

FEESA – IPM

Consultancy Services

- Integrated production modelling for optimal decision making
- Simple or complex models for flow assurance confidence
- Supported by best-in-class *Maximus* proprietary modelling software

Our Background

Founded in 2001, FEESA-IPM is a management and employee owned oil & gas engineering consultancy specialising in conceptual engineering studies and flow assurance.

FEESA-IPM's consultants are recognised as amongst the best in the world. They are supporting operators of oil & gas developments with conceptual engineering and flow assurance studies in many economically sensitive locations, including the UKCS, offshore Angola and the Australian NW Shelf.

Whilst FEESA-IPM's consultants are experienced users of the major transient and steady state flow modelling software, they have the advantage of *Maximus*, the company's proprietary software.

Maximus is spearheading a new breed of fast, accurate, and functional integrated production modelling software that is setting a new industry standard:

- SPEED: modern code and software design
- ACCURACY: better flow physics over life of field
- FUNCTIONALITY: model scenarios ranked by economic / engineering performance criteria.

Maximus models of reservoir to upstream surface network scenarios through field life facilitate confident decision making during the conceptual design phase of oil & gas field developments, and provide a valuable link to FEED flow assurance studies through the detailed modelling of production and injection systems.

The FEESA-IPM Advantage

Model scenarios of oil & gas production systems are essential during the conceptual phases of field development. The subsurface and surface engineering options adopted have an enormous bearing on field economics. Scenarios provided by Integrated Production Modelling (IPM) have been

demonstrated to provide a valuable decision making "hub" during this critical phase of a project.

FEESA-IPM consultants work with an operator from the earliest stages of project feasibility mapping, through FEED. Early feasibility mapping usually begins before there is a mature reservoir model, and our consultants will work with key operator personnel to build accurate and user friendly life of field model scenarios using *Maximus*, with output in the form of either engineering or economic performance criteria, possibly linked to the terms of production sharing or gas sales contracts. As conceptual engineering develops towards FEED, the *Maximus* reservoir module can be substituted by detailed performance data from market leading reservoir simulators, and during FEED the *Maximus* model can still be used by the operator as a management tool, which "binds together" the different detailed models involved in the development project.

FEESA-IPM Flow Assurance

Detailed flow assurance and optimisation analysis can be undertaken by FEESA-IPM's consultants using *Maximus*, either as a steady state flow simulator, or developing full life of field deliverability models linking in results from industry standard transient flow simulators.

FEESA-IPM's skills cover an extensive-range of flow assurance requirements, including:

Steady State Thermal Hydraulic Modelling

Steady state modelling of multiphase well, pipeline and riser systems using advanced engineering tools such as *Maximus* software. FEESA-IPM's consultants are able to develop comprehensive and accurate models of converging, diverging and/or looped production and injection systems including the selection of

appropriate inflow performance relationships for modelling reservoir flows.

Deliverability Modelling

Using Maximus as an Integrated Production Modelling (IPM) tool, FEESA-IPM has performed numerous studies for major clients to investigate deliverability and production. Building a model from the reservoir to the facilities, we have looked at the effects of tubing and pipeline size, multiphase boosting, gaslift injection, subsea separation and various novel technologies such as hydrate slurry flow on the production rates achievable from a given configuration. By investigating a large number of system permutations, clients have been able to use the production profiles generated by *Maximus* to perform comparative economic selections, thus identifying the optimal configuration.

Transient Multiphase Modelling

With the increasing flow assurance challenges encountered with deepwater developments and long-range subsea tiebacks, transient multiphase flow simulation has become a standard technique for investigating system behaviour and operability. FEESA-IPM's consultants have developed considerable experience in this area with both Scandpower's OLGA and analytically derived methods, where appropriate. This experience has been developed via a number of projects including some high-profile deepwater developments.

Flow Assurance Operability Studies

The key to the successful use of steady state and transient modelling is interpreting the results into a comprehensive operating strategy. FEESA-IPM has gained considerable experience in the evaluation of flow assurance operability of dozens of complex production networks. Results from thousands of simulations can be compiled to develop operating guidelines that are sufficiently comprehensive to be Peer Reviewed, yet still intelligible by other disciplines. Issues typically addressed are terrain induced slugging, hydrate, wax and asphaltene prevention and remediation, thermal control, production boosting, erosion/corrosion and complex rheology.

