CASE STUDIES

Real-time Production optimisation using the Petroleum Experts Digital Oilfield:

The RasGas success story

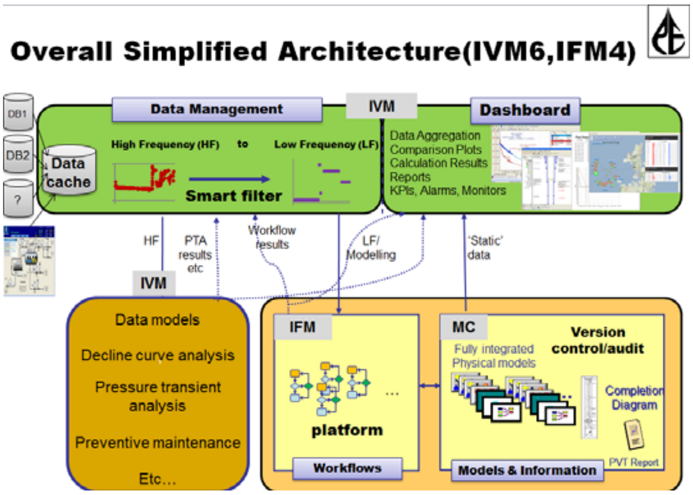
Editor's Note

The below article is based on "RasGas Experience with Production Optimisation system, a success story", paper 17255 published and presented at the IPTC conference in January 2014, Qatar.

It essentially documents the experiences in developing and implementing a production optimisation technology for reservoir management using real time surveillance in a sustainable way. For further details and references please refer to the original paper.

Introduction

In recent years RasGas Company Limited (hereafter referred to as RasGas) has increased their offshore production from its lean condensate reservoir that produces from multiple reservoir block and completions. This upstream system feeds a downstream Liquified Natural Gas terminal (LNG), and as such there are production targets (volumes and compositions) that need to be honoured.



Challenges

The idea was to create a system which produces wells/field to meet short term gas production targets while honouring the long-term reservoir depletion strategy . ***All of the above is desired, while respecting operational limits, and planned/ unplanned downtimes.***

Objectives of the Solution

The main objective is to optimise the wellstream composition mixing to increase the value of the sales gas stream of LNG while managing the reservoir depletion and honouring physical and operational constraints.

To be able to achieve these objectives, a production optimisation and surveillance system is necessary.

Solution Formulation

- Develop a fit for purpose optimisation engine for well streams' mixing and network production optimisation (rather than using the EXCEL sheet that was initially in use).
- Allow timely recommendations to Operations in response to changing operational constraints and production demands with greater consistency.
  - The intention is not to have a real-time control system or replace engineers, but rather give them the information to take actions when required.
- Enable adequate response to short-term conditions with tactical well streams composition mixing recommendations.
  - This was done manually in EXCEL, and as such avoiding this would enhance the effectiveness of current practices by automating a time consuming manual spreadsheet. The advantage of this are:
    - More comprehensive considerations
    - Better predictions of mixing of the different well stream compositions
    - More timely analysis allowing engineers to respond to short term events
- Effectively integrate data sources and databases available within RasGas and have the ability to easily export data to other existing platforms for display, surveillance and analysis.
  - As with any organisation, there are multiple sources of information. A single platform that could bring all of this together and remove the need for copy/paste and double entry would increase the accuracy, consistency, and efficiency with which the organisation works.
- Provide a seamless interface to major modelling software packages available within RasGas required by the system.

