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INTEGRATION OF NEW EVALUATION TOOL FOR PRODUCTION FORECAST MANAGEMENT IN PHM: A SUCCESS STORY

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Abstract.

An integrated material balance tool (new software) was introduced and used to improve the reliability of field production forecast. The integration of this tool will be elaborated in three phases : 1) Selection Phase; describing the approaches to select the software including the calculation speed comparison of each available software in the market, 2) Integration Phase; describing the efforts to ensure that the software is fit for forecast purpose and ready to use as part of business process; and 3) Improvement Phase; elaborating how the software evolving become a dependable evaluation tool for future development projects and other purposes.

The new tool tackles the major limitation of the previous tool where surface constraints were not integrated thus resulting in a more reliable production forecast. Evaluating short term and long term forecast as well as future development projects is now faster. It is also bringing the benefit of efficiency, as the calculation speed of the software allow more detailed evaluation of project production forecast profiles at the same timeframe. All of these improvements eventually contribute to field development optimization. Some of the projects were benefitted from the software such as well head compressor (WHC) and drag reducer agent (DRA) which were dedicated to Sisi Nubi and South Mahakam fields.

The evaluaton tool integration process is practical and relatively easy to replicate. This paper also demonstrates how the integration of surface limitation and subsurface evaluation brings additional value for field development.

Keyword: Evaluation; Management; Forecast; Integration; Software; Field Development

1 Introduction

Pertamina Hulu Mahakam (PHM) and previous operator Total E&P Indonesie (TEPI) have been developing Mahakam block for more than 50 years. The Mahakam block consists of 7 fields in which 5 of them are gas fields. The company business process requires short and long term gas production forecast as a basis of reservoir management, gas marketing activities, company annual budget as well as long term development strategy.

In 2005, an initiative was launched in order to improve the way of these forecasts are managed. There were two main issues; the first was that the software to integrate forecasts of each field; called Predic; is less user friendly with a delicate programming language. There were few persons in the company whom able to worked with the software. It had no longer support from its developer and couldn't properly represent subsurface aspect of several complex field. The second was that each Assets uses different software to develop their forecast. The reason may vary; it can be due to different subsurface aspect of the field or due to the preference of the team member. In addition to that, on a more strategic view, the management also foresee several upcoming challenges. There will be more fields come on stream resulting in a production increase, more drilled wells thus fast growing data. A robust production forecast will still be required but there will be also more development phase. The surface facilities may as well be modified in the future, therefore it is important to have an integrated surface and sub-surface simulation tool which can quickly adapt any change.

A new integrated material balance software was then introduced to replace Predic. This paper elaborates how PHM integrates this new tool to become a reliable part of its production forecast management.

2 Methodology

The integration process will be described into three phases; Selection, Integration and Improvement. The Selection phase describes how did PHM decide which tool to replace Predic. The integration phase will describe the efforts to ensure that the new software can provide results at the desired level while the improvement phase will also describe out how the software eventually be used to answer new challenges and ideas outside the initial scope.

2.1 Selection Phase

As previously elaborated in introduction part, the problem which would like to be solved is already there. At the time, it has already been decided that a new tool (software) will replaced Predic. Meanwhile, a study on gas planning tool has already started at Total headquarter. Current practice of gas network and reservoir modelling in three affiliates: Total Indonesie, Total Netherland and Total France were reviewed. The aim of the study was to find the key features a software that could have an answer the needs of each affiliates and use them as a basis to find the best tool to be used across the group. As for TEPI, 3 key features were listed: 1) Material balance calculation for multi-wells/multi tanks as gas fields in Mahakam formed by multi layered channels and bar dominated reservoirs. 2) Pressure drops modeling for well and network, emphasizing the importance of pressure changes to the potential of the fields and 3) Ability to generate production profiles, the key deliveries of the tool. At the end of the study, it was concluded that for TEPI, the search for Predic substitute will continue through a proof of concept exercise in which developers built sector models of Tunu field (Poncin, 2005).

