E06 • Selective Inflow Performance

E06.1 • Introduction

Selective inflow performance (SIP) provides a mean of establishing the IPR for each rate producing layer. The well is flowed at several different stabilized surface rates and for each rate, a production log is run across the entire producing interval to record simultaneous profiles of downhole flow rates and flowing pressure. Measured in-situ rates can be converted to surface conditions using PVT data. The SIP theory is only valid for single phase flow and usage of the SIP option is not recommended in case of multiphase flow.

The SIP option is enabled when:

- There are at least two interpretations (in two different surveys)
- Schematic logs exist for those interpretations
- The reservoir zones (green) have been defined in the Document panel.

A typical SIP diagram is shown in Fig 6.1.

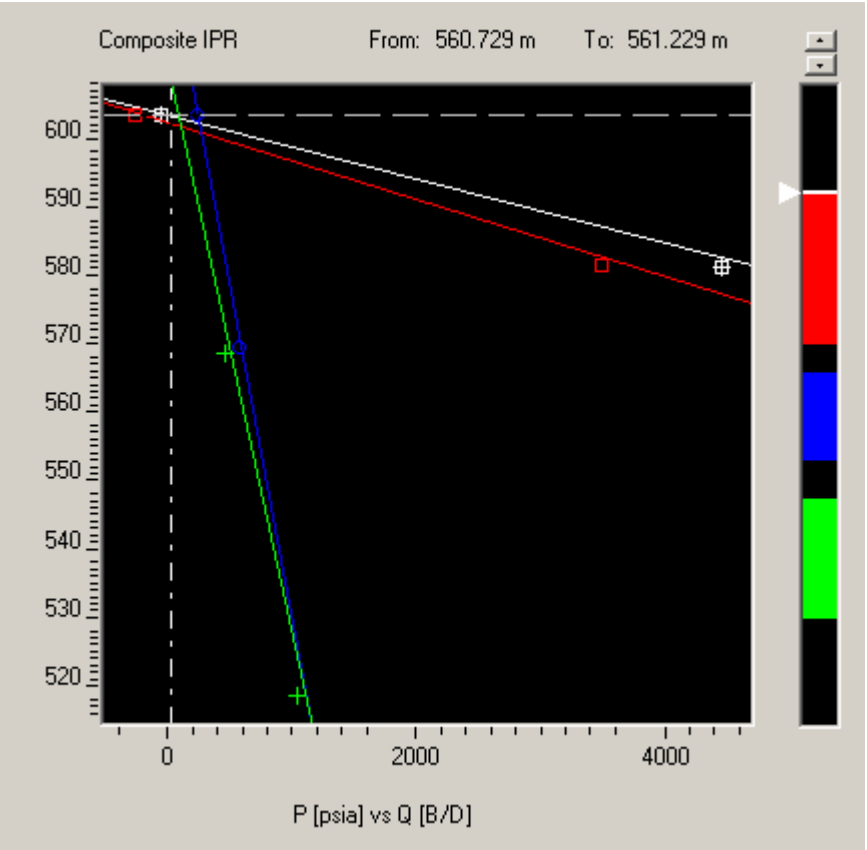

Fig 6.1

To each reservoir zone corresponds for each survey/interpretation a couple [rate, pressure] used in the SIP calculation. For the pressure, the interpretation reference channel is interpolated at the top of the zone. For the rate, the value used in the SIP is the contribution. It is calculated for a given reservoir zone as the difference between:

- values interpolated on the schematic logs at the top of that zone
- values interpolated on the schematic logs at the bottom of that same zone

E06.2 • IPR Type

The user can decide to fit the data with different types of IPR equations: Straight line, C&n, and LIT relations. In the case of a gas well, the pseudo pressure m(p) can be used instead of the pressure p to estimate the gas potential. All the results are summarized in the results grid dialog accessible from the 'show results' button.

Straight line or Darcy's law

$$q_o = PI \times \left(\overline{p} - p\right)$$

with $\overline{p}$, is the calculated average pressure

PI, the productivity index

This option requires at least two valid data points and accept negative rates for the regression (typically for shut-in surveys with cross flow or for injection wells).

For this option only, the user can interactively re-define the straight line with the mouse (slope and intercept). The results are updated automatically. See section E6.2.1.

LIT or Jones (A & B)

$$\overline{p}^2 - p^2 = A \times q + B \times q^2$$

with $\overline{p}$, the calculated average pressure

A, the turbulence term, must be ≥ 0

B, the Darcy flow term, must be ≥ 0

This option requires at least two valid data points and negative rates are disregarded for the regression.

Fetkovitch or C&N

$$q = C \times \left(\overline{p}^2 - p^2 \right)^N$$

with $\overline{p}$, the calculated average pressure

C, coefficient dependent on fluid properties, must be ≥ 0

N, exponent, must be between 0.5 and 1

In this case , the user can fix a value for the N exponent.

This option requires at least two valid data points; negative rates are disregarded for the regression.

E06.3 • Pseudo Pressure m(p)

The equations used in the IPR analysis assume constant fluid characteristics (compressibility, viscosity, formation volume factor). In gas well this is seldom the case and the real gas potential or pseudo pressure m(p) must be used instead.

Pseudo pressure is given as:

$$m(p) = \int_{p_0}^{p} \frac{p\,dp}{\mu z}$$

with p_0, the atmospheric pressure = 14.7 psia

μ, the fluid viscosity

z, the gas compressibility factor

The calculation of z(p,t) and μ(p,t) uses the pressure and temperature reference channels of the considered interpretation and the associated PVT module.

When calculating the IPR data points, Emeraude will build a table relating the pseudo pressure to the corresponding pressure. This table is used to extract the average pressure $\overline{p}$ from the calculated average pseudo pressure m($\overline{p}$).

E06.4 • Datum correction

The default is to generate the SIP without pressure correction to a common datum. However the user can select this option defining the following parameters: reference depth + reference(s) channel(s) (pressure and temperature if pseudo pressure is used); by checking the check box called 'correct at depth', the computed correction is applied to the data point and IPR lines.
This option is used to correct for the hydrostatic gradient of the well bore fluid column, so that pressure potentials from layers at different depth can be compared to an arbitrary common datum. It can be used to highlight cross flow between layers. Note that the average pressure of each of the layer remains the same and results will not be affected by these corrections.
In order to correct for the hydrostatic gradient, a reference pressure channel, preferably the shut-in pressure, must be available.
The shift will then be calculated as follow:

$$\Delta p_{IPR} = p_{ref\,(shut-in)} @\ datum\ depth \quad - \quad p_{ref\,(shut-in)} @\ IPR\ depth$$

The IPR depth is taken as the top of the IPR zone.
All the potential within the same IPR will be shifted by the same amount Δp_{IPR}.
If the pseudo pressure potential is used, then the user must also supply a reference temperature channel to compute the $\Delta(m(p)_{IPR})$.

E6.5 • Phase Selection

Although the SIP theory only applies to single phase flow, the user can restrict the IPR's computations to a particular phase; only contribution of the selected phase will be taken into account. The default is set to the phase with the most important total contribution in each survey (the condition must be consistent between all surveys); the mixture option is chosen otherwise.

This facility has been implemented so that the user can withdraw the minor contribution of marginal phases showing in the rate schematic log (typically bottom zone water production in an oil or gas well).