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A Comprehensive Study on the Application of Production Analytics Solution Across Indonesia's Mature Fields

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Abstract

The oil & gas industry is currently moving from traditional workflows to the implementation of analytics and artificial intelligence in accelerating and enhancing repetitive tasks. All is driven by the need to automate low-cognitive tasks enabling engineers to spend more time on high-cognitive components of the existing workflows, thus leading up to smarter decisions. This has been made possible by the recent developments and adoption of various analytics and machine learning tools. We are now changing the game in Indonesian mature field's production optimization strategy using Analytics.

Well Portfolio Optimization (WPO) is one of the implemented production analytics solutions for Workover Candidate Selection, which intends to keep asset teams permanently aware of underperforming wells in need of a workover and is particularly suited to rapidly screen and rank hundreds or thousands of wells. The solution enables the proactive management of existing wells by identifying and prioritizing workover candidates through a hybrid and automated decision-support system. 'Hybrid' refers to the integration of traditional petroleum-engineering analysis methods and best practices with advanced algorithms for autonomous well performance signature identification, as well as client business logic.

This solution has been implemented in one field in Indonesia. Given the result of the first deployment, this paper will describe the effect of the expansion of similar project across all mature field in this country. Comprehensive topic starting from the readiness of our data infrastructure, until the potential values of the full-scale practice, will be outlined, looking from the nation's perspective.

Introduction

Industry 4.0 is currently accelerating business in any sector, by giving analytics and artificial intelligence implementation to support operational and managerial liabilities. The oil and gas industries are absorbing the transformation given the technology provided will revive analysis and reduce risks incorporated within the operation. The benefits provided will give the companies time reduction, therefore, the deferred production could be brought forward faster.

Indonesia's national production target is 775,000 barrels oil per day, while the actual production is around 752,000 barrels oil per day. The forecasted decline is 10.7% annually and declared target is 783,600 barrel per day, which translated into 83,000 barrel per day shortage in 2 years if we are still doing the business as per today. Currently, there are 88 working areas for exploitation within Indonesia, and 46% of them are mature fields. For each mature field, there is an asset team which objective is to extract production fast and efficiently to reach field's target.

The asset team is responsible to calculate well potential, design and conduct optimization plan and achieve production target, all using enormous amount of data using certain workflow. Here, production solutions have been one of the most crucial hope to transfer the traditional workflows to the implementation of

analytics and artificial intelligence in accelerating and enhancing repetitive tasks. This has been made possible by the recent developments and adoption of various analytics and machine learning tools. We are now changing the game in Indonesian mature field's production optimization strategy using Analytics.

Mature Fields in Indonesia

Nowadays, 66.67% of the world's daily oil production comes from mature fields, referred from IHS Cambridge Energy Research Associates. In the study, fields were defined as mature field when they had produced more than 50% of established proved plus probable resource or had produced more than 25 years. The biggest oil reserve in Indonesia is in East Java with 653,1 MMstb reservoir, and the highest gas potential is from Bintuni with 13,932.7 Bscf reserve. Indonesia has 2 peaks of production in 1977 and 1995 with around 1,700 Mboepd rate. Currently we are at 755 Mboepd oil production rate, with 10-12% decline each year. The production issues are ranging from inadequate pressure support, water production issues, formation damage up until wax and hydrate formation, depends on the type of the reservoir and operating conditions the field is producing.

In the middle of high demand of oil and gas production, there is a drive to enhance oil production of the existing well stock through better well management. As fields get older, the well intervention work is expected to grow in term of magnitude, complexities, need for new technologies, cost impact and new challenges. In 2018, there were 76,485 well service activities and 628 workovers executed in the areas of Well Surveillance, Well Optimization, Well Restoration and Well Integrity. Well Optimization is oil generating activities such as additional perforation, water shut off, gas shut off, stimulations, etc. All activities to maintain old wells oil potential will be under Well Restoration, such as ESP replacement, gas lift valve re-installation, tubing wash, etc. Other than well interventions, there are 278 infill wells drilling activities, 681 sq-km 2D seismic and 4,003 sq-km 3D seismic to search for new reserves within the same field and to validate subsurface model accuracy.

One of the superiorities working with mature field is that they are predictable, both in production and cost terms, thus could provide reliable cash flows. In Indonesia, in average, both workover activities and well intervention activities delivered 3.4% increment each from the last production. Infill drilling only adds around 6.9% increments, while the capital taken is 7-15 times bigger compared to workover activities. Accordingly, workover and well intervention activities are more appealing in terms of gain and investment ratio. Thus, the next chapter will discuss more on how to put workover and intervention candidate selection into automation and analytics to get the well ranking effectively.