Fast-forward to 2006, It was concluded that two solutions will be proposed for the case of TEPI. Tool A is a combination of several widely known software from one of the biggest service provider in Oil and Gas industry. While tool B is a relatively new software which has been proven in modelling gas storage operation and were developed by an US based startup company. These two tools were selected after building comparison matrix consists of 5 aspects of gas network and reservoir modelling with 17 features being reviewed on 11 software. The list of these features are available in Table 1.

These two solutions were then presented to TEPI as the final user to collects opinion and feedbacks as an input for the Technical Committee in charge of deciding the final results. Tool B was in favor due to several reasons; 1) Tool B is simpler as an integrated tool, it already has network representation (in addition to reservoir and wells) in its main platform. 2) Tool B is more adapted to the business process workflow mainly due to dynamics system overview available on main screen allowing quality control on network configuration and debottlenecking (TEPI, 2006). Finally, it was decided to use Tool B. Figure 1 shows a simplified workflow of the selection period.

Table 1. 17 key features used to build comparison matrix

ASPECTS	FEATURES
Reservoir	▪ Model Structure (Region and Layers) ▪ Thermodynamic ▪ Field representation ▪ Commingle production, multi layers reservoir ▪ Take into account water influx
Well	▪ Well Representation: Inflow ▪ Well Representation: Outflow ▪ Well re-start
Network	▪ Surface network model ▪ Compression
Workflow	▪ Able to provide production forecast profile (short and long term) ▪ Organization ▪ Potential ▪ Controlled Forecast
User/Interface	▪ Automation and Optimization ▪ Calculation time ▪ User Friendliness, Visualization and Documentation

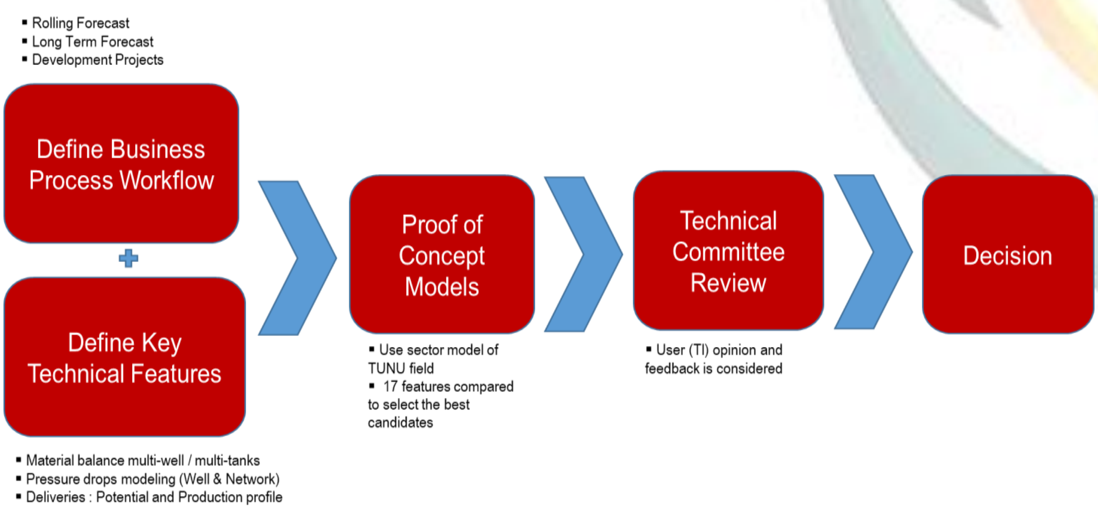


Figure 1. Simplified workflow of selection period

2.2 Integration Phase

As soon as Tool B was selected, the integration period began. During this stage, several efforts were done in order to ensure the new tool can deliver the required information at the highest quality. One of the most important thing during this period is the assignment of one champion. The champion is a senior reservoir engineer which had experience working with several gas field in Mahakam and high competency in reservoir simulation. The role of this champion is: 1) Propose correction, modification or customization to the tool developer (Tool B) to answer the needs of each fields. 2) Perform Quality Check all of the tool's features to be in line with the company context and 3) Deliver basic training for key user per field/asset, preparing a numbers of expert for the future. Figure 2. illustrates the role of the champion.

