



From Manual to Mobile – PEARL Based on Android Operating System as Innovative Technology for Designing Sucker Rod Pump (Study Case: PDN – 039)

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Abstract. PDN-039 is one of active oil production well at Limau Field using ESP (Electric Submersible Pump) as its lifting. Based on Quadrant Mapping Analysis, PDN-039's existing ESP is not optimum and has short lifetime production because the ESP design is not suitable with the well characteristic. Engineering & Planning Team decide to change the lifting from ESP to Sucker Rod Pump. There are obstacles in changing the pump such as existing sucker rod pump design in Microsoft Excel there are many rounding calculations so it is less accurate and coordination with related department is late because we only can do the design at office and using computer. Other than that, based on Work from Home Regulation we find some difficulties to access any excel calculation from our home. Realizing these problems and supporting industry 4.0 era where all is become digital, we invent PEARL Application. This application is built based on international standards such as API RP 11 L and literatures for designing sucker rod pump and calculating well potential which is translated into Android Language. By PEARL Application, we transform the lifting design from manual and limited access with Microsoft Excel become mobile and can be conducted anytime and anywhere. This technology is applicable and helpful during this work from home regulation, so we can do the design very easy. With PEARL Application, the accurate calculation result and give easiness to the user to operate it anytime and anywhere so it eliminates the late coordination problem. By applicating the sucker rod pump Design from PEARL Application, PDN – 39 has longer lifetime production. PEARL Application is an original innovation technology from PT. PERTAMINA EP Limau Field and has been implemented massively in several fields under PT. PERTAMINA EP. This application technology is supported Production Engineering Job for knowing the well potential and design sucker rod pump.

Keyword: Application; Sucker Rod Pump Design; Industry 4.0; Technology

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1 Introduction

PDN-039 is one of active oil production well at Limau Field since October 2018. During 2019, in daily operation (February 2019 – August 2019), this well is using ESP (Electric Submersible Pump) as its lifting with average production rate is 429 bfpd / 94 bopd. As a petroleum engineer, we have responsibility to monitor and analyze the well production and pump performance. Based on Quadrant Mapping Analysis,



is an analysis between well submergence (in meter) and pump performance efficiency (in %), PDN-039's existing ESP is not optimum as shown on figure 1.

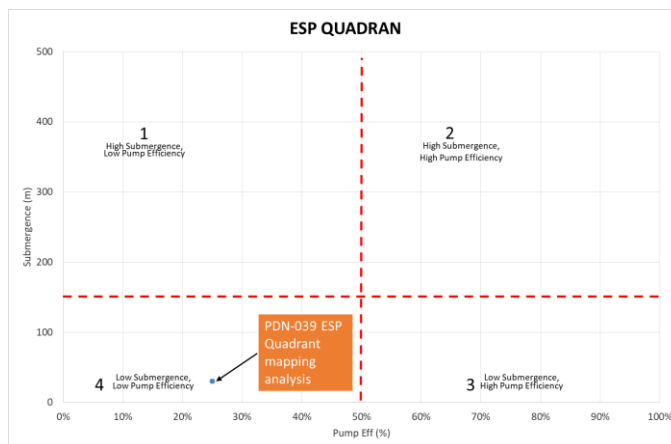


Figure 1. PDN-039's ESP Quadrant Mapping Analysis

Besides that, PDN-039 has short lifetime production (± 1 month) and has done 4 times well services in 5 months because the ESP design is not suitable with well characteristic as shown on figure 2.

