Rate-weighted Productivity Plot = q-weighted J-plot

One of the Productivity Diagnostics methods based on correlation between rate-weighted average pressure drawdown:

(1) $$\overline{\delta p}(t) = \frac{1}{Q} \int_0^t \left(p_{wf}(\tau) - p_e(\tau) \right) q_t d\tau$$

and rate-weighted average total sandface flowrate:

(2) $$\bar{q}_t(t) = \frac{1}{Q} \int_0^t q_t^2(\tau) d\tau$$

where

τ	production/injection time
q_t	total sandface flowrate as function of time τ
p_e	drain-area formation pressure as function of time τ
p_{wf}	bottomhole pressure as function of time τ
Q_t	total sandface cumulative offtake/intake: $Q_t(t) = \int_0^t q_t(\tau) d\tau$

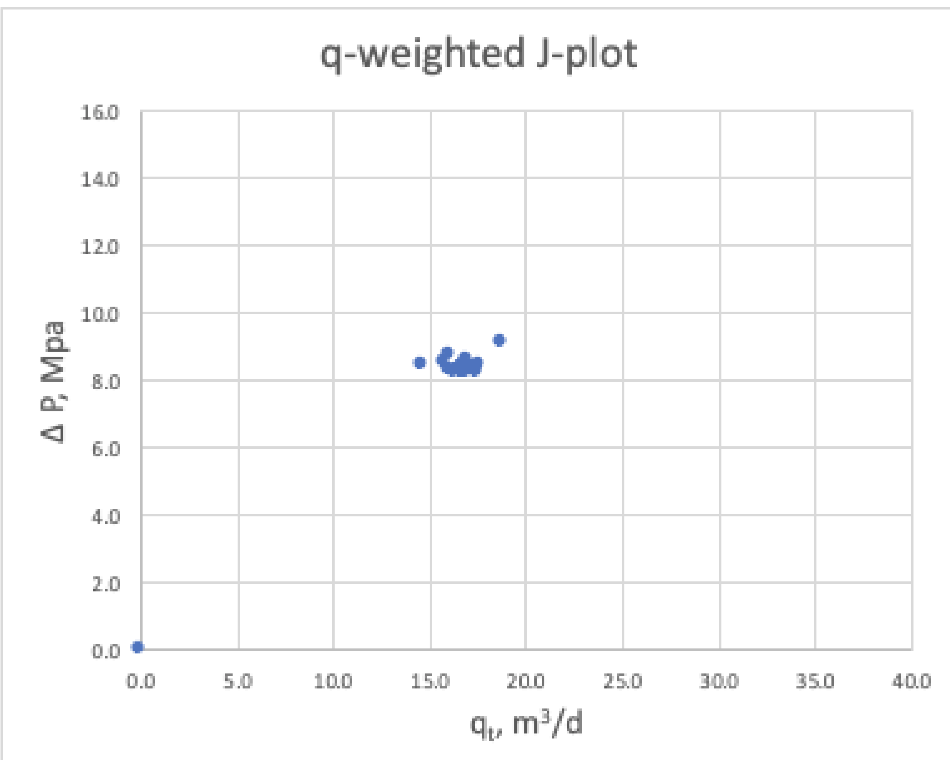

Fig. 1. q-weighted J-plot

It shows unit slope on log-log plot for stabilized reservoir flow:

(3) $$\overline{\delta p}(t) = J^{-1} \bar{q}_t(t)$$

where

J	constant productivity index

Due to integration procedure the q-weighted J-plot has a better tolerance to uncertainties in formation pressure and bottomhole pressure comparing to Unweighted J-plot and usually results in more accurate estimation of productivity index.

It is highly recommended to plot sandface flowrates rather than surface flowrates to achieve better linearity in correlation for stabilized reservoir flow.

The average pressure drawdown $\overline{\delta p}(t)$ is usually calculated over interpolated values of formation pressure and bottomhole pressure :

$$\overline{\delta p}(t) = \frac{1}{Q} \int_0^t \big(p_{wf}(\tau) - p_e(\tau) \big) \, q_t(\tau) \, d\tau = \frac{1}{Q} \sum_k \big(p_{wf}(\tau_k) - p_e(\tau_k) \big) \, q_t(\tau_k) \, \delta \tau_k$$

The main difference between q-weighted J-plot and t-weighted J-plot is the averaging methodology.

The t-weighted J-plot gives equal weight to all data points $w(t) = \frac{1}{t}$, while q-weighted J-plot gives more weight to higher flowrate data points, lower weight to lower flowrate data points and zero weight to no-flow data points ($q = 0$): $w(t) = \frac{q_t}{Q}$.

When flowrate is constant $q = \rm