HYDRAULIC MODELING FOR UPSTREAM GAS PRODUCTION PLANNING AND ALLOCATION – SIGNIFICANCE, CHALLENGES, AND RECOMMENDATIONS
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ABSTRACT

Upstream gas supply planning and allocation contains 3 cycles namely long term (20 years - end of life of a field) mid-term (up to 1 year) and short term (72 hours). Since the upstream assets are owned/operated by different companies under various production sharing contracts, each of the operating companies prefer to maximize their production and recover the investment costs at the earliest. A regulator acts as a custodian to ensure that all stakeholder’s entitlements are protected. The custodian relies on economic and hydraulic modelling to analyse the production plateau’s shared by various operating companies together with the demand profiles for viability. The commercial planning team of the custodian works closely with flow assurance engineers before confirming the production numbers as the planners are unaware of any capacity constraints in the physical network for flow. In the short term, an integrated network operator breaks the long term demand numbers and controls the network for seamless delivery of gas from upstream to LNG plants (mostly). The purpose of the paper is to highlight the challenges faced by planners and engineers during the planning cycles and to make appropriate recommendations.

INTRODUCTION AND BACKGROUND

There are 3 gas regions under the custodian and we focus on one region where the complexity is more as there are several production sharing contracts, a greater number of hubs and junctions and a wide range of gas quality.

The network overview of the region under consideration can be viewed in Figure 1.

Generally, gas produced by each field is gathered in gas hub and then sent to the risers i.e. FRA, FRB and FRC. These risers are connected to onshore gas receiving facility at a terminal from where they are sent to the LNG plants. In terms of quality, the gases gathered in Riser FRA are normally the sweetest, which corresponds with the stringent requirement in the downstream of the slug catcher SLCat-1. In terms of supply, the highest priority is usually given to the state’s electricity company. The gas gathered in Riser FRA mostly flows to the onshore facility into SLCAT-1, combined with the gas gathered in By and D_351. A portion of the gas flow in Riser FRA also spills over to Riser FRB, combined with the gas produced from the other fields and then flows mainly to the onshore gas receiving facility into SLCat-2 and a portion of it also flows into Riser FRC. Riser FRC is also linked to receive gas directly from M_1 which is a hub gathering gas from SERI and JAN fields. M_1 has the flexibility to flow its gas either to Riser FRB or Riser FRC or both at the same time.

Gas in Riser FRB flows into SLCat-2 at onshore via Trunk line 3 and Trunk line 4. SLCat-2 also receives gas from Kum cluster via a different pipeline. At onshore, SLCat-2 has another source of gas which is from SLCAT-1, but this line is normally not used.

Principally the flow of the line between SLCAT-1 and SLCAT2 should be controlled to flow only from SLCAT-1 to SLCAT-2 to ensure low CO2 content at Met-1 because CO2 content in SLCAT-2 is commonly higher compared to SLCAT-1.

Gas in Riser FRC flows into SLCAT-3 via Trunk line 5 and Trunk line 6. In its current operation, Riser FRC does not receive gas from any other fields except M_1. This situation may change in future with several new fields linked to this riser.

At the downstream of SLCAT-2 and SLCAT-3, there are several more different sources of gas. Downstream of SLCAT-2 has a link from a dry gas diverter manifold which is gas received from another gas terminal via a cross country pipeline apart from FROB. The supply to LNG-2 systems from this
facility is measured in MET-A. For LNG-3 system, the gas from the manifold is measured in MET-B. At the time of development of the gas coordination tool, the cross-country pipeline is not ready (therefore no gas flow through MET-A and MET-B) for operation and the gas from FROB is sent to the downstream of SLCAT-3.

The condensates from the slug catchers are sent to the stabilizers (STABIL 1,2,3,4,5 and 6). There are some minor contributions to the gas network from the gas recovered from all the stabilizers. However, these flows are negligible when compared to the overall gas production and hence not considered in the development of the gas co-ordination tool.