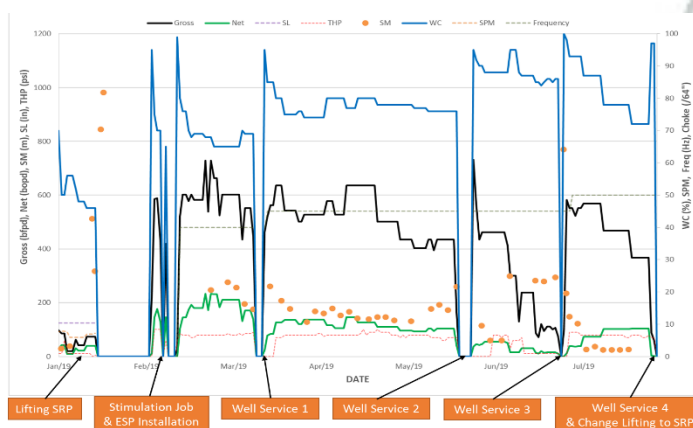


Figure 2. PDN-039's Well Production Performance

Then, Petroleum Engineering Team decide to change the lifting from ESP to SRP (Sucker Rod Pump). In calculating, designing, and optimization IPR & Sucker Rod Pump we still use the manual calculation which adapted from API RP 11 L and has been developed in Microsoft Excel. There are several limitations in this manual calculation such as we only can operate it at office. Therefore, if the engineer is not at office and cannot operate computer, IPR analysis and Sucker Rod Pump design will be obstructed and coordination with another related department will be late. Furthermore, currently manual Sucker Rod Pump Design has several steps of complex calculation with consequences miscalculation and analysis time more than 3 hours. Other than that, based on Work from Home Regulation, we find some difficulties to access any excel and paid application calculation from our home.



2 Methodology

Realizing the problems above, we decide to invent an artificial lift design application which is mobile, has simple calculations, and accurate result due to support PT. Pertamina EP transform in the 4.0 industry era.

2.1 PEARL Application Build

In PEARL invention we do several methodologies to make a magnificent mobile application to support well production and artificial lift design. PEARL is built based on international standards and engineering practice. These are the steps of IPR calculations with Vogel's Equation and Swab refers to Kermit E. Brown – The Technology of Artificial lift Methods volume 1 as shown in figure 3.a. The steps of Sucker Rod Pump design and is referred to API RP 11 L, Kermit E. Brown – The technology of Artificial lift Methods Volume 2a, and Gabor Takacs – Sucker rod Pumping Hand Book are shown in 3.b.

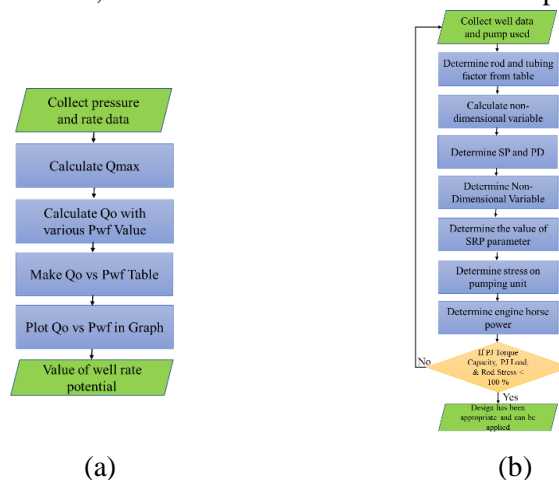


Figure 3. (a) IPR Calculation Flowchart, (b) Sucker Rod Pump Design Flowchart

In order to make the calculation mobile, we make the application with android based in Android Studio as shown in the figure 4.

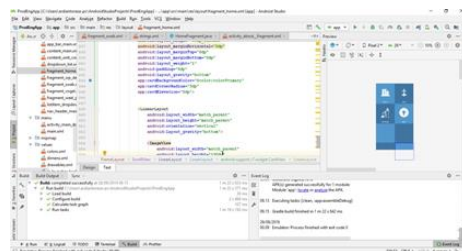


Figure 4. PEARL Application Build in Android Studio

After that, we check and trial the application to fix the bugs and error so the application can use properly.

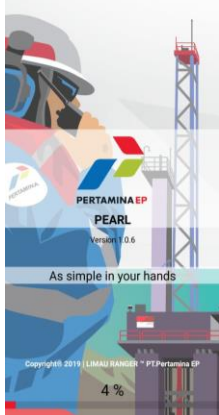
3 Result and Discussion

3.1 PEARL Application Features



PEARL Application has several features and can be operated in Android based mobile phone. The first feature of PEARL Application is well potential / Inflow Performance Relationship (IPR) calculation

based on rate production (Well PI) and swab data. The second feature is Sucker Rod Pump Design. The interface and features of PEARL Application are shown in figure 5.



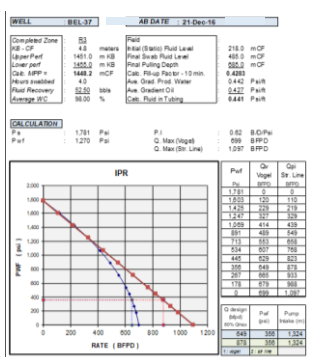
(a)



(b)

Figure 5. (a) Interface of PEARL Application, (b) Features of PEARL Application

PEARL Application gives user-friendly calculation display, so the user is easy to input the data and operate it. The comparison and transformation of calculation display between Microsoft Excel and PEARL Application features are shown in the figures below.