Case Studies

Real-time Production optimisation using the Petroleum Experts Digital Oilfield:

The RasGas success story

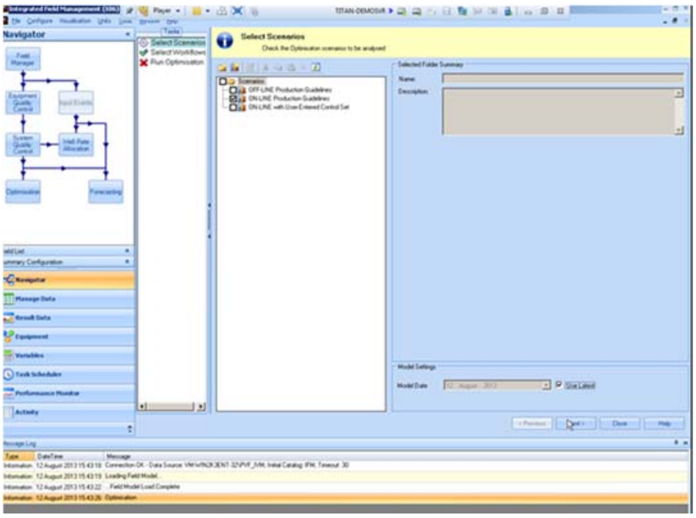
The high level solution: Petroleum Experts Digital Oilfield

To be able to achieve the stated objectives (and overcoming the issues), a production optimisation surveillance system is necessary that combines the physical models of the field with real time data. The petroleum Experts Digital Oilfield was chosen to do this.

The premise was to capture the entire system from wellbore to the slug catcher, whilst being connected to a high frequency real-time monitoring/updating system. This was achieved using the following Petroleum Experts tools: **PROSPER**, **GAP**, **RESOLVE**, **IFM** and **IVM**. These were selected because they would be able to carry out the below tasks which is a pre-requisite to having a sustainable on-line production optimisation system:

- Model the entire production system from well to slug-catcher
- Design and integrate workflows that allow model updates as new data becomes available
- Automatically update the model to allow engineers to monitor deviations
- Communicate with the Subsurface Production Database to get the highly frequency real-time data and past trends of production and operating parameters for all components of the production system
- Provide optimum production recommendations, called Production Guidelines, under various scenarios honouring constraints and objectives associated with production
- Track Production Guidelines compliance
- Track actual well performance
- Report conditions outside defined bounds
- Continuously monitor field performance
- Detect and diagnose changes of behaviour and production conditions
- Capture and use the above information to carry out optimisation activities to keep the field producing at its potential and respond to planned and unplanned events in a timely fashion

A detailed description of the System



The **Digital Oilfield (DoF)** is made up of three key layers (under which we may sub categorise tasks/software):

- Physical Models (*IPM*)
- Integrated Field Management (*IFM*)
- Data Management and Integrated Visualisation of the system and its associated sub components (*IVM*)

Integrated Production Modelling (IPM)

The *Integrated Production Modelling (IPM)* tool kit was used to build models which captures the physics, these were built using **PROSPER**, **GAP** and **RESOLVE** (which in this context allowed for integration from the reservoir simulation to the process level).

These physical calculators (physical models) are at the core of all of the engineering calculations.

Integrated Field Management (IFM)

These models are intended for use by engineers to represent field reality and as such a system is required which can identify and remedy any deviations from reality. This meant that a system needed to be provided which could help in identifying the causes for any divergence between model and reality. *IFM* is composed of two sub systems: ***Model Catalogue*** and the ***Workflow manager***:

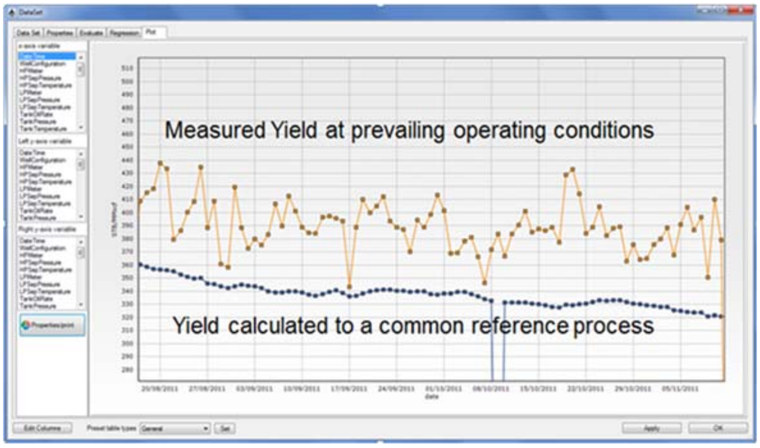
CASE STUDIES

Real-time Production optimisation using the Petroleum Experts Digital Oilfield:

