

Multi-well Trunkline Network Model

Summary

The EnSys Yocum *Multi-well Trunk Line Network Model* is a powerful model for optimizing the development of fields when trunkline networks operating in single or multiphase flow are being considered for up to 100 oil wells producing simultaneously.

A case study feature permits the automatic generation of alternative network figurations for determining the optimum field producing systems and for examining the technical feasibility of each alternative.

This model is particularly well adapted to the design of offshore subses gathering systems.

! The flow rates through each branch of a complex trunk line system are calculated along with the pressure-temperature profile of each section of the system,

including the reservoir and oil well sections, and for the individual oil wells comprising the network.

A manifold end pressure must be specified, and all oil well and branch line flow rates are converged to that terminal system pressure.

! A noteworthy feature of this model is its ability to input different physical correlations of properties for each producing well to reflect variations in reservoir fluid properties. The calculational algorithm employed by the model is designed to blend the physical properties, gas-to-oil ratios (GOR) and water cuts throughout the network system.

! There is considerable flexibility available in defining a

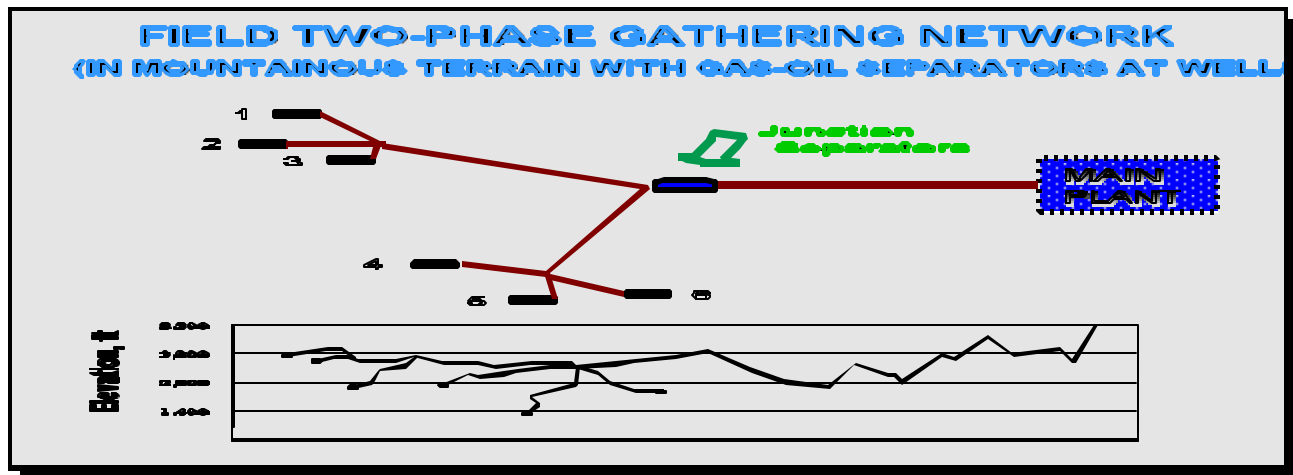


Exhibit 1

! The *Trunk Line Model* is an extension of the calculational abilities of the *EnSys Yocum Black Oil Field Production Facilities Model*. Using the Trunk Line Model, the full calculational power of the Production Facilities Model for the reservoir, oil well, and flow line sections may be applied to the solution of a trunk line system.

trunk line system configuration:

- Well flow lines may flow directly to a main line junction or the flow from several wells may combine in a branch line, which in turn, flows to a main line junction.
- Well line, branch line, and main line flow lines may consist of multiple segments and may be looped lines.

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- Gas/oil/water separators may be located at any point along the pipeline and at any branch line or main trunk line junction points.

Examples

Exhibits 1 and 2 are examples of actual trunk line networks that have been modeled and designed using the *Trunk Line Model*.