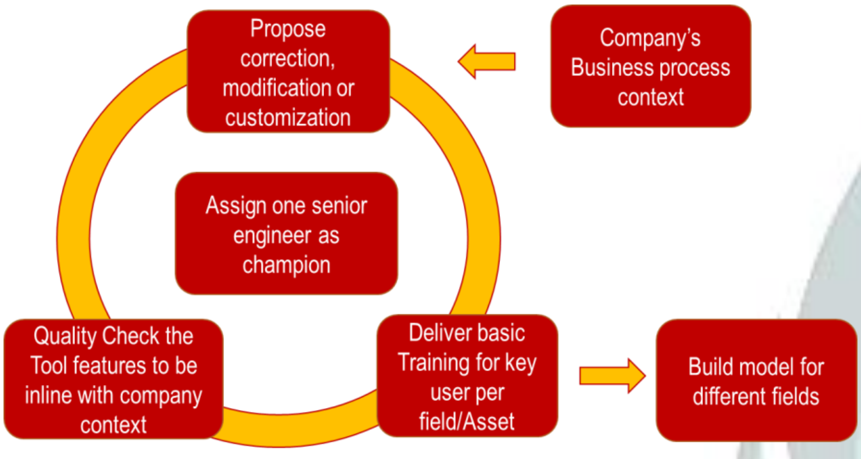


Figure 2. The role of champion

During this period, a full field model of 4 fields were developed and used for forecast delivery. In addition to that, 6 (six) important customizations and 4 (four) detail method review were carried out to improve the quality of the tool (RAA, 2011). The champion played a very important role on these developments. Some of these customization and method review are elaborated below:

Well and/or layer static and flowing pressure.

To calculate various pressures (static and flowing) and its variants (P/Z calculation, etc) at various depths at layer or well scale. The requested parameters are: layer and well's pwf, static pressure at well's datum depth and well head level (Figure 3). The calculated pressure is used to improve history match; The tool P/Z plot at well datum is now comparable with P/Z plot (at the same datum) from well head shut- in pressure measurement and the simulated layer Pwf and static pressure can be compared directly with the one from production logging survey (PLT). This modification is very essential as gas field in Mahakam consists of multi-layered reservoirs in which one well could penetrate up to 50 reservoirs.

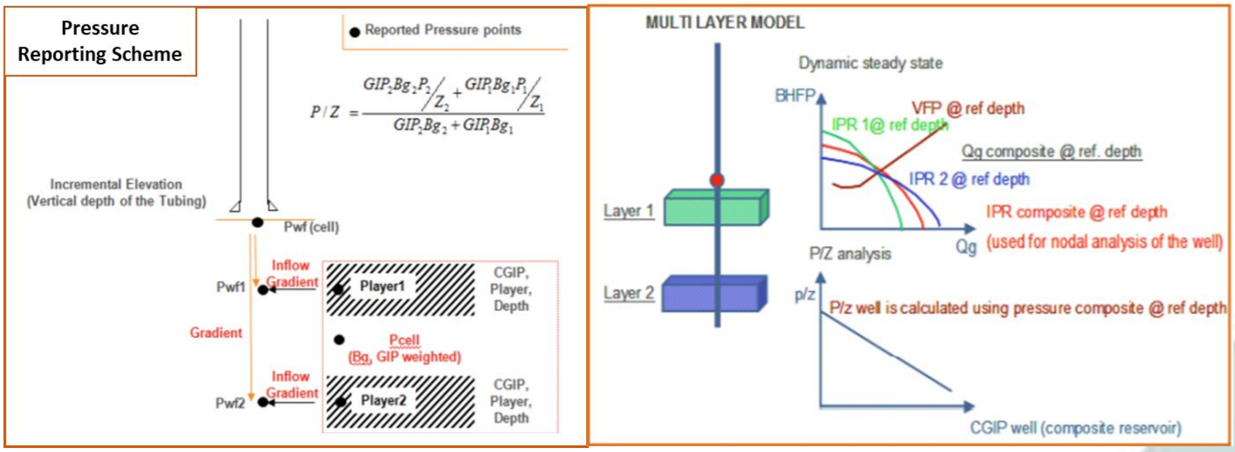
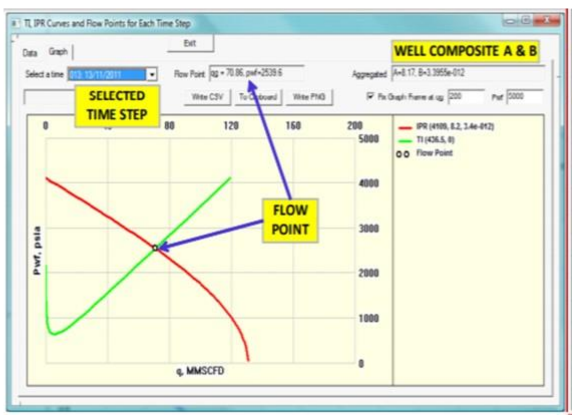