The RasGas success story (continued)

*Using **IFM** allowed model updates and calculations to occur during the update process. One key example of this is the **PVT Transformation workflow:** this translates the rate measurements at measurement conditions to test conditions via a common reference.*

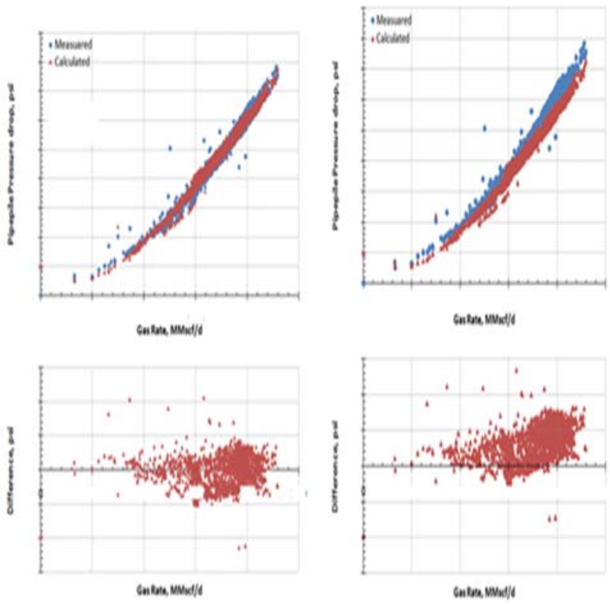
Considering a long multiphase pipeline (>100km) which is transporting fluid from 20 condensate wells. The oil yield being measured was oscillating (yellow curve below) over a 24 hour period and this was simply due to the fluctuation in temperatures from day to night.



Looking at the graph initially it was thought that some upstream piece of equipment was to blame, and correcting the PVT to a common reference pressure and temperature shows that the oil yield is in fact fairly constant (blue line).

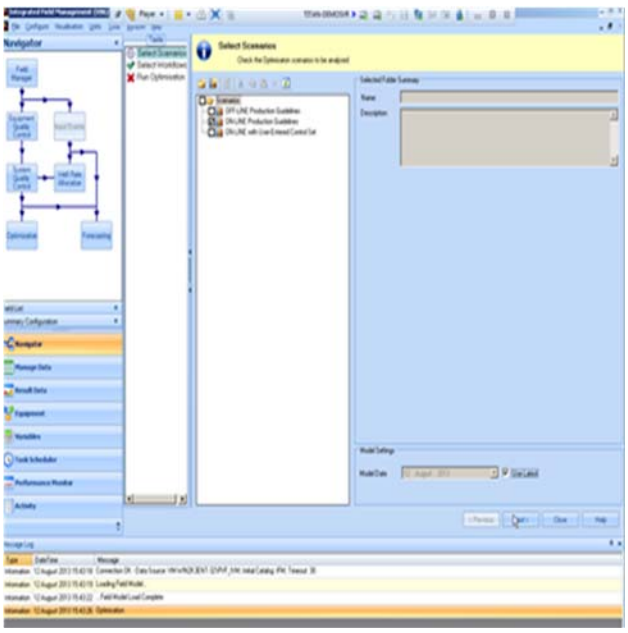
Once the rates were known, the pressure drops in the pipeline itself could now be considered.

The well rates were being measured in real time using wet gas flow meters, and aggregating all of these wells together gives the pipeline total flowrate. The upstream and downstream pressures were available, and as such the engineers were performing model validation of pressure drops in GAP:



Using the fluctuating rate, there appeared to be a deviation (approximately 10-20% in pressure drops between measured and calculated values. In this case the flow correlation was forced (by process of matching the gravity and friction term) to over predict the pressure drop.