The required quality of users in LNG-1, LNG-2 & LNG-3 systems are as below:

<table>
<thead>
<tr>
<th></th>
<th>CO2</th>
<th>H2S</th>
<th>N2</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNG-1</td>
<td>max 8.5</td>
<td>max 50</td>
<td>max 3.0</td>
</tr>
<tr>
<td>LNG-2</td>
<td>max 7.5</td>
<td>max 400</td>
<td>max 2.2</td>
</tr>
<tr>
<td>LNG-3</td>
<td>max 8.8</td>
<td>max 500</td>
<td>max 2.0</td>
</tr>
</tbody>
</table>

Table 1. Desired Gas Quality at Delivery Limit (Indicative)

OPERATING ENVIRONMENT AND CUSTODIANS ROLE

To protect the entitlements of all the gas producers, the custodian of the resources acts as a regulator of supply allocation through the functions of gas planning, flow assurance and control room operations. While the economic viability of the production plateau is verified by commercial planning, capacity constraints in the physical network are identified by the hydraulic models prior to the confirmation of baseline production numbers by the gas planners.

The operators of the production sharing contracts share their annual production numbers over a period with the custodian. Once received, the custodian will have to check these against business rules that include priority of supply, internal business goals, contractual compliance, engineering constraints and reservoir management plan. Some of these rules are valid for short term planning while others hold good for long term planning. Once verified, the custodian confirms the production plateau numbers with the operators of the PSC’s by means of letter of intent. While the custodian mainly performs long term planning, the control room operations at the region derives short term plans based on the confirmed PSC numbers and reports the daily and monthly production to the custodian. Depending on the prevailing conditions the custodian adjusts the original long-term plan upon discussion with the operations, commercial and the LNG marketing teams and releases adjusted plan numbers from time to time which forms the new baseline long term plan.

CHALLENGES IN THE AS-IS BUSINESS PROCESS

The custodian of the petroleum reserves depends on the gas planners for evaluation of the PSC numbers by means of spread sheets built by senior planners based on thumb rules. The past experiences of the planners were heavily relied upon while determining the feasibility of the profiles shared by the PSC operators. This made the whole process very persona based, and the key personnel involved have remained in performing the same role over longer periods of time due to lack of skill development and knowledge transfer. Even with all this experience, the plans that were endorsed for long and mid-term by the planners encountered difficulties in implementation by the control room operators in short term as they are the ones who does the actual supply demand balancing on a day to day basis.

Several times discrepancies were noticed when a comparison is made between the long term and short term planning. Some of the situations that are not considered in the long-term plan like sudden un-planned field or equipment shutdown are reasons for such a mis-match. Apart from this, the spread sheets used by the long-term planners only consider volumes and do not track the gas composition quality in the network. As the gas quality is not tracked in the long-term planning, implementation of it in the short term can lead to Gas Sales Agreement (GSA) violations which forms the basis for a sales invoice. Once when GSA violations are identified, the control room operator makes instantaneous plans by adjusting the upstream gas supply. These adjustments do not form a part of the long-term planning and hence a new base line long term plan becomes necessary. If there are too many such occurrences happening in a short-term planning cycle it becomes highly difficult to track the plans and this can lead to an unmanageable situation. Hence a decision was made to investigate the missing links between the long term and short-term planning in terms of the business processes employed. During this process, it was realized that there is a requirement to validate the production profiles against pipeline hydraulic constraints. While the short-term planning does this by means of a hydraulic model, the same is not the case in the current state of long-term planning. So, it was decided that before the confirmation of the PSC numbers with the contractors, the same would be verified in a hydraulic model against Min/Max pipeline capacities, Min. compressor turn down, Min/Max pipeline velocities and gas quality. Inclusion of this can significantly enable the control room operators to closely follow the long-term plan. Subsequent years of planning
was carried out in this way. This process works under normal steady state operations in closely matching real time and longer-term plans, however a gap remains when any sudden transient ex: unplanned field production shutdown/ equipment maintenance. This is mainly because the simulation model developed for long-term planning is a steady state model and hence not capable of capturing the pipeline hydraulics under transient conditions. Although the revamped business in the long-term planning could reduce the number of adjustments, complete alignment between long- and short-term planning remains a task to be achieved.