Specialist Fluid Flow Studies

FEESA-IPM's consultants have a detailed understanding of the fundamentals of fluid flow and heat transfer which has been put to good effect on a number of specialist fluid flow studies.

These have included the analysis of sand transportation in multiphase flows, the evaluation of erosion effects due to particulate transfer, the modelling of non-Newtonian flows in gelled oil systems, hydrate slurry transportation and the investigation of jet-pump hydraulics in a gas-field development.

Selected Previous Projects

FEESA-IPM has successfully executed numerous conceptual field modelling and flow assurance studies for major clients. Brief details of selected projects are listed below:

BP – Angola - Appraise/Select Projects

BP's flow assurance consultant of choice during the conceptual design phase of six deepwater developments offshore Angola. This involved numerous *Maximus* IPM and flow assurance studies to verify the deliverability, thermal performance and operability of hundreds of proposed configurations, in collaboration with BP reservoir and facilities engineers. Key to the success of this series of projects was the development of hydrate management operating guidelines.

BP Angola – PSVM FEED

When the first Angola Programme project moved out of the "Select Phase", FEESA-IPM seconded some of its key consultants into the FEED contractor's team. This ensured better flow assurance continuity between the design phases, improved the contractor's learning curve, and removed thermal hydraulic simulations from the critical path for the pipeline, subsea and integrity management studies, thus improving the efficiency of FEED as a whole.

Woodside – Great Western Flank Development

Development of several *Maximus* IPM models for Woodside as part of a conceptual study of a 20+ reservoir gas development on the North West Shelf of Australia. Numerous development strategies were investigated, simulating up to three compression platforms with tieback to existing field developments. Models were validated against data from existing fields, and a new method for modelling the reservoirs and wells was developed and introduced.

Woodside – Chinguetti Development, Mauritania

Flow assurance peer review for this large deepwater heavy oil development, offshore West

Africa. This was facilitated by **Maximus** modelling of the production systems from the reservoir to the FPSO. Supported the Woodside team in the liaison with the FPSO and topsides contractors.

BP Angola – Block 15 Future Development Study

Maximus IPM models have been built to assist BP in investigating the feasibility of numerous new tiebacks proposed by their Joint Development Partners.

ENI – Kashagan Development, Kazakhstan

Consultancy to the ENI/KDPC design team for the flow assurance design of the Kashagan development. Developed operating guidelines and recommendations to focus future transient studies.

ConocoPhillips US – Large Offshore Gas System

Developed a **Maximus** model to investigate the trade-off between the cost of additional drilling and offshore compression for a large offshore US gas system. MEG injection rates were predicted to ensure the avoidance of hydrate deposition throughout the life of the entire network.

ConocoPhillips US – Malakia Study, Malaysia

Gas lift optimisation study using **Maximus** for a small development offshore Malaysia.

BP Angola – Greater Plutonio FEED Study

Developed the flow assurance strategy for BP's Greater Plutonio Development. This work included life of field steady state and transient studies to prove that the project could operate successfully.

CalEnergy – Anglia NW Tieback, UKCS

Peer Review of previous flow assurance studies, leading to the development of an integrated reservoir life of field model. This model was used to evaluate the effect of backout of existing wells, and hydrate inhibitor injection requirements.

Gaz de France – Anglia NW Tieback, UKCS

A study to evaluate the sensitivity of life of field predictions to the well completion assumptions, including producing length, permeability and skin factor. The analysis also included an analysis of refined hydrate inhibitor injection requirements taking account of pressure evolution through field life. Simulations were performed with a third-party simulator and **Maximus**.

Hess – Chestnut Development, UKCS

Performed parametric transient studies of various tieback alternatives for the Chestnut field in order to examine cooldown and stability behaviour.

PetroCanada – Guillemot West Extension, UKCS

Flow assurance services to the Veba WEP team, concentrating on the production chemistry implications of bringing a higher CO₂ fluid into a carbon steel production system.

Saipem – Support to Subsea Design Team, Fano

Provided flow assurance support to Saipem's subsea design team, based in Fano Italy, across a range of projects, including a deepwater project in the Gulf of Mexico.