The well rates were corrected from wet to dry gas (as expected by the model), and it was seen that the models were predicting the pressure drops without any matching/fine tuning.



Thus the IFM platform allowed for model management and the execution of field management activities to be set up in an organised fashion. The engineers could use the standard workflows to carry out the majority of the tasks which were automated and scheduled to run every twenty minutes to update results through IVM.

Case Studies

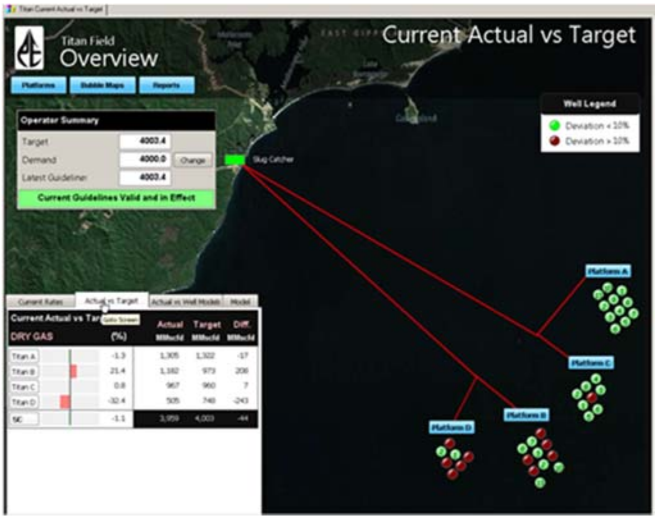
Real-time Production optimisation using the Petroleum Experts Digital Oilfield:

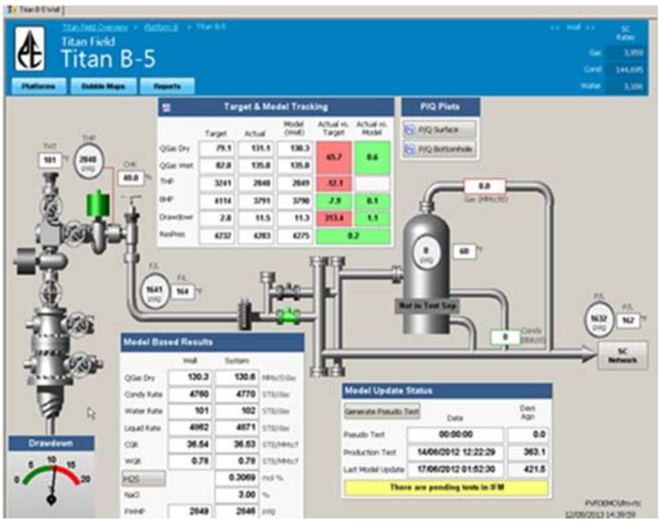
The RasGas success story (continued)

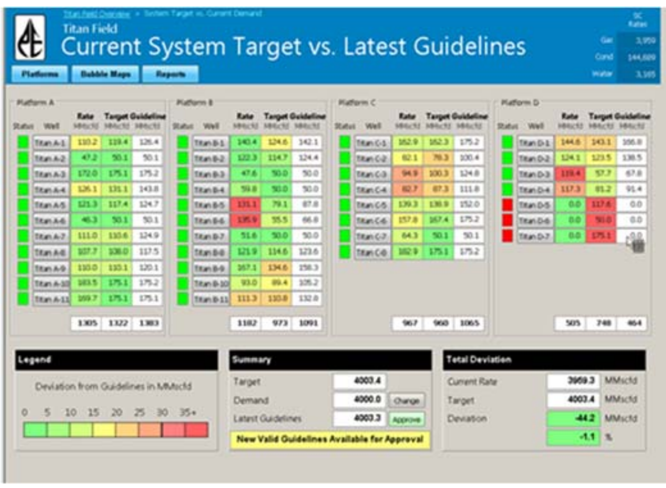
Integrated Visualisation Management (IVM)