**BUSINESS PROCESS WITH HYDRAULIC MODEL**

The following flow chart (Figure 2) illustrates the re-vamped process that is now carried out by the planners and flow assurance engineers before confirming the production profiles with the PSC contractors under long term planning.

**HYDRAULIC MODELLING FOR LONG TERM AND CHALLENGES**

As hydraulic modelling now becomes part of long-term planning, an appropriate simulation tool must be selected for model development. ICON software was first used to develop the model. However, during the process of simulating various scenarios, it was realized that ICON is not capable of simulating P-P boundary modelling (Pressure-Pressure) and is only capable of modelling P-Q (Pressure-flow) or Q-P (flow-pressure) boundary scenarios. This resulted in a series of trial and error analysis for matching the boundary pressure conditions thereby involving considerable time in identifying the maximum capacity for the whole network. Since long term planning involves at least 20 years, the simulations must be repeated to identify whether the long terms production profiles generated by the operators are feasible or not over this period. ICON software also does not have a graphical way of capturing the results and hence the data generated from the output of the simulator had to be transferred into another tool like Excel for graphical representation for presentation to the management for them to take a decision. The simulators found this method to be very cumbersome. The time taken for generating the simulation results for a specific scenario defined by the planners is high as ICON is not a fully flexible pipeline simulation modelling environment.

The simulation team then began to look at other available multi-phase steady state modelling tools and identified PIPEsIM as a capable tool. PIPEsIM is a steady state modelling tool for multi-phase simulation. The advantage with PIPEsIM is that it can model all P-Q, Q-P and P-P boundary analysis. However, the challenge of graphical output remained and all the data from the simulator were exported to Excel for generating graphical outputs. But the ability to simulate P-P modelling scenarios has at least eliminated the cumbersome job of trial and error determination of maximum pipeline capacity and to that extent have reduced the simulation time. The analysis was carried out in a classic version of PIPEsIM 2012. Typically, it used to take 4 hours for a single run of a 20-year scenario as each time the input (supply profiles) must be entered manually, run and the results transferred from PIPEsIM to Excel for management interpretation. During the analysis of the results at times the planning team changes the profiles upon direction from the teams of sub-surface, LNG operations or trading. If this happens, then the simulator again would have to re-run the scenarios and carry out all the tasks. This process normally leads to a delay in the confirmation of the PSC numbers with the operating companies.

To overcome this and for quickly running the model for a 20-year planning cycle, an interface between PIPEsIM and Excel is developed that will allow any user with basic simulation knowledge to provide the input/run the hydraulic simulation and extract the results. However, the results are to be further interpreted and analysed by the user according to the inputs provided. It is programmed to allow the user to run defined scenarios for multiple years based on the respective input and to reduce manual intervention in the model for providing the inputs in the simulation model. Upon successful simulation run, the results will be displayed in the customized graphical template based on user's prerequisite. This interface is supported with PIPEsIM classical interface i.e. up to PIPEsIM 2012.3 version which supports Open link coding.

However, upon usage it has been realized that the interface has some limitations that include the following:

1. The excel interface is limited to the PIPEsIM classic version until 2012.3 and cannot be utilized for advance version i.e. 2014 onwards. In the latest version of PIPEsIM (2017) this interfacing is not supported and hence all the work had to be carried out in the former versions and this hampers migration to a latest version.
2. The excel interface is currently customized to extract the boundary parameters for multiple year scenarios; however, it needs to be further enhanced to extract the details like velocity, pressure profile etc. for the network elements.
3. User should have some elementary working knowledge of “PIPEsIM” to simulate and analyze the results generated by the interface.
4. Any modifications to the network need to be carried out in the PIPEsIM model only. The interface then needs to be aligned with the changes manually.
5. The interface works for a specific network and is not generic. The interface needs to be customized for any addition or deletion of fields, terminals, pipelines etc.
6. The interface does not perform any input checks and proceeds with the user data.

7. The interface strictly follows a sequencing of the network components and will not work if there is any change to the sequencing or if any additional network components exist in the simulation model that are not defined in the interface. No errors are reported during the data transfer and the user would have to identify these manually.

