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INTELLIGENT PRODUCTION PLANNING AND OPTIMISATION TOOL FOR GAS PROCESSING COMPLEX

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ABSTRACT

Structured production planning is very important to achieve good financial performance in the oil and gas industry. This is especially crucial in an integrated oil and gas supply chain which encompasses feed gas supply, gas processing plants, and petrochemical plants. In the current offshore production climate, the nature of feed gas qualities has evolved. Gas from offshore fields has progressed from having minimal to much higher CO_2 content, exceeding the CO_2 limits of existing gas processing plants. It is generally impossible to curtail productions from high CO_2 gas fields, leading to a loss of revenue. Optimised blending of the feed gas sources is therefore vital to adjust to this changing environment. An intelligent production planning tool was designed to meet the multiple objectives of a gas plant and optimise production. The sales gas demand must first be met based on available feed gas supply and individual plant availability and reliability. Economic factors such as maximising profit from by-products were also factored in by ranking the loading of each processing plant and prioritising plants with higher recovery. Planning strategies were also tailored to each plant's unique operational limits and turndowns, modes, and challenges. Combining these complex objectives and constraints into a powerful optimisation tool allows a new level of connected intelligence in the production planning of the gas processing complex. The innovative optimisation tool was officially released in 2019 and is currently utilised by production planners in different modes: long-term (5-year duration), medium-term (90 days), and daily operational planning. The planning tool was also designed to be digital-ready and equipped with much improved automation and robustness to embrace the digital transformation agenda. These optimised workflows would improve efficiency and ultimately result in better production planning and decision-making by plant personnel.

Keywords: *Production planning*

INTRODUCTION

In the current offshore production climate, the nature of feed gas qualities has evolved. Gas from offshore fields has progressed from having minimal to much higher CO_2 content, exceeding the CO_2 limits of existing gas processing plants. It is generally impossible to curtail productions from high CO_2 gas fields, leading to a loss of revenue. Optimised blending of the feed gas sources is therefore vital to adjust to this changing environment. The objectives of developing the planning tool are:

1. To improve data management from various sources of the database into one calculation platform.
2. To automate the gas planning and distribution workflow for three modes of gas planning:
    a. Short term planning: Daily
    b. Medium-term planning: Monthly
    c. Long term planning: Key Performance Budget Indicator (KPBI)

MATERIALS AND METHODS

The core simulation engine utilises Microsoft Excel® with VBA, applying primarily the Solver Add-In functionality. Solver is a Microsoft Excel add-in program that is very powerful in performing what-if analysis. The Solver finds optimal value for a formula in the objective cell subject to constraints, or limits, on the values of other formula cells on a worksheet. Symmetry (iCON®) 2020.3 simulation model for upstream feed and gas processing facilities was concurrently

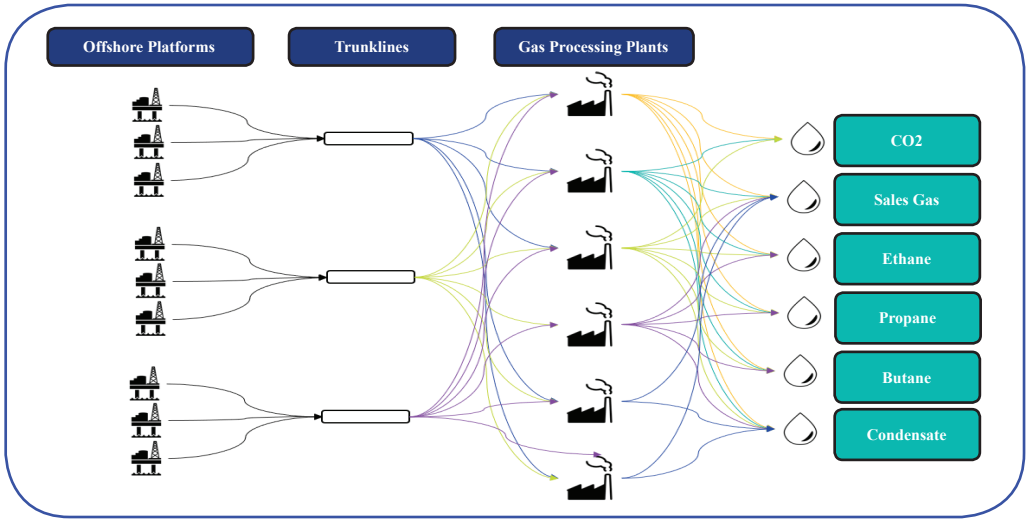

Figure 1 Overall modelling boundary and simulation network

developed as the model validation and consolidation tool of choice.

RESULTS AND DISCUSSION

The modelling boundary for the study is from the field gas trunkline outflows until the gas processing plant product line, as shown in Figure 1. As the gas network blending permutations are complex with multiple constraints, a robust solver algorithm was designed to meet the multiple objectives of a gas plant and ultimately optimise production.