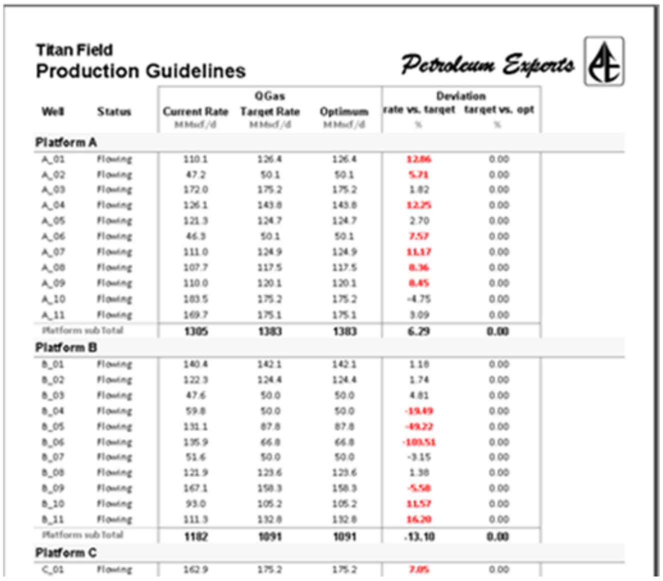
IVM is made up of the *Data Manager* and the *Integrated Visualisation* component.

Interest in the system and the associated results is unlikely to remain with the engineers alone. Different disciplines across an oil company such as managers and the business departments would also likely wish to view any information relevant to them concerning the project. In this case, we will be referring to the engineers' perspective in which visualisation formats were configured to provide: high level views of the field, performance of single components to generate reports, alarms and notifications based on real-time results to pre-process input data for the system as well as outputs from the workflows. This approach is intended to make it easy to maintain, extend and upgrade the system.









Titan Field
Production Guidelines

Well	Status	QGas Current Rate MMscf/d	QGas Target Rate MMscf/d	QGas Optimum MMscf/d	Deviation rate vs. target %	Deviation target vs. opt %
Platform A						
A_01	Flowing	110.1	126.4	126.4	12.86	0.00
A_02	Flowing	47.2	50.1	50.1	5.71	0.00
A_03	Flowing	172.0	175.2	175.2	1.82	0.00
A_04	Flowing	126.1	143.8	143.8	12.25	0.00
A_05	Flowing	121.3	124.7	124.7	2.70	0.00
A_06	Flowing	46.3	50.1	50.1	7.57	0.00
A_07	Flowing	111.0	124.9	124.9	11.17	0.00
A_08	Flowing	107.7	117.5	117.5	8.36	0.00
A_09	Flowing	110.0	120.1	120.1	8.45	0.00
A_10	Flowing	183.5	175.2	175.2	-4.75	0.00
A_11	Flowing	169.7	175.1	175.1	3.09	0.00
Platform sub Total		**1305**	**1383**	**1383**	**6.29**	**0.00**
Platform B						
B_01	Flowing	140.4	142.1	142.1	1.18	0.00
B_02	Flowing	122.3	124.4	124.4	1.74	0.00
B_03	Flowing	47.6	50.0	50.0	4.81	0.00
B_04	Flowing	59.8	50.0	50.0	-19.49	0.00
B_05	Flowing	131.1	87.8	87.8	-49.22	0.00
B_06	Flowing	135.9	66.8	66.8	-103.51	0.00
B_07	Flowing	51.6	50.0	50.0	-3.15	0.00
B_08	Flowing	121.9	123.6	123.6	1.38	0.00
B_09	Flowing	167.1	158.3	158.3	-5.58	0.00
B_10	Flowing	93.0	105.2	105.2	11.57	0.00
B_11	Flowing	111.3	132.8	132.8	16.20	0.00
Platform sub Total		**1182**	**1091**	**1091**	**-13.10**	**0.00**
Platform C						
C_01	Flowing	162.9	175.2	175.2	7.05	0.00

IVM allows daily or high frequency monitoring of the production deviations from targets which trigger revisiting the well model and perform its updates (all of which can be generated into specific reports for the operations team).