Another important challenge in using the tool for long term planning is the visualization of results and the data input into the model for a 20-25-year scenario. Since it is a steady state simulator, there is no feature to define time-based scenarios. Therefore, the simulation must run for each year and results captured and reported after 25 simulation runs. This can be tedious for any network simulator. This creates a need for such transient features as it would be easier for the user to run a 25-year scenario by defining all the production profiles of the supplies at one place. This kind of features exist in some single phase simulators (PipelineStudio) but not in multi-phase modeling tools like PIPESIM. While transient scenarios can be defined in some of the advanced multi-phase simulators like OLGA, the creation of a baseline model and the simulation run time acted as deterrents in considering those tools.

An integrated graphical interface within the steady state simulator (PIPESIM) for viewing the output like the pressure/flow/composition of selected network elements over a period (trending) is another feature that needs to be developed. This would eliminate the need for the creation and maintenance of an interface for data transfer to other party tools like MS-Excel of the interface.

The long-term simulation model that is developed cannot be used for control room operations as the nature of input and the operational philosophy vary vastly. Hence it was decided to look at any other available tools for the short-term planning and control room operations.

**SHORT TERM PLANNING**

The onshore gas coordination centre is a single point reference for managing upstream gas supply to meet the downstream demand. Gas co-ordination activities include Real time monitoring of the gas network operational condition, Look Ahead prediction on gas quality at the terminal, Manual reallocation of upstream supply under events of operational deviations and demand variations, What if analysis on gas supply and quantity, Short- and long-term planning of the gas nomination and optimization of gas distribution.

Daily gas coordination for the region under consideration was previously managed by a very large oil and gas major as part of production sharing contract. However, when the PSC term has ended, the control over the gas coordination centre was handed over to the custodian. The earlier tool (Production Universe) which was used for the control room operations is no longer available to the custodian as the previous operator was not willing to share the technology. This has left the custodian with little choice but to develop a solution within a very short span of time.

However, in the process of identification of the tool, it was realized that there is no off the shelf product available for this kind of control room operations and a custom solution needs to be developed. After looking at the available options, the management has agreed to develop one based on data analytics.

The gas coordination tool will use the demand numbers and the business rules in determining each PSC nomination and subsequently feeds this number into the optimizer. In summary, the following are the business rules. The 6 rules are numbered in the order of their priority:

1. Reservoir Management
2. Gas Sales Agreement (GSA)
3. Supply Allocation
4. Facilities Constraints
5. Gas Specifications
6. Volume to the Plant

**ANALYTICAL SOLUTION**

This tool is a hybrid model based on engineering, analytics and the internal business rules. The aim of this solution is to perform two kinds of simulation namely forward simulation and reverse simulation/optimization. The forward simulation is performed using near real time production data to simulate future production on variable time span ranging from daily to as long as medium term taking into account the near real time data, production, composition, blending and operational modes. The target of the reverse simulation/optimization is to overcome the challenges of priority of supply/demand, contractual compliance, production constraints, operational issues and engineering limitations.

An overview of the analytical model is as shown in Figure – 3.
CHALLENGES IN THE USAGE OF DATA ANALYTICS

The analytical model is highly dependent on the timely availability of real time data although such a data is not available at all the off-shore platforms as some of the platforms are very old and do not have SCADA or data historians. Data from such off-shore platforms and the control centre are shared on a 4 hourly basis in a manual mode. This means that 100 percent data for running an analytical data model is not available. Other reason why data is not available is because of the PSC operators for whom investing in historians is not the first priority as they have other production issues to attend.

For real time monitoring, the model is supposed to run at an interval of 15 minutes with an updated real time data. The model will be run from the onshore gas coordination centre. But since all the platforms at off shore do not capture data on a real time basis, the onshore coordination centre do not have the real time data to update the model on a 15-minute interval. Where real time data is not available, the data is collected at a 4 hourly interval and is then shared with the control room operators through a fax. Any event or a production trip happening in between is not captured immediately and the control room operator knows this only in the next 4 hourly cycle. This leads to a situation that if a production shut down happens at any platform, the model is unaware of this and the 4-hour delay in obtaining this data leads to incorrect inventory tracking. Hence the model can either run at a four-hourly interval with a live set of data or at a 15-minute interval with a hybrid of real time and manual entry data.