Figure 3. Pressure reporting scheme and what they are used for

Well nodal analysis

To create nodal analysis (VLP- IPR) module at well scale, based on composite IPR methodology of a well with multilayer. Two modules were created: 1) Nodal analysis at user disposal. This module allows users to evaluate the sensitivity of the model based on IPR (layer pressure, A&B Forcheimer coefficient) and VLP (well head pressure and WGR). 2) Nodal analysis at each simulation time step. This module allows having post simulation evaluation from IPR/VLP tracking. The calculation output also useful for asset data base and for further evaluation/ study. Figure 4 illustrate the well nodal analysis.



No.	Date	q	Pstat	Pwf	Pwh	WGR	CGR	RF	A-calc	B-calc
		MMSCFD	psia	psia	psia	B/MMCF	B/MMCF	Frac	psia2/cp/...	psia2/cp/scfd2
			732.8	3272.05	438.951	5	20	0.00917646	4.99931	1.23463e-008
			665.56	3229.06	438.822	5.09176	19.9816	0.0182106	4.99938	1.23461e-008
3	03/11/2011	88.91	4598.4	3185.89	438.719	5.18211	19.9636	0.0271016	4.99941	1.23459e-008
4	04/11/2011	87.5993	4537.59	3146.46	438.627	5.27102	19.9458	0.0358616	4.99944	1.23458e-008
5	05/11/2011	86.2804	4476.63	3106.89	438.536	5.35862	19.9283	0.0444896	4.99944	1.23458e-008
6	06/11/2011	84.9591	4415.55	3067.14	438.444	5.4449	19.911	0.0529855	4.99943	1.23458e-008
7	07/11/2011	83.7362	4359.06	3030.4	438.361				4.99942	1.23459e-008
8	08/11/2011	82.5406	4304.04	2994.51	438.28				4.9994	1.2346e-008
9	09/11/2011	81.3258	4248.89	2957.98	438.198	5.69614	19.8608	0.0777458	4.99938	1.2346e-008
10	10/11/2011	80.1229	4194.33	2921.78	438.117	5.77747	19.8445	0.0857581	4.99937	1.23461e-008
11	11/11/2011	79.0358	4144.98	2889.14	438.045	5.85759	19.8285	0.0936617	4.99935	1.23462e-008
12	12/11/2011	77.9445	4095.48	2856.35	437.974	5.93663	19.8127	0.101456	4.99932	1.23464e-008
13	13/11/2011	76.8496	4045.86	2823.4	437.902	6.01457	19.7971	0.109141	4.99931	1.23464e-008
14	14/11/2011	75.7557	3996.56	2790.43	437.832	6.09143	19.7817	0.116717	4.99929	1.23465e-008
15	15/11/2011	74.7662	3952.42	2760.68	437.768	6.16718	19.7666	0.124193	4.99928	1.23466e-008
16	16/11/2011	73.7729	3908.14	2730.77	437.705	6.24195	19.7516	0.131571	4.99927	1.23467e-008

