Flow assurance
OIL & GAS CONSULTANCY SERVICES
Flow assurance involves the reliable, continuous and simultaneous transport of liquid crude oil, gas, water and sand from the formation to the processing facilities. As offshore production ventures into more remote and deeper waters, untreated formation fluids travel longer distances through pipelines, valves and pumping devices before reaching process equipment. Frequently, untreated hydrocarbons are characterized by the presence of more than one phase therefore requiring flow assurance evaluation and analysis during the engineering design stages of the project. Multiphase fluid transport is a complex and challenging issue. Most hydrocarbon formations contain a mixture of liquid crude oil, natural gas and water. Additionally, dislodged sand can be carried with the well fluids. All these components or phases can be simultaneously present during the production process.

BMT has extensive expertise in multiphase flow analysis using Computational Fluid Dynamics (CFD) for Oil and Gas applications. CFD allows you to perform three-dimensional (3D) simulations of interpenetrating or immiscible fluids that include effects of pressure, temperature and liquid/gas mass transfer in detail. The results of these simulations can be used to provide qualitative evaluation of flow assurance issues such as erosion, slugging and hydrate formation.

BMT’s experience in CFD modeling for the Oil & Gas sector and providing informed analysis of the data can help designers and operators solve flow problems, extend life of flow lines and ultimately, assure the efficient and reliable delivery of the product.

KEY SERVICES

- Multiphase pipe flow evaluation
- Multiphase flow simulations in manifolds, pipe junctions, pumps and separation equipment
- Sand erosion and sand blockage assessments
- Prediction of conditions leading to hydrate and paraffin/wax formation

KEY BENEFITS

- Appraisal of 3D multiphase flow effects, not available from empirical 1D tools
- Comparison of different design configurations to minimize sand erosion on piping and equipment
- Detection of potential conditions that could result in the formation of hydrates and wax
- Hydrate cleaning equipment performance
- Hydrate chemical treatment strategies evaluation
- Separation and processing equipment performance

SAND TRANSPORT

Sand carried by formation fluids is potentially a very serious operational hazard as it can lead to severe erosion and catastrophic failure of piping systems and associated equipment. Sand management and control are crucial to the safe and economical operation of production facilities.

Sand erosion is dependent on dynamic factors such as impingement velocity and impact angle, as well as sand grain size, shape, hardness and wall metal properties. CFD tools can be used to accurately calculate the behavior of sand particles within production fluids taking into account all of these factors in the calculation process. The modeling provides the sand velocity field from where the impingement velocities, angles and loading are calculated. With this information, empirical relations are used to estimate the erosion rates. An additional benefit of the modeling is that it can be used to identify areas where sand can potentially accumulate and form plugs that disturb or totally block the flow field, particularly around pipe elbows and inside flow line equipment.

BMT offers in depth expertise performing CFD modeling of sand erosion and transport on down hole and surface equipment. Qualitative comparisons of different designs and conditions can be evaluated, as well as estimating the requirements for the piping and equipment materials.
SLUG CONTROL

Gas-liquid flows in pipes can present different flow patterns depending on the fluid properties, concentrations, flow rates and pipe inclination. Various regimes can be identified, including bubble flow, slug flow, plug flow, churn flow and annular/wavy flow. Of these, slug flows are the most concerning from the operational perspective, as the liquid flows in concentrated parcels or slugs in an intermittent pattern. This can cause severe problems in the downstream receiving facilities like spills, flaring and underperformance of separation units.

BMT has extensive experience using CFD to evaluate gas-liquid flows. Consequences of slugs on separators and similar equipment can be identified. The effectiveness of mitigation devices like slug catchers can be assessed for different slug patterns. Additionally, 3D phenomena over sections of pipelines at different inclinations can be simulated, allowing for implementation of remedial strategies before the slug pattern can develop.

HYDRATE AND WAX FORMATION

Operation in deep water and colder climates expose production fluids to low temperatures. Certain combinations of temperature and pressure can result in the formation of hydrates and wax that can potentially plug the flow line and damage submerged equipment.

Hydrate and wax formation has severe consequences for the safe and reliable operation of hydrocarbon pipelines and systems. Hydrates occur when water molecules in hydrocarbons crystallize and form a solid. This can cause partial or complete blockage of the pipeline. Similarly, paraffin wax deposition at cold temperatures can have the same effects. For both cases, increased pressure drops or complete shut down of the system are undesirable outcomes.

Although CFD technology does not yet include general models to simulate complex hydrate and wax formation processes, it can be used to assess 3D local temperature and pressure conditions that can potentially lead to the formation of hydrates and paraffin wax deposition. The effectiveness of prevention devices like heaters can be rapidly assessed. Additionally, the dispersion of inhibitors inside subsea equipment can be evaluated to ensure it reaches the required locations, as well as the flow around cleaning devices like pipeline pigs.

BMT’s experience in multiphase flows including conduction, convection and radiation heat transfer provides our clients with practical engineering analysis to evaluate the potential of hydrate formation and wax deposition scenarios to occur and the effectiveness of remedial work and management strategies.
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