Another challenge encountered was that data has to be collected manually at many offshore platforms. PSC operators have their own method of sharing data with the centralized control room at onshore in the absence of any standard format for data entry. Collection of data manually and then entering the data directly for real time analysis is a cumbersome task for the control room operators who have to manage other operations also during their 8-hour shift cycle.

With this reasons, it became clear to the operator’s that the tool that would be made available to them after the transfer of operations would not suffice their requirements.

Considering these challenges, a decision was made to develop an alternate model that works on hydraulic modelling and one which would work with the data from the available historians.

HYDRAULIC MODELLING TOOL FOR SHORT TERM PLANNING

The scope of the tool for gas coordination system includes:

- Field production Vs nomination
- Gas production by PSC Vs actual nomination
- Customer gas demand Vs actual delivery
- Traffic lights for overall status of the network

Real Time Monitoring (RTM) for Gas Coordination

ICON was chosen as the modeling engine since there are existing licenses available and since this is a back up solution, management was not willing to invest more money on the licensing of other hydraulic tools. Once when the data at all locations is available, the analytic solution should take over as the primary solution.

The Real Time Monitoring Tool (RTM) is one of the main component of Gas Coordination System built upon iCON (modelling tool), and integrated with Excel VBA, the objective of this tool is to aid operators to acquire the real time data of PI as well as the data from manual log sheet, then load it into iCON and finally produce a set of anticipated results in order to compare with the actual results.

Based on input from each field’s production data into the model, CO2 content to arrive at onshore is predicted. The RTM tool uses “Historian” live data as the main input to run the ICON Simulation model. The live data includes the gas flowrate across the fields, Gas Metering Skids and receiving facilities. At this point of time, some of the Historian connections are unavailable which restrict the functionality of RTM whose accuracy would improve in future as and when more historian data is made available.

A manual log sheet is the second input for the RTM tool. It is updated every four hours by the production controller at the gas coordination centre. The main objective of the manual log sheet is to provide data required for the RTM tool (e.g. gas flow rate) in an event the Historian connections is down. When the RTM detects that the data coming from a historian (PI tags) are down, then it would automatically load the data from the manual log sheet into the ICON model.

A Sample manual log sheet with the field flows at a particular time are as shown in Figure -4.

Different legend is given to the data based on its availability in the plant historian, manual entry or over ridden by the user.

A detailed work flow of the real time monitoring tool is shown in Figure – 5.

The results of the real time monitoring tool can be seen through the dashboard. Some of the results displayed include:

- Customer gas demand Vs actual delivery
- Gas production by PSC Vs actual nomination
- Field production Vs nomination
- Traffic lights for overall status of the network

The display of the RTM dashboard is as depicted in Figure – 6.
Short Term Gas Planning

The gas coordination tool will use the demand numbers and the business rules in determining each PSC nomination and subsequently feeds this number into the optimizer.

The work flow of short term planning is depicted in Figure- 7.

Gas Blending Optimizer

The optimizer would use the PSC nomination number and allocates a production number to each field under the PSC while considering the limitations at that facility.

The work flow of the optimizer is depicted in Figure- 8.

What If Analysis (Predictive)

Based on user scenarios and the production input from each field, the model predicts the CO2, H2S, and GHV contents at onshore such that the operators at the onshore gas coordination centres can make appropriate decisions in managing the supply-demand.

From multiple sessions of model validation exercise carried out with the Subject Matter Expert (SME), a number of what if cases have been identified, a few of them are listed below:

1) F_231 Down (Flow < 50 MMSCFD)
2) E11 PA Down
3) F_61 Down
4) B_111 Down

In case where there are no such flow shutdown’s, then the model will run under NORMAL mode. The cases were shortlisted by SME based on its significance of impact to the CO2 content that arrives at onshore. The activity was done considering only ONE disturbance. Any requirement to cater for multiple disturbances requires further validation of the current model. In its current form of the monitoring tool, the engine can only handle one transient at a time.