(a)



(b)

Figure 6. (a) IPR Based on Swab on Microsoft Excel, (b) IPR Based on Swab on PEARL Application

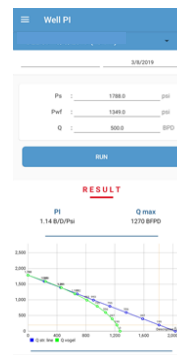
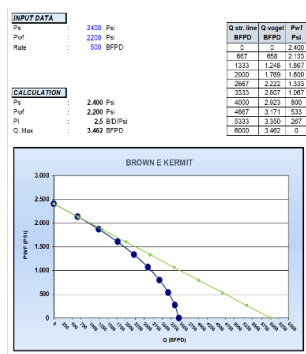




Figure 7. (a) IPR Based on Well PI on Microsoft Excel, (b) IPR Based on Well PI on PEARL Application

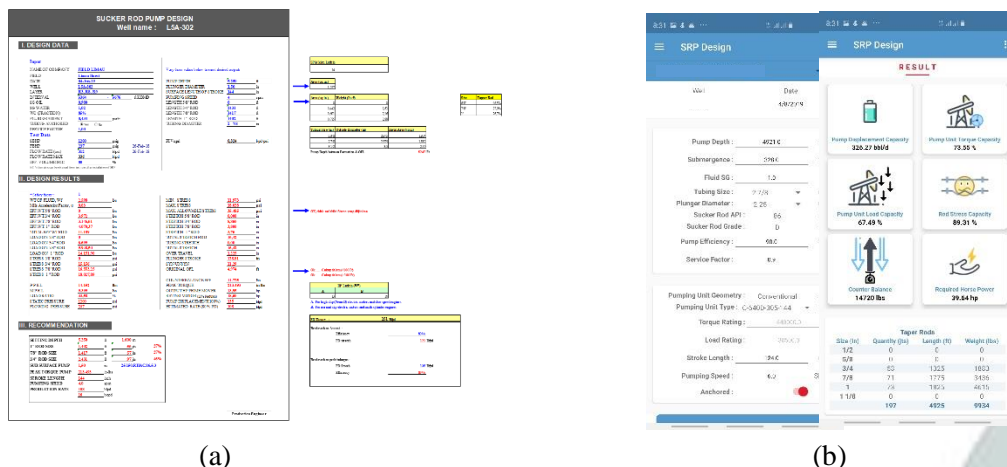


Figure 8. (a) Sucker Rod Pump Design on Microsoft Excel, (b) Sucker Rod Pump Design on PEARL Application

3.2 PDN'039's Sucker Rod Pump Design

After the PEARL application is ready, we use it to design sucker rod pump of PDN-039 as shown in figure 9.

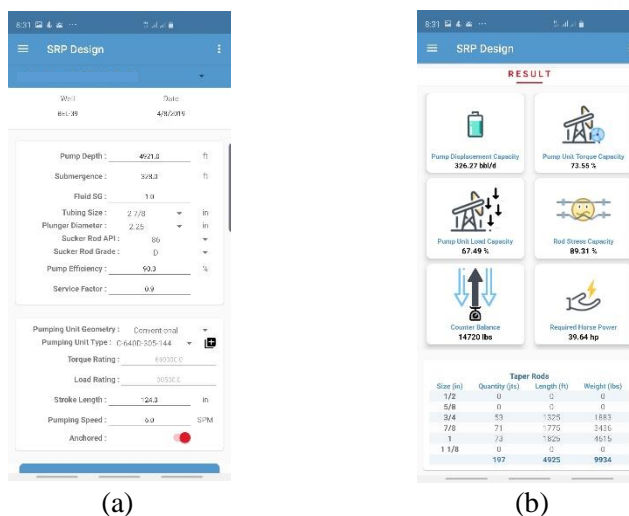


Figure 9. (a) PDN-039 Sucker Rod Pump Design Parameter Input, (b) PDN-039 Sucker Rod Pump Design Result

Based on the sucker rod pump design, with plunger size 2.25", stroke length 144", and pumping speed 6 SPM (stroke per minute) the optimum production rate of PDN-039 is 440.35 bfpd. This design can be applied to the well because the pumping unit parameter as shown on the result (on figure 6.b) is less than 100% which means the pumping unit is still capable to be operated.