Figure 4. Well Nodal Analysis features on the tool

Network Validation

The new tool uses simple model in the network (mono ID for a line, limited flow correlation, etc.). Thus, a calibration process of a network model is mandatory. The calibration process is basically a comparison between simulator calculated pressure and pressure from measurement at platform level. For this purpose, a synthetic well model is created to represent the total flow rate of a platform. Sisi Nubi (one of the offshore field in Mahakam Block) network model is taken as subject investigation and evaluation since it has been validated while using other commercial software. Result from the study shows that even though different approach and calculation method were used between the software, the same level accuracy of pressure prediction is obtained (less than 5% error) (Figure 5).

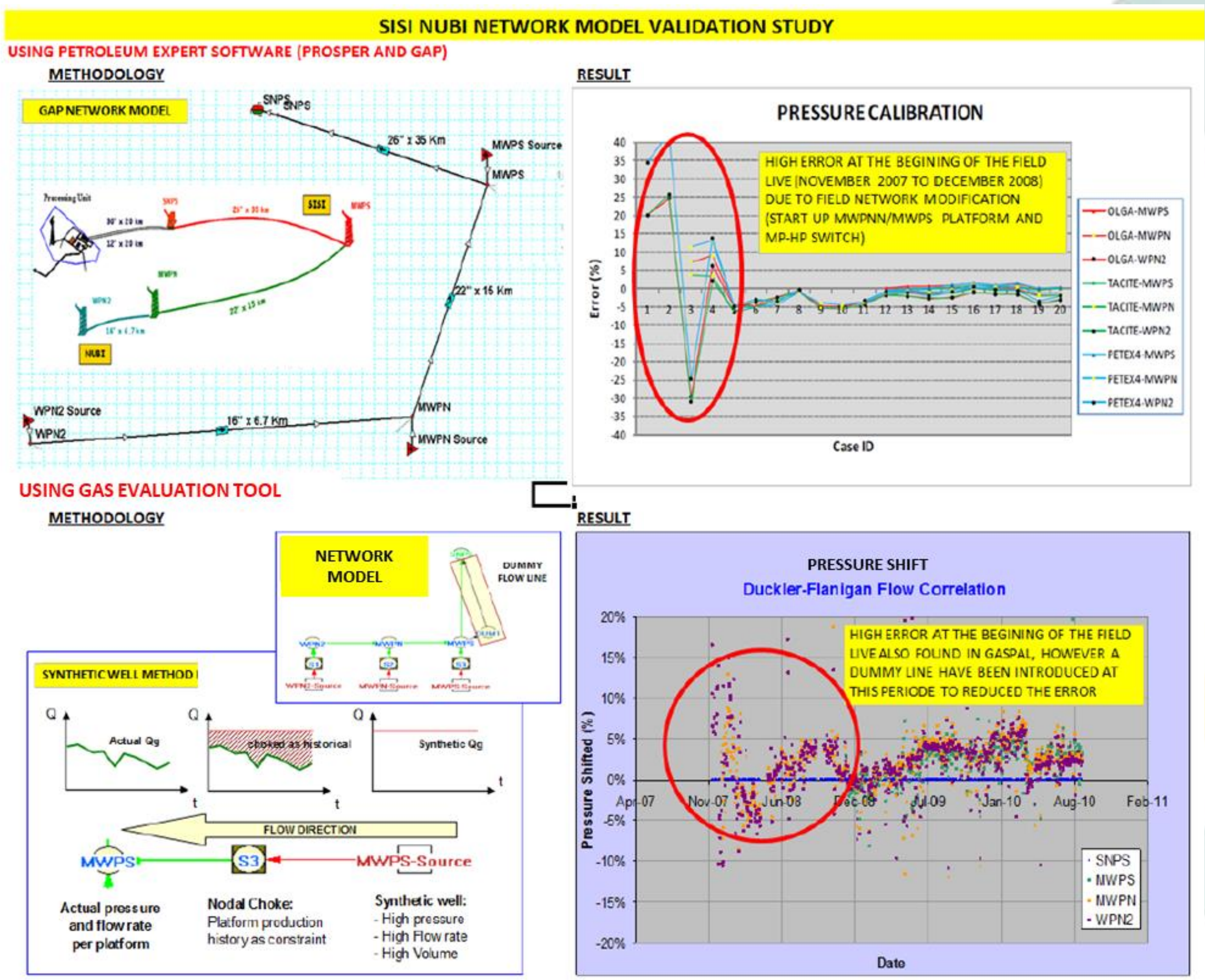


Figure 5. Network Validation GAP vs Gas Evaluation Tool

The integration period lasted for around 7 years (2007 – 2014) and ended when there was no longer customization idea/needs in relation to the main features of the tool. It is important to understand also that despite the long process of integration, the new tool had started to gradually replace PREDIC since 2011.

2.3 Improvement Phase

At the start of the period (2014), 5 engineers have been assigned as champion with another 5 are acknowledged as advance or key user. The situation showed the improving learning curve on the company. A robust tool support and development scheme has also been established as shown in figure 6. Anytime user encounter problem while working with the tool, he/she can quickly discuss with the champion. The champion would record the issue and provide solutions. In a rare case where the champion was not able to answer, He/She would