All the cases are using algorithm defined by users in determining splitting ratios of the gas at the riser level based on the limitations faced.

Some of the generalized algorithm’s to be applied in the cases are specified as below: -

A1: In this method of algorithm, for flow to happen between FRA and FRB, the demand at LNG-1 system must be fulfilled first.

A2: FRA to FRB = In this method, it is assumed that the gas distribution will first fulfil demand in LNG-2 and LNG-3 systems.

A3: FRB to FRC = In this method, it is assumed that the gas flow can happen between FRB and FRC when all the demand at LNG-2 system and the domestic electricity consumptions are met.

Since there are no flow meters available across the risers, the above algorithms only are used to calculate the cross over flows between the risers.

The work flow for what-if analysis is depicted in Figure-9.

Summary Table upon the evaluation of simulation tools based on users’ feedback:

A number of modeling tools were tried as possible options for hydraulic modeling in long term and short term. A comparision between them is as listed below:

(A)

<table>
<thead>
<tr>
<th>Simulation Type</th>
<th>Tool</th>
<th>Multi-phase</th>
<th>Multi-state</th>
<th>Transient</th>
<th>Ease of use</th>
<th>Ease of modeling</th>
<th>GUI Interaction with Excel</th>
<th>Nature</th>
</tr>
</thead>
<tbody>
<tr>
<td>Offline</td>
<td>PIPESIM</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Easy</td>
<td>Easy</td>
<td>Difficult</td>
<td>Hydro-silk</td>
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<tr>
<td></td>
<td>ICON</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Difficult</td>
<td>Loaded</td>
<td>Not possible</td>
<td>Hydro-silk</td>
</tr>
<tr>
<td></td>
<td>OLGA</td>
<td>Y</td>
<td>Y</td>
<td>Y</td>
<td>Difficult</td>
<td>Loaded</td>
<td>Not possible</td>
<td>Hydro-silk</td>
</tr>
<tr>
<td></td>
<td>Analytics</td>
<td>Y</td>
<td>Y</td>
<td>N</td>
<td>Difficult</td>
<td>Loaded</td>
<td>Not possible</td>
<td>Analytics</td>
</tr>
<tr>
<td></td>
<td>TQNET</td>
<td>N</td>
<td>Y</td>
<td>Y</td>
<td>Easy</td>
<td>Easy</td>
<td>Good</td>
<td>Available</td>
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</table>

(B)

<table>
<thead>
<tr>
<th>Simulation Type</th>
<th>Tool</th>
<th>Real Time Engine</th>
<th>Ease of Use</th>
<th>Comment</th>
</tr>
</thead>
<tbody>
<tr>
<td>Online</td>
<td>PIPESIM</td>
<td>Y</td>
<td>Easy</td>
<td>Offline, multi-phase only, transient calculations exist</td>
</tr>
<tr>
<td></td>
<td>ICON</td>
<td>Y</td>
<td>Difficult</td>
<td>Offline, multi-phase steady state calculations only</td>
</tr>
<tr>
<td></td>
<td>Analytics</td>
<td>Y</td>
<td>Difficult</td>
<td>Offline, multi-phase steady state calculations only</td>
</tr>
<tr>
<td></td>
<td>OLGA</td>
<td>Y</td>
<td>Difficult</td>
<td>Running of the model is difficult as large amount of fine tuning is required</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>Simulation Type</th>
<th>Tool</th>
<th>Real Time Engine</th>
<th>Ease of Use</th>
<th>Comment</th>
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</thead>
<tbody>
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<td>TQNET</td>
<td>Y</td>
<td>Easy</td>
<td>Single phase only, transient calculations exist</td>
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<tr>
<td></td>
<td>PIPESIM</td>
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<td>Offline, multi-phase steady state calculations only</td>
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<td>Y</td>
<td>Difficult</td>
<td>Offline, multi-phase steady state calculations only</td>
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</tbody>
</table>
CHALLENGES AND LIMITATIONS

There is no flow meter reading available to indicate how much is the flow going between the risers. The splitting ratio at header changes with the fields’ production rate, which causes the quality of the spill over line to vary. This factor leaves with no option except to ‘approximate’ the splitting ratios at headers and risers by matching on actual CO2 (historical from PI) at slug catcher level.