BP EPTG – Cold Flow Modelling

Applied **Maximus** to model BP/SINTEF's novel Cold Flow process. This included the simultaneous modelling and simulation of up to seven coexistent phases in the pipeline transportation system, including gas, oil1, oil2, water, hydrate I, hydrate II and ice. The simulations were performed to optimise tubing/pipeline sizes, subsea multiphase boosting requirements and subsea free water separation.

Masons – Expert Witness Support

Provided expert witness services to the legal firm Masons, acting on behalf of a consortium of Oil Companies. Advice given for the design, optimisation, and operation of ultra-long oil transportation pipelines with intermediate pumping stations.

Chevron – Caledonia Development, UKCS

Constructed steady state and life of field models to investigate tieback options for the Caledonia field. Analysed different production enhancement options including subsurface ESPs, gaslift injection and subsea multiphase boosting. Performed parametric transient simulation studies to evaluate slugging and cooldown behaviour.

TMF – Multiphase R&D

Sponsors and participants of the Transient Multiphase Flow R&D Programme directed by Professor Geoff Hewitt of Imperial College, London. Carried out two separate reviews of active slug control systems and non-Newtonian flows. Also interfaced **Maximus** to the research code TRIOMPH to allow integrated transient slug prediction.

Our Consultants

Martin Watson (Director): Martin holds a PhD in Multiphase Flow from Imperial College London. He subsequently worked on a number of field developments as a flow assurance engineer for Granherne before co-founding FEESA-IPM. Martin specialises in IPM modelling, transient multiphase flow analysis and the development of flow assurance operating strategies and guidelines. Martin has developed significant experience in deepwater gas-oil developments and large gas gathering networks.

Neil Hawkes (Director): Neil holds a PhD in Multiphase Flow from Imperial College London. He subsequently joined Baker Jardine & Associates where he was responsible for the development and product management of a novel life of field simulation tool called Pipesim-FPT, now marketed by Schlumberger. While at Baker Jardine he also performed a number of consultancy studies for clients such as PDVSA, PEMEX, BP and Norsk Hydro. Since co-founding FEESA-IPM, Neil has been responsible for the development of the **Maximus** integrated production modelling tool. He has used his in-depth knowledge of IPM in detailed modelling studies for BP Angola and Woodside Australia.

Silvère Barbeau (Senior Consultant): Silvère holds a PhD in Slug Flow from Imperial College London. He developed a three-phase slug capturing model in the research code TRIOMPH, which may ultimately replace traditional "slug tracking" methods for accurate slug sizing calculations. Since joining FEESA-IPM, Silvère has conducted numerous **Maximus** and OLGA studies on all the BP Angola Deepwater Programme Appraise and Select studies.

Eduardo Luna Ortis (Consultant): Eduardo gained a PhD from the University of Manchester in Control System Optimisation, after which he lead a project on transient modelling and control for oilfield systems at Imperial College London. Since joining FEESA-IPM, Eduardo has worked on the optimisation of numerous water and chemical injection and production system networks.

Tian Lim (Consultant): Tian joined FEESA-IPM as a Chemical Engineering graduate from Imperial College London in January 2009. He has quickly learned FEESA's unique design methods for deepwater systems, and brings a fresh perspective to their analysis. Under supervision,

Tian has carried out numerous Maximus IPM studies, and various shutdown, blowdown and restart simulations using OLGA as part of the development of a hydrate avoidance strategy for a major deepwater development.

Kwun Ho Ngan (Associate): Kwun Ho is completing his PhD thesis on Multiphase Flow at University College London, and will join FEESA-IPM in January 2010. Ho is very highly regarded by his PhD sponsors, Chevron, and will be a perfect addition to the consultancy team.

Paul Pickering (Associate): Paul holds a PhD in Transient Multiphase Systems from Imperial College London. He initially worked for British Nuclear Fuels plc, carrying out dynamic simulation of process systems, before moving into the oil & gas industry, first working for Granherne Ltd where he was responsible for performing steady state and transient studies of subsea production systems. Paul subsequently worked on flow assurance projects and software development for Baker Jardine & Associates and Smith Rea Energy Ltd before co-founding FEESA-IPM. He has developed considerable expertise in both IPM and flow assurance through working on many challenging projects around the globe.

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