contact the software developer and cascading any information that is given. In addition to that, a technical workshop is held every year. The workshop invites the lead developer to deliver training for beginners, lead workshops for advance users and participate in a technical discussion. Technical discussion session has been proven to gives a great benefit for the company as it leads to solving the up and coming problems not only related to production forecast, but also with field development. Some of the important case in which the tool play a role are the following:

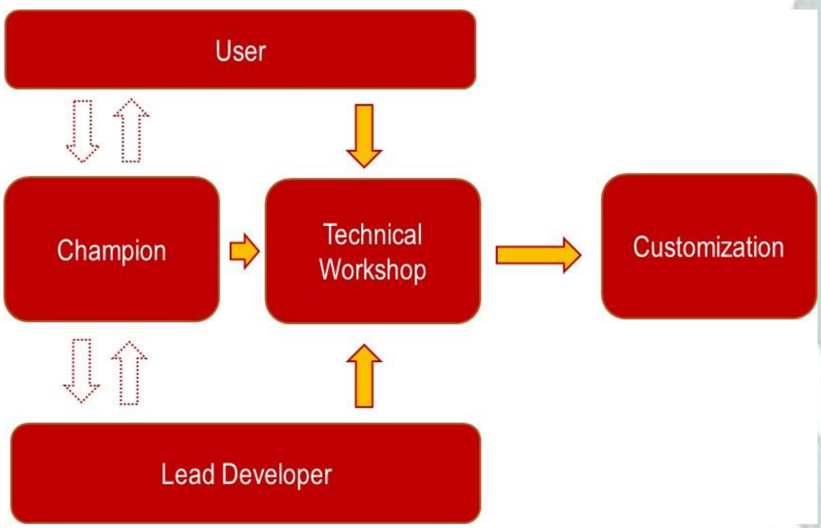


Figure 6. Tool support and development scheme

Well Head Compressor

The decreasing reservoir pressure was also triggering the initiative of lowering the network pressure. One of the possible scenario for field development is installing wellhead compressors. The original evaluation tool only has compressor represented at a node, apart for a well. But adding a new features of compressor installation on top of a wellhead was feasible. After being requested in mid-2018, the feature was ready to use in 2019. The new features were used to perform conceptual study of wellhead compressor project at several fields.

Drag Reducing Agent (DRA) Injection

South Mahakam field gas production is transported to the Senipah Processing Area through 63 km of 24" pipe which generate an important backpressure. Drag Reducing Agent (DRA) is expected to reduce the backpressure. The impact of this DRA injection can be simulated by the evaluation tool after adding a simple backpressure reduction assumption by changing the pipe efficient. A study was performed using the evaluation tool to assess the impact of different injection duration to the incremental gain as a function of manifold pressure and production rate.