For almost half of the duration of this project, particularly at the beginning when the gas coordination activity is still handled by another large oil and gas super major, the access to the data is restricted/limited and the process to acquire the actual operational data is difficult. The extraction of data had to be done manually in the gas co-ordination centre utilizing only the mirror image of DCS visual since there was no way of getting the PI connection or the screenshot saved. There is complete reliance on the SME’s at the coordination centre to extract and process the data in order to do the validation process.

From the model validation activity conducted, it is found that there is no individual condensate flow reading for each slug catchers. Thus, the validation can only be done based on the total condensate volume.

Observations made throughout this project found out that there are a lot of Historian data that are in error status for a long period, from time to time. However, not much information is obtained even from the users on the cause of these errors. In this case, the data filtering mechanism in this tool will use the manual log sheet, which is updated annually by the technician on duty every 4 hours, as the input to model. It is important to acknowledge that this factor and workflow will impact the model data input and results accuracy since the tool is meant for the ‘real time’ (and seamless) monitoring, at a frequency of 15 minutes. The un-updated data input into model could lead to a situation of error in results prediction, especially involving the high production fields/hubs. The hydraulic model in its current state is only capable of performing “What if” analysis for select scenarios (that too one at a time and no simultaneous transient scenario situation). Besides this, the tool is configured to work for the model that is built in and any changes to the infrastructure like new supplies, deliveries or pipelines adding into the present network, would need a model up gradation.

Since an analytical solution is also under development and which is supposed to be the primary tool for the gas co-ordination activity, most of the referenced documents are shared between the two solutions. Combining the different sets of requirement into common templates introduces a series of changes in the layout and sequence of data in the documents, so each time there is any change introduced, amendment is mandatory in the development workflow and/or scope of the hydraulic tool.

RECOMMENDATION

The gas network under consideration is a complex grid in terms of determining the movement of the sour content and guaranteeing the on-spec quality for the customers, while maximizing the throughput at the same time.

This is however very difficult to be coordinated with very limited means of control. The manoeuvring by the coordination centre is mainly done by varying the field production rates.

In order to achieve effective co-ordination, it is recommended to have in place monitoring instruments (i.e. flow meter and CO2/H2S concentration analysers) to be installed at the spill over lines between the risers. The availability of the monitoring instruments becomes more imperative as the network is still expanding and there will be more linking points in the years to come.

The most ideal way to run a real time monitoring tool is by having all the data required automatically loaded into the tool at a defined frequency (as short as 5 minutes) and with minimal intervention by the operator. At this state, any disturbance at production field or potential disturbance at onshore can be detected much faster and with higher accuracy and confidence. The operator will have more time to respond either to rectify the problem or highlight to the customer, which makes the coordinating activity more effective.

CONCLUSION

The gas co-ordination suite was developed closely with the presence of Subject Matter Expert’s and underwent a series of feedback and validation sessions throughout the duration. The current tool available still has room for improvement especially in catering for multiple disturbances and upcoming fields to ensure the coordination activities can be run more effectively. With the installation of real time monitoring tool, the processing of data is automated and less effort is needed in conducting routine calculation/comparison. The gas coordination centre will be able to use the tool to monitor and prepare ahead of time in case of any anticipated disturbance.
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Figure 1. Network Overview for Illustrative Purposes (Not all sources and deliveries shown due to network size)
Figure 2. Flow chart for Production number verification with a Hydraulic model
Figure 3. Analytical Model Overview

Figure 4. Manual Log Sheet
Figure 5. Workflow in Real Time Monitoring

Figure 6. RTM Dashboard
Figure 7. Simplified data transfer workflow between components in short-term planning

Figure 8. Workflow in gas supply optimization
Figure 9. Workflow in "what if analysis"