor turns the shaft of the motor which is connected to the seal shaft, connected to the gas separator shaft, connected to the pump shaft, transforms the downhole submersible system into an internal rotating electrical submersible pumping system. As the ESP system is turning, fluid enters into the gas separator and are pushed through chambers that separate the gasses from the fluids. Gas is ejected out of the gas separator through portholes, and into the well annulus meanwhile, the fluids are pushed upward into the intake of the centrifugal pump. The pump receives the fluids and flows the fluid to the surface, as described in figure 3. Figure 3: Describing the electric submersible pump system ESP Power Cable ESP power cable is the critical link between the downhole equipment and the power source. Power is transmitted to the submersible motor by banding a specially constructed three-phase ESP electric power cable to the production tubing. This cable must be of rugged construction to prevent mechanical damage, and able to retain its physical and electrical properties when exposed to hot liquids and gasses in oil wells. ESP power cables are constructed in both round and flat configurations, as shown in figure 4. Mostly, cable is composed of at least four components; a conductor, insulation, jacket, and armor. Due to the extreme and varying nature of oil wells, cable must be durable in a wide range of conditions. Long cable life is most effectively achieved by preventing decompression damage and mechanical damage resulting in durable, long-lasting ESP cables. Figure 4: ESP power cable cutaway Methods 2Since the ESP well run life plays the essential role in keeping the oil production and maintenance cost to re-activate the ESP well failures for spending well service rig cost, ESP equipment maintenance and avoid oil production lost due to well failures caused by incapable of 1ESP power cable, so this study evaluated the 3 ESP power cable brands being used in ASD block. Well failures caused by the ESP power cable contributed significant impact to well run life when average ESP well run life should be more than 2 (two) years meanwhile couple ESP well had short-run life. The evaluation methods applied in this screening were the physical band test to 3 ESP power cable brands to see the quality of physical cables which influenced the quality ampere and evaluated the ESP well failure records of each 3 downhole ESP power cable after the installation 2in the ESP wells. Records of oil lost, rig & equipment spending cost and purchasing power cables price were gathered as additional data to consider. Physical Power Cable Band Test The method procedure was applying the same testing for the 3 1ESP power cable brands X, Y, and Z as follow: o For each product was cut 1.5-meter length. o For each cable was banded it 5into the tubing 2-7/8 ", with jaw openings and the number of the band, it tensioner was the same (4X). o Do Hypot Test with 10K voltage injected about 5 minutes for each cable. o Do Physical Check for the thickness of armored cable and flexibility armored in physical banding test for each cable. Well Failure Records In this method, gathering all the ESP well failures caused only by shortage due to 1ESP power cable. This method evaluated the data of run life of ESP well using each of 3 ESP power cable brands installed in the ESP wells. Better its quality will give the long well run life. The evaluated data were taken in 2011, and then, all ESP wells run life from 2011-2015 will be compared to see the impact after reducing 5the number of inability bad power cable quality. 2RESULTS AND DISCUSSION The 3 ESP power cable brands ordered by ASD block has the same minimum technical specification among others round type, AWG#4, Galvanize Armor, 5 kV, 5500 ft/ reel, EPDM Insulation DL90-5KV Oil Resistant Barrier Tape, Tedlar tape and EPDM CL 185 Special Oil Resistant Jacket. Power Cable Band Test X power cable During band test was found that its armor was sunken. Physically check, the armor of X power cable was also thin. For hypo test by injecting 10 kV for 5 minutes was found 0.3 microampere leaking. Y power cable During band test was found that no armor sunken. Physically check, the armor of Y power cable was thick and flexible. For hypo test by injecting 10 kV for 5 minutes was found 0.3 microampere leaking. Z power cable During band test was found its armor was very little sunken. Physically check, the armor of Z power cable was thick and flexible. For hypo test by injecting 10 kV for 5 minutes was found 0.3 microampere leaking. Figure 5: Band test result of X, Y, Z ESP power cable Figure 5 and Figure 6 