- Exhibit 1 represents a complex network operating in hilly terrain with looped lines and gas/oil/water separators at the wellheads.
- Exhibit 2 represents an offshore field development with the well platforms connected by branch trunk lines to a main junction platform. The three phase flow is then transmitted 61 miles to shore via a 26 inch trunk line. At the shoreline, there is a possibility of slug flow generation in the riser. A slug flow correlation for inclined or vertical risers is incorporated into the *Trunk Line Model*. The correlation is based on field tests and is updated as new applications are made and as new field data becomes available.

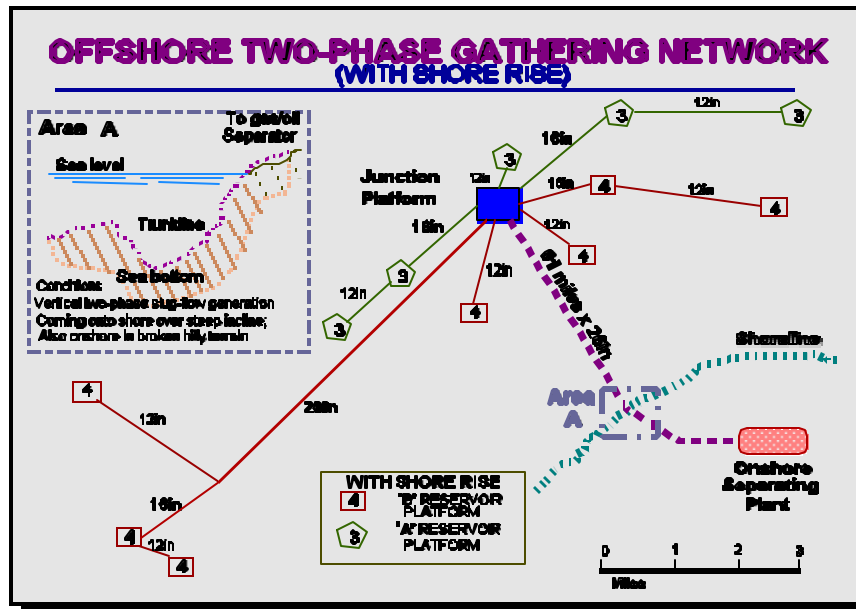


Exhibit 2

a main line.

- 2) With the coefficients calculated, the trunk line system solution is now divorced from further detailed calculations of specific oil well and branch line configurations.

A last junction point pressure is assumed, where the last junction is taken to mean the junction most distant from the main line terminus. Using the coefficients, the combined flow rate, temperature, GOR and other fluid properties entering the last junction may be calculated for the assumed pressure. A rigorous pressure-flow calculation is then made along the main line up to the next junction point.

The combined flow, temperature, GOR and other fluid properties entering into the second main line segment may be determined by using the pressure calculated for this point. This procedure is repeated for each main line junction point until the terminus of the system is reached.

- 3) A comparison of the calculated terminal junction pressure with the desired specified system end pressure is made.

An appropriate adjustment is made to the last junction pressure and the entire main line calculation is repeated between junction points. The entire procedure is repeated again in iterative fashion until a convergence is obtained against the

Trunkline Algorithm

In constructing the *Trunk Line Model*, the logic inherent in defining and converging a trunk line system was superimposed on the existing logical structure of the *Production Facilities Model*.

The heart of the extension is the trunk line algorithm. This is described below in a stepwise manner:

- 1) Coefficients are generated for each oil well in the system relating exit pressure, temperature, three phase mass balances and physical properties to flow rate. Similar coefficients are generated for branch lines. The word "exit" is defined as the point where an oil-well flow line enters either a branch line or a main line and where a branch line enters

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desired system temperature
and pressure.

- 4) **If desired, the user may instruct the program to recalculate each and every reservoir, oil well, oil well flow line, branch line, and main line segment of the trunk line system using the converged flows which have been previously calculated.**

This enables complete calculational detail along the entire system to be obtained. As an alternative, the user may request that only a summary table be reported containing flow rate, pressure, temperature, and GOR information at key trunk line system network points.