3 Result and Discussion

It is fair to say that PHM has been enjoying the fruit of the long integration process of the evaluation tool in managing the gas field production forecasts. The most apparent benefit is the accuracy of production forecast. For example, the average gas production (year-to-date) realization is within 5% difference with the RKAP 2020 target for the field in which the evaluation tool is used. (Figure 7). It is true that the achievement is also a result of good planning and coordination between multiple entity, but nevertheless, it confirms that the tool can adapt with the running business process and contribute to the excellent forecast.

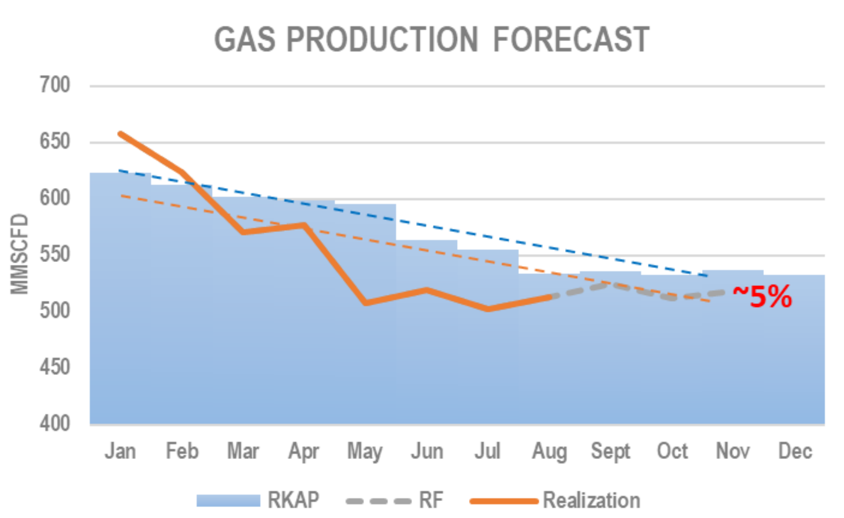


Figure 7. 2020 Gas Production Forecast

The detailed study performed on network validation proven to be a key factor when the field and surface facilities faces maturity. As the reservoir pressure and network pressure are getting lower, having a new high pressure well put on production on the network will generate an important backpressure effects to other wells connected to the same network. This phenomenon initially caused an over pessimistic forecast. However, thanks to the flexibility of the tool and with a good communication with the developer, an improvement on the calculation method were quickly introduced, enabling good representation of the backpressure effect and production behavior on mature fields/surface facilities. This sort of things would be impossible to be done using Predic, as it lacks the surface aspects constraints/representation.

Evaluation on lowering network pressure, including installing wellhead compressor was performed to portray the economic benefits during late life of the gas field. Gain estimation for 4 platforms of Sisi Nubi field, 4 platforms of South Mahakam and 3 platforms of Peciko was calculated with the help of the tool in relatively easy manner. Additional constraint and information from field observation were easily introduced to the calculation, resulting in a realistic incremental gain of up to 60 bcf.

DRA injection study were also successfully performed. It was concluded that the injection should be performed until 2018 and it will generate an incremental gain up to 3 bcf until 2020. The case again showcased the important of having a good representation of network on gas production evaluation tool.

Another benefit from the integration, is that the forecast profile exercise is relatively faster. The most complex model only took less than 5 minutes of running time. Having this, the engineer's work become more efficient, as he/she can spend more time evaluating the forecast profile rather that making them. Author believes that this increase of efficiency also has an important role to the PHM's production forecast level of accuracy.

4 Conclusion

PHM has successfully integrate a new evaluation tool to be part of its gas production forecast management through 3 (three) periods:

1. Selection Phase, a process of evaluating the key characteristic need from a software to eventually decide the best alternative.
2. Integration Phase, a process of quality checking, features customization and learning curve development.
3. Improvement Phase, a process of establishing a robust support and development scheme

The evaluation tool has positively contributed to the accuracy production forecast and as well as to the evaluation of several development projects. One of the key value of the tool is its network representation as well as their developer response to any queries from the user. Authors hope that the experience of PHM can be useful for other parties that may currently considering integration of a new software or tool for their business process.

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