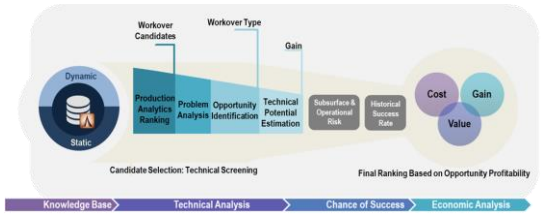
Production Analytics Solution

Many operators worldwide have invested millions of dollars into sustaining and revitalizing older assets which converts to intelligent field efforts. This enables an engineer sitting at desk hundreds of miles away to monitor entire fields single handedly.

Well Portfolio Optimization

The solutions that have been implemented has the concept as a Well Portfolio Optimization, was built as a continuous intelligent system for automated well candidate screening based on current workflow at the designated field. Well portfolio optimization intends to keep asset

team permanently aware of underperforming wells in need of an intervention and is particularly suited to rapidly screen and rank hundreds or thousands of wells. The solution enables the proactive management of existing wells by identifying and prioritizing intervention candidates through hybrid and automated decision support system. 'Hybrid' refers to the integration of traditional petroleum-engineering analysis methods and best practices with advanced algorithms for autonomous well performance signature identification, as well as client business logic.



The component of the solution is divided into 4, knowledge base, technical analysis, chance of success and economic analysis, which aspect and applicability within Indonesia would be described in detail. One mature offshore field in Indonesia, and 2 fields worldwide have implemented this solution subsequently after its release back in 2018 and had given satisfactory result.

Figure 1: Production Analytics Solution Workflow

Knowledge Base

Great analysis came from the finest data. Having a robust and integrated database as a knowledge base which holds all the variables and values needed by the analysis is critical. The best environment for the analytics solution to work on is at cloud environment. However, there is no cloud server yet in Indonesia, which ability to put the data inside cloud server outside is also restricted by data residency regulation. Therefore, we had to build on premise solution for applying production analytics at the operator's environment.

The basic need is to have Production Database Management System (PDMS), which most company implement the system from third party. This to ensure that the data could be accessed, manipulated, processed and transformed rapidly, while maintaining the integrity of production data. If PDMS system had performed well, then the production analytics solution is most likely able to be implemented there.

Technical Analysis

This component is to run all the petroleum engineering workflows used to define under performer wells and calculate the technical potential for each of them. For each candidate, we run an intelligent system that could also recommend the workover or intervention type in order to get the highest NPV based on their own restrictions. The candidates are also ranked here, based on each company's KPI.

The engine that had been developed in background, for example, are automated Decline Curve Analysis, automatic interpretation on Chan Diagnostic Plots, Heterogeneity Index calculation, and Behind Casing Opportunity machine learning model. There are more engines to be built based on the company's manual workflow that will support the engineer in making decisions.

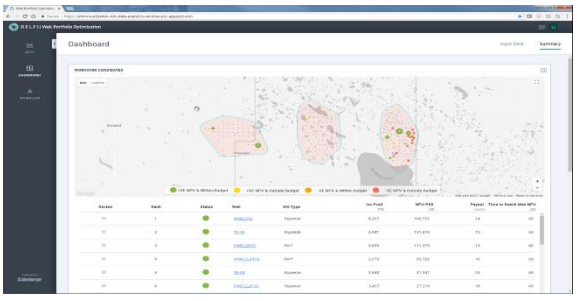


Figure 2: Well Portfolio Optimization Dashboard

Chance of Success

Chance of success is how big the chance was to get the workover or intervention result corresponding to initial gain forecast. This chance of success varies depend on the field or reservoir and the workover or intervention job itself.

The risk assessment is based on the amount of the risk they possess both from subsurface and operational perspective to be queried for each completion and the string.

Economic Analysis

Once the Technical Analysis results have been reviewed, we can proceed for the economic analysis. Economic Analysis consists of the following components: Total gain for gas and oil, total cost calculation (CAPEX, OPEX, lost cost), NPV calculation, historical success, estimated value. There is assumed that all the recommended case opportunities have been implemented in each well. As the result the user will review the opportunities from the technical analysis and economic analysis which would give differ from the calculation.

Total gain Calculation is calculated by comparing pre-workover conditions and post-workover conditions. Production forecasts are simulated for each scenario and the incremental is pick up as the total gain. Thus, there will be total gain in oil and total gain in gas production. The SKK pricing model was used for oil and gas price scenarios and the total gain could be converted to dollar values.

