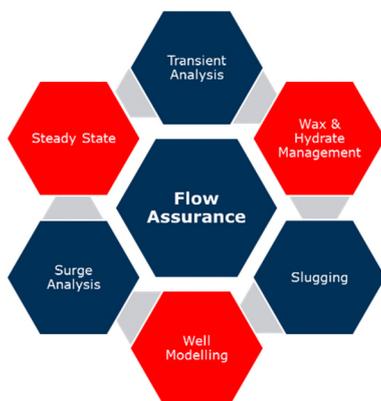


Flow Assurance and Process Design

Flow Assurance

Z-Subsea has capability to perform flow assurance and process design of subsea and onshore pipelines. We have extensive experience in flow assurance of multiphase production fluid starting from the reservoir, through the production tubing, Xmas Tree, Choke and subsea pipeline up to the subsea or onshore processing facilities. We also specialise in single phase oil, Liquefied Petroleum Gas (LPG) and natural gas flow assurance. We have long experience in hydraulics of special petroleum products like Aviation Turbine Fuel, which needs special treatment.

Our areas of expertise is shown below.



Z Subsea's Flow Assurance Expertise

Multiphase Flow Assurance

Production Fluid comes out of reservoir as a mixture of oil, gas, water and sludge. Pipeline transportation of the fluid poses flow assurance challenges. Based on the composition of the fluid, its reservoir pressure and temperature, ambient temperature of the environment in which the pipeline is laid, several challenges may arise. We engineer the system to make sure that uninterrupted production takes place and at desired arrival condition.

As part of multiphase flow assurance, steady state and transient analysis is performed.

Steady state Analysis

Steady state analysis is the first step towards understanding the overall behaviour of the transportation of the fluid, independent of time, after the flow has stabilized. As part of steady state analysis, pressure and temperature profile along the pipeline length is calculated. Flow rate shutdown analysis is also performed.

Velocity of fluid is maintained below the erosional velocity calculated as per API RP 14E.

Transient Simulation

Transient simulation is time dependent. This analysis is performed to study the behavior of various flow assurance parameters during the transition between the start-up of the flow and steady state.

As part of the transient simulation, following analyses are performed:

- Start-up
- Shutdown
- Ramp-up and Ramp-down
- Joule-Thomson cooling
- Surge Analysis

Slugging Assessment



Slugging occurs in multiphase flow condition as a result of difference in velocity of liquid and gas phases (hydrodynamic slugging) and as a result of terrain condition (terrain slugging). While the liquid phase flows in the lower section of the pipe, the gas phase being lighter flows on the upper section of the pipe. As a result of skin friction between the two layers, liquid moves and gets accumulated at the lower section of the pipeline, for example at the bottom of the riser and lower sections of spool pieces. Intermittently, a large liquid volume arrives at the separator, which may result in severe vibration of the riser or spools. To accommodate the large liquid volume at the separator, slug catcher is required to be designed.

Z-Subsea perform the slugging simulation and calculate the slug density and slug volume, which is used to calculate the force on the riser or sections of the spool. Volume of the slug catcher is also calculated.

Flow Assurance and Process Design

Z-Subsea can also perform slug tracking in which a visual representation of course of movement of slug is simulated.

Software used

Software used for slugging is Pipesim, OLGA Core and Slugtracking Module of OLGA.

Pigging

In pigging simulation, pigging velocity and slug volume calculated because of pigging is calculated. Pigging simulation is performed by OLGA or Pipesim.



Hydrate Management

Hydrates are crystalline structures of water and natural gas, which form at high pressure and low temperature.



If the temperature of the fluid in the pipeline goes below the hydrate formation temperature, hydrate plug could form in the pipeline leading to blockage and consequently production loss. We adopt two-pronged approach of hydrate management as below:

- Hydrate formation avoidance
- Hydrate Inhibition

Hydrate Formation avoidance

In this approach, we make sure that the fluid temperature is maintained above the hydrate formation temperature along the pipeline. We perform flow assurance modelling and recommend appropriate level of insulation, flow rate etc. to make sure that the temperature of the fluid is maintained above the hydrate formation temperature.

Softwares used

Z-Subsea use industry standard softwares like OLGA-Hydrate, Pipesim in association with Multiflash Hydrate or DELFI to perform this simulation.

Hydrate Inhibition

In case hydrate formation can not be avoided, we adopt an alternative approach by which hydrates molecules formed are not allowed to grow. This is achieved by hydrate inhibition: There are three techniques of hydrates inhibition as given below.

- Environmental inhibitors
- Thermodynamic inhibitors
- Kinetic inhibitors

In environmental inhibition, the production fluid is dried before it cools down by alcohol or silica gel or by adsorption of hygroscopic salt. Water is also removed by heating the production fluid and condensation subsequently.

Thermodynamic inhibition is achieved by

- Reducing the pressure of the gas
- Injecting salt solutions
- Injecting glycols/alcohols

Z-Subsea perform calculation of dosage rate of glycols/alcohols/salts.

Typically, glycol used is Mono Ethylene Glycol (MEG), and typical alcohol used is Methanol.

Flow Assurance and Process Design

Kinetic Inhibition

In Kinetic hydrate inhibition, LDHI (Low Dosage Hydrate Inhibitors) are used to stop agglomeration of hydrates. LDHI are typically polymers and copolymers. In this technique, rate of hydrate formation is reduced such that hydrate is not formed by the time the fluid reaches the destination. This method is not effective in case the fluid remains in the pipeline under stagnant condition during prolonged shutdown or line packing condition. We perform calculation of dosage rate of kinetic inhibitors.

Wax Management

We perform wax formation study to calculate potential for wax formation and deposition in the pipeline. As an outcome of this study, recommendations are made on insulation requirement for the pipeline such that fluid's temperature does not go below Wax Appearance Temperature (WAT) along the pipeline. If this can not be achieved by insulation of the pipeline, several other techniques could be recommended such as

- Dilution of the fluid in case of onshore pipeline
- Use of wax inhibitors (like Pour Point Depressants)
- Use of electrical heating systems



We also perform calculation of thickness of wax deposited on the inner wall of the pipeline.

Softwares Used

OLGA Wax
Pipesim
Multiflash Wax

Softwares

There are many commercially available softwares popularly used in the oil and gas industry as given below.

Software	Capability
Pipesim	Steady state, single phase and multi-phase flow assurance
Olga	Steady State and transient, single phase and multiphase flow assurance
Pipeline Studio (TLNET/TGNET)	Single Phase steady state and transient Oil and Gas pipeline flow assurance
Maximus	Life Cycle Management Software
Flowmaster	Flow Assurance Software
DELFI	<p>DELFI is a web-based environment, which includes Pipesim and OLGA and all its associated packages. This feature has been recently launched by Schlumberger in which the access to unlimited use of Pipesim and its associated suit of software is provided to the user based on a committed monthly or yearly subscription. Use of OLGA and its associated packages is provided on an hourly simulation based payment.</p> <p>The advent of DELFI has made more cost effective access to the Pipesim and OLGA packages, which was otherwise prohibitively expensive. We at Z Subsea make are keen to help our clients perform flow assurance studies with industry recognized softwares at reasonable.</p>

For further info about Z-Subsea Flow Assurance and Process capabilities contact us on enquiries@z-subsea.com.