showed 2the results of the band test and hypo test of those 3 ESP power cables. By those testing, the Y 3power cable is the best, the Z power cable is having a little impact on armor and Z power cable is getting sunken which means will be easier getting the lower protection and more high risk in physical problem causing ESP well failures due to power cable shortage. Figure 6: Hypo test 10 kV of X, Y, Z power cable results . Well Failure Records and Analysis As seen in figure 2 that X 4ESP power cables in 2011 records were only installed in 18 ESP wells from 67 ESP wells in ASD Block. It was only 27 % from total 1ESP power cable population, but the X ESP power cable contributed 18 of 24 well failures caused by ESP power cable shortage or electrical power shortage. The data showed that X ESP power cable was very easier for getting failures 2compared with the other two brands. Band test also showed that X power cable was the weakness and the lowest physical quality when its armor 1to protect the cable was sunken and high risk in problem due to thin. When 4the ESP power cable installed into the well, armor must be banded and clamped to the tubing, so the quality of the X ESP power cable electricity current will be degraded after installing in the ESP well due to bad armor protection. Figure 7: Number well failures due to 1ESP power cable in AS Block from 2011-2015 By these findings, the engineering team recommended to reduce the number of X ESP power cable and replaced to other Y or Z ESP power cable when the wells using X ESP power cable getting failure more often. The population of X ESP power cable had been reduced gradually since then. Figure 7 showed improvement of reducing well failures caused by ESP power cable after reducing the number installed of X ESP power cable when in 2011 its number was in 18 wells and gradually reduced to 13 wells in 2012 and reduced to 2 wells in 2013. No more X ESP power cable was installed since 2014. After reducing the population of X ESP power cable, the number of well failures due to power cable were decreasing from 24 failures in 2011 became 19 failures in 2012 and 5 failures in 2013. In 2014, increasing power cable failures became to 10 well failures, although no more X power cables. It was caused 5after more than 3 years, repeated Y & Z power cable happened, but it showed reasonable condition which means Y & Z power cable still have good long run life compared with the X power cable which repeated failures cable within a short time. In 2015, only 2 1ESP power cable failure cases were found. Oil Lost and Well Service Cost Refer to well failures data that total oil lost and spending well service cost to put on production the well failures due to ESP power cable problems from January 2011 till February 2015 is about the US $ 3,503,527, and for X ESP power cable contributed the US $ 1,786,562. For the year 2011 only, total loss is about the US $ 1,454,747 and X ESP power cable contributed about the US $ 978,526. Figure 8 showed there was an improvement in reducing total oil lost since reducing 3the number of installed X ESP power cable. In 2011, the total lost was the US $ 1,540,894 for both oils lost converted to the dollar and rig & equipment cost. In 2012, total lost was the US $ 1,238,124. In 2014 when the population X 1ESP power cable was 2 wells (3 %), total lost was only the US $ 249,014. Good improvement trend of loses were as the result of replacing the X ESP power cable gradually with Y or Z ESP power cables which had better technical and physical quality. Figure 8: Oil lost and spending well service & ESP equipment cost to put on production well failures Power Cable Purchase and Price ESP power cable 2is one of consumable part of the ESP system. The procurement process of ESP 3power cable is often separated when needed and after 3-4 times used, it needs to be replaced with the new one, so process procurement through tender is conducted. Refer to procurement data before 2011. There were five times open tender process were conducted. Figure 9 showed last five procurement 2process of ESP power cables when the last three procurement process, X power cable was awarded although the US $/ft price was more expensive compared with the Y & the Z power cable brands. X 1ESP power cable price in last three times were the US $ 6,8/ft in June 2010, the US $ 6,8/ft in November 2010 and the US $ 7/ft in March 2011, meanwhile Y & Z ESP power cable price were only US $ 5.25/ft & US $ 4.41/ft. X ESP power cable brand was awarded due to having high local content; meanwhile two other brands were no local content. X ESP power cable tended to increase its price from 2010 