Upstream Feed Consolidation

Upstream feed flowrate consolidation is designed to suit three different modes of planning listed in Introduction. The information required for each upstream field includes gas volumetric flow rate and composition. The gas mixture is then calculated for associated trunklines and collecting points, as shown in Figures 1 and 2.

Gas Planning Tool Features

A single, consolidated tool was developed to be robust enough for all three planning modes. The tool is divided into several sections, as summarised in Table 1.

Optimiser Workflow

The algorithm sequence for the automated run sequence is as follow,

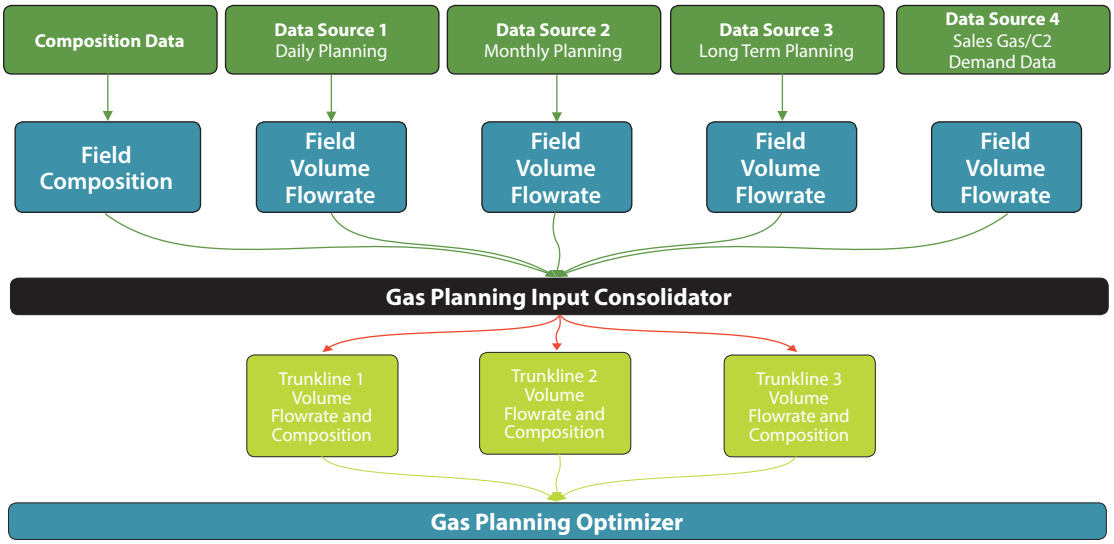

Figure 2 Data sources and consolidation

Table 1 Features of the gas planning tool

Category	Features	Functions and Description
Main page	User Input	Landing page for users to key in all input required for the model
Input Consolidation	Input Summary	Summarises the main trunklines and phases compositions and flowrates to be sent to the optimiser engine
	Database	Summarises composition and flow rate of fields. Flowsheet where user updates field composition if required.
Optimiser Results	Simulation Results	Summarises optimiser calculation results after each run
	Daily Results	Displays the optimiser calculation results for "Daily" planning mode by matching the daily date. New results will be appended to the worksheet.
	Monthly Results	Displays the optimiser calculation results for "Monthly" planning mode
	KPBI Results	Displays the optimiser calculation results for "KPBI" planning mode
	Plant Mass Balance Monitoring Dashboard	The main dashboard for the overall mass balance
	Overall Dashboard	The overall mass balance monitoring dashboard with the detailed flow for an individual plant
	Plant PFD Dashboard	The detailed PFD will be updated with calculated feed and product compositions. Individual page for each plant.

Optimiser 1: Total feed distribution algorithm

Objective: "How much total feed should each plant process?"

The calculation is based on information specified in the User Input sheet, including once-off information (plant ranking, maximum turndown, feed phase selection) and individual dataset information (minimum turndown, availability).

Optimiser 2: Feed selection algorithm

Objective: "How much should each plant process from each phase?"

For planning purposes, the feed blending is optimised to constraints specified by the user, such as feed phase selection, CO2 limit, and C3 limit at each plant. The optimiser will solve the feed distribution until the sum of gas processed equals the total feedgas nominated upstream.

Optimiser 3: Product recovery optimiser

Objective: "How much is the recovery of each product?"

The composition and flow rate of each product stream will be calculated based on specified demand (C2), recovery (C2, C3, C4), and slowdown (C2, C3, C4).

CONCLUSION

The tool developed has successfully been launched and tested by Production Planners for each planning mode, namely Short-term Planning, Medium-term Planning, and Long-term Planning. The *Digital Production Planning and Optimisation Solution* provides automatic data extraction from any Microsoft Excel database, minimising error and time taken for manual data entry. The tool would automatically calculate compositions and flowrate, which will then be fed into the feed distribution and product recovery optimisers. Feed distribution results are summarised in the "Simulation Results" section and, for easy viewing purposes, the visualisation dashboards.

ACKNOWLEDGEMENT

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REFERENCES

iCON® (Symmetry) User Manual (2020)