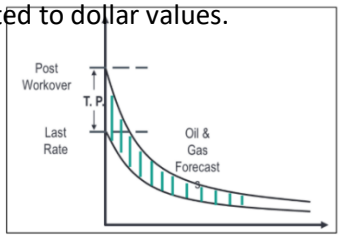


Figure 3: Total Gain Calculation Concept

ESP & SRP Data Analytics: Automated Event Detection

The electrical submersible pump (ESP) and sucker rod pump (SRP) are the most common forms of artificial lift pumping techniques used in mature fields. At the best manner, ESP and SRP are being monitored real-time and the parameters are taken in a high frequency manner.

Generally, ESP works best under steady-state flow conditions. A successful monitoring option will work to avoid low or no-low conditions. This is because without flow, an ESP experiences damaging heat rise and vibration which reduce the health of the system. If ESP operates with no flow for a long time, the ESP would eventually failed. Using analytics, we can create predictive analytics in order to detect should there is any issues happened based on the data signature.

For example, the automated identification of downhole restriction at Figure X. With the knowledge provided, the engineer would have been aware of the deadhead condition earlier, providing ample time to make adjustments or contact the field to avoid unplanned shutdown. In the end, the correct decisions taken will elongate the ESP lifetime and decrease workover cost substantially.

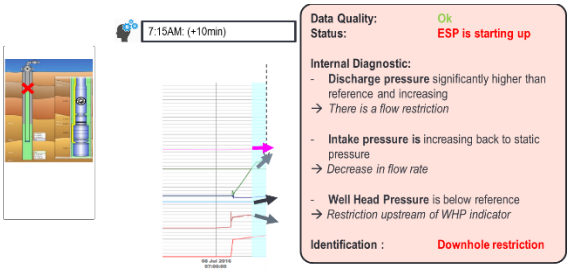


Figure 4: Artificial Lift Real-time Monitoring

The engine is event-centric. By establishing event severity and type, the alarm list can be prioritized to focus on the attention of surveillance personnel on the most critical events. This helps quickly identify when the event is happening, while also showing contextual trends from before to help the engineer making effective decision. Additionally, the historical log of event types and their duration can be used to generate insights which help engineers assess the performance and operating plans for each well.

Potential Values of Full-Scale Practice

At the current state, usually an asset team need 3 months of data gathering, manual workflow run, production forecasting and evaluating before getting the well list that is going to be executed. Using this technology, we can reduce the screening time, leaving most time on high-level analysis.

Thus, within the same timeframe, we can generate more than 4 lists of wells to be executed.

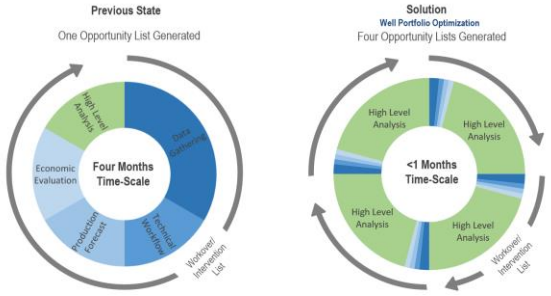


Figure 5: Well Candidate Screening Process

This solution could detect issues and analyze the cause faster. If we take a look at diagram below, the faster detection could lead to incremental production volume for the particular completion. Imagine having the system for all completions, all the deferred production that could be brought forward.

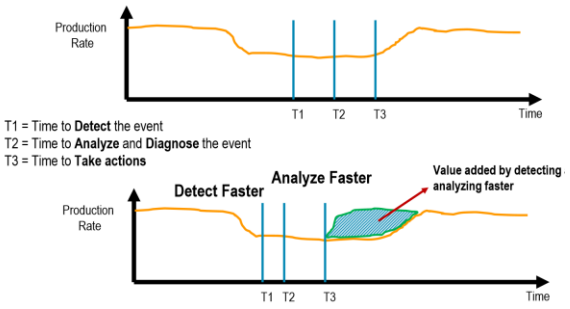


Figure 6: Before and after using WPO and ESP/SRP Analytics

Conclusions

For decades, the EV/cost has been the parameter that is useful and act as common decision-making tool for screening and ranking the wells for workover or intervention. Here, production analytics solution able to reduce the time in creating EV/Cost, from previously 4 months for a field, to only 10 minutes. The final result will be displayed as well ranking so the engineers are aware of their opportunities in the field. This solution is suitable for Indonesia's mature field since most of the workload for mature fields is on intervention or workover. Using this, each field could search 4 times more opportunities, do high-level petrotechnical actions and save up to 90% of their time doing repetitive tasks.

We are also able to predict any undesirable event within the operation, such as pump shut down and compressor shut off. This is suited to fields in Indonesia which has ESP and SRP as the most common artificial lift methods. Using the predictive analytics, the real-time ESP and SRP operation will be fully supported by indicator and forecast of an event that is likely to happen. In the long run, it will lengthen the ESP and SRP lifetime and reduce workover cost.

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