to 2011. Figure 9: Historical procurement 2process of ESP power cable in AS Block Afterward, the procurement process of ESP power cable in ASD block was changed through open tender with complete set purchasing ESP units including power cable or through calling out power cable in a maintenance contract. By the process, Y 1ESP power cable price was the US $ 6/ft, and Z ESP power cable was the US $ 5,31/ft. Figure 10 showed the comparison of actual Y &Z purchasing power cable and projected X power cable during March 2011-Feb 2015 through open tender complete set & call out in maintenance contract with Y&Z ESP power cable brands. By reducing not to install X ESP power cable, the actual ESP power cable need in Block AS became increased in 2012 to 214,500 ft to replaced broken X ESP power cable to Y&Z ESP power cable. After 2012 up to 2015, 5the need for power cable reduced drastically to 38,500 ft in 2013, 27,500 ft in 2014 and 23,000 ft in 2015. Figure 10: Comparison of actual spending cost of Y & Z purchasing 1ESP power cable and projected cost of X ESP power cable from March 2011-February 2015 Purchasing ESP power cable from March 2011 to February 2015 also saved US$ 538,292 due to cheaper price in Y (US $ 6/ft) & Z (US $ 5,31/ft) using call out the price in maintenance contract compared X brand (US$ 7/ft). CONCLUSIONS By completing 1the evaluation of ESP power cable screening strategy through Physical Band Test and Failure Record Evaluation , there are couple of conclusions which can be summarized as below: 1. Lifting method in ASD Block was dominated by ESP (67 ESP oil wells of 71 oil producer wells). 2. In 2011, high well failures due to ESP power cable was 24 well failures. Although its population is only 27% (18 of 67 ESP wells), X ESP power cable contributed 75% well failures due to power cable problem. 3. Based on Physical Band Test on those three different 4ESP power cables, Y power cable shows best physical quality without physical armor change, Z power cable is very little armor change, but the X power cable is sunken its armor. Physically, sunken armor power cable will lead more easily physical damage when installing into the wellbore during ESP installation. 4. Hypo test by injecting 10 kV to the all power cable brands found all are leaking about 0.3 microampere. 5. Recommendation not to use X ESP power cable and replaced with other two brands Y&Z gradually from 2011 till 2013 gave positive impact when number well failures due to ESP power cable problem decreased from 28 well failures in 2011 became five well failures in 2013 and only two well failures in 2015. 6. Replacing X ESP power cable from X brand with Y & Z brands also gave the positive impacts by reducing the oil lost & well service cost from US$ 1,540,894 in 2011 becomes US$ 1,238,124 in 2012, US$ 249,014 in 2013, US$ 438,020 in 2014 and US$ 78,946 in 2015. 7. The number of purchasing power cable need was also reduced from 214,500 ft in 2012 became 38,500 ft in 2013, 27,500 in 2014 and 23,000 ft in 2015. 8. Historical procurement proses in last five open tenders, X ESP power cable was the most expensive US$ 7/ft. 9. The procurement process for power cable in ASD block was changed from open tender only for ESP power cable to open tender complete ESP system & to call out process as part in a maintenance contract. As a result, power cable price was cheaper from US $ 7/ft (X ESP power cable price) becomes US $ 5,31/ft (Z ESP power cable price) & US $ 6/ft (Y ESP power cable price). Through a new process, the company can save US$ 538,292 for procurement to provide ESP power cable from 2011-2015.

Acknowledgments We acknowledge to Operation and Production PHE and all parties who supported to complete this paper, and to ICEMINE 2019 publishing this paper which in turn benefits to the society.

References 1. Baker Hughes Artificial Lift System, "Presentation Files" 2. JOB Pertamina Talisman Ogan Komering, "Procurement Data from 2007 – 2015" 3. JOB Pertamina Talisman Ogan Komering, "Workover and Well Service Data from 2011 – 2015". 4. Weatherford Artificial Lift System, "Presentation Files"

Sources

1	https://petrowiki.spe.org/ESP_optional_components INTERNET 6%
2	https://www.researchgate.net/publication/275379023_Subsea_Electrical_Submersible_Pump_Significance_in_Petroleum_Offshore_Production INTERNET 3%
3	https://www.slideshare.net/OmarOmrane/omaromranefinalreport-64624291 INTERNET 2%
4	https://patents.justia.com/patent/10036210 INTERNET 2%
5	https://www.scribd.com/book/359724193/Electrical-Submersible-Pumps-Manual-Design-Operations-and-Maintenance INTERNET 1%
6	https://ec.linkedin.com/in/carlos-villa-3846aa60 INTERNET <1%