CASE STUDIES

Real-time Production optimisation using the Petroleum Experts Digital Oilfield:

The RasGas success story (continued)

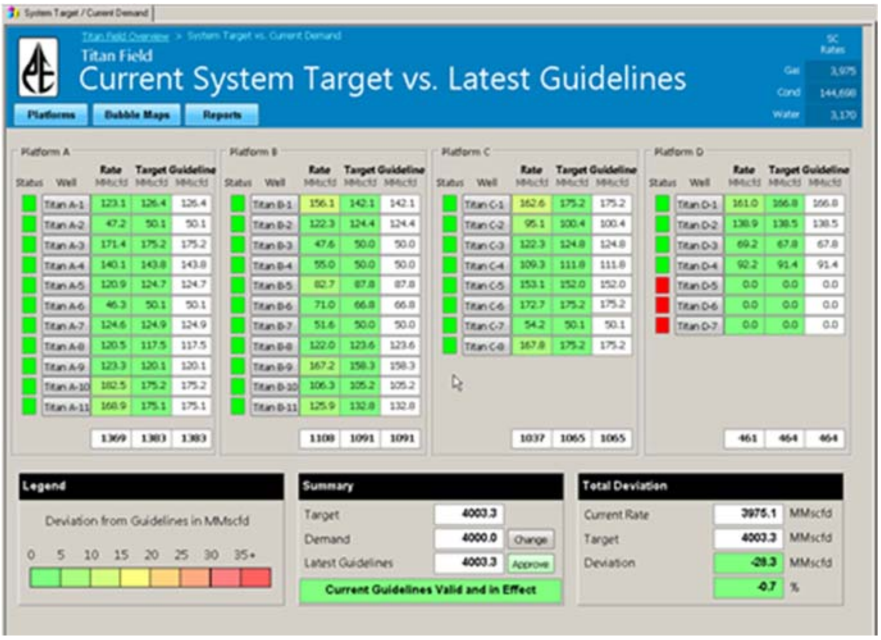
Field Surveillance and Monitoring

It was important to ensure that easy access to information was provided to the engineers. This information is related to the current field performance monitoring and surveillance and is then shared through *IPM*, *IFM* and *IVM*.

Engineers can therefore be presented with field and well overview screens which contain measured data as well as the information calculated from the various workflows. This also ensures that overview screens for each of the slug catchers were provided showing all of the data related to the gathering system from the platform departure pipelines to the corresponding slug catcher.

Production Guidelines

The production guidelines were really developed to address recommendations on how best to produce the wells to meet demand while honouring the optimisation target rates and the reservoir management strategy. In other words, the production guidelines are generated by combining the physical response and the controller element.



By predefining the company's strategy, objectives and criteria the engineers within RasGas were provided with a system which allowed them reach timely and effective decisions with respect to any unexpected events on the field whilst also allowing for future planning of the system to be carried out.

Summary

The Digital Oilfield solution implemented has successfully demonstrated its reliability in supporting RasGas efforts to achieve the following:

- Production benefits
  - Real-time monitoring for daily well management is now possible to ensure that well operation is within the desired management strategy envelope.
  - The ability to consider different production Scenarios have allowed long-term depletion strategy to be honoured, whilst still honouring short- term constraints.
  - Short term optimisation and deliverability of the contractual demand to the LNG plant.
  - Used to plan for intervention activities (such as pigging operations, train turn-around, platform shut ins, etc.) and ensure that demand to LNG is still supplied.
- Organisational Benefits
  - The speed of this system has allowed extra flexibility and a proactive response to unexpected field developments (downtimes and shutdowns).
  - Significantly improved the process of generating Production Guidelines (compared to the old manual process in EXCEL)
  - Information that has long been available, is now available at the click of a button
  - Decision making processes were streamlined regarding well rate adjustments in the events of unexpected upsets, constraints or sudden increases in demand.
  - Ownership of models and responsibilities are clearly defined

Acknowledgements:

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