The quality of the sucker rod pump design is also confirmed by the BEL-039's dynamograph test as the representative of pumping performance. The result is full pump and pumping unit is on its best performance as shown in the figure 10.

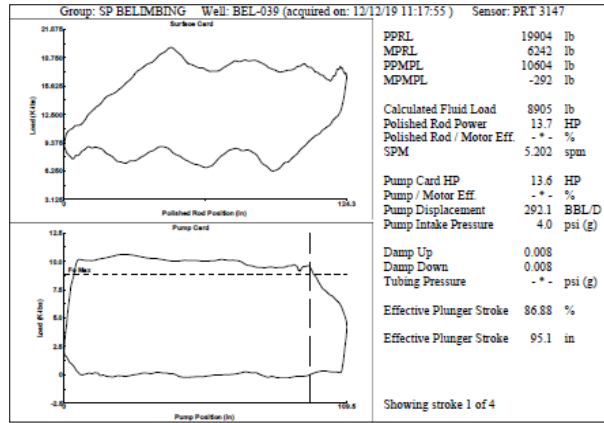


Figure 10. PDN-039 Sucker Rod Pump Dynagraph Test

While the design is applied, it makes the well has longer production lifetime since changed the lifting to sucker rod pump from August 2019 – now (more than 8 months) with average production rate 180 bfpd / 63 bopd as shown in the figure 11.

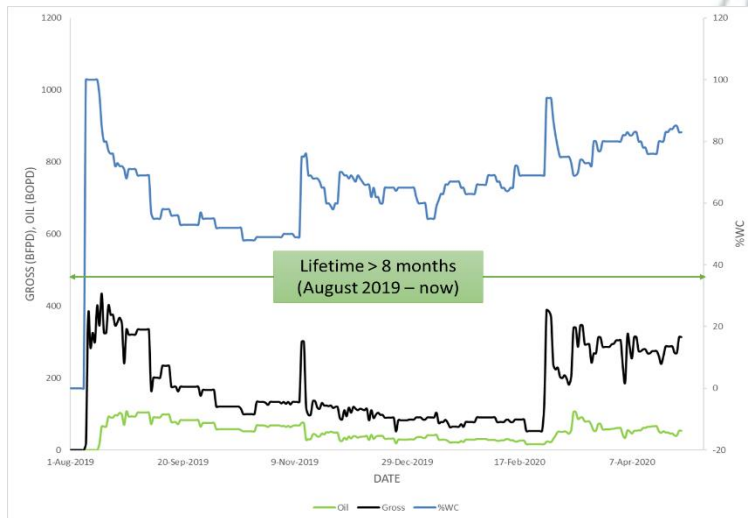


Figure 11. PDN-039 Production Performance (August 2019 – now)

4 Conclusion

PDN-039 is one of active oil production well since October 2018 which is produced using ESP on February 2019 – August 2019. While PDN-039 production is using ESP, there are 4 times well services because the ESP cannot perform optimally. Since August 2019, PDN-039's lifting is converted to sucker rod pump. There are several obstacles in changing the pump such as existing sucker rod pump design in Microsoft excel has limited time and access because we only can operate it using computer at office and make the coordination disturbed. The manual calculation also has several complex steps so it probably



causes miscalculation. PEARL Application invention is built referred to international standard and engineering practice brings PT. Pertamina EP to the 4.0 industry era which can be the answer to change manual calculation and using computer to mobile application. This technology is too applicable and helpful during this work from home regulation, so we

can do the design very easy. PEARL's Sucker Rod Pump Design result can extend BEL-039 production lifetime from ± 1 month become more than 8 months (August 2019 – now) and has good pumping unit performance (full pump based on dynagraph test). PEARL Application gives easiness to the user to do analysis and calculation anywhere and anytime so it becomes the solution to increase coordination efficiency with another related departments.

References

- [1] API RP 11 L. 1988. Recommended Practice for Design Calculations for Sucker Rod Pumping Systems (Conventional Units). American Petroleum Institute. Washington DC.
- [2] Brown, Kermit E. 1977. Technology of Artificial Lift Methods Volume 1. PennWell Books. Oklahoma.
- [3] Brown, Kermit E. 1980. Technology of Artificial Lift Methods Volume 2a. PennWell Books. Oklahoma.
- [4] Takacs, Gabor. 2015. Sucker-Rod Pumping Handbook Production Engineering Fundamentals and Long-Stroke Rod Pumping. University of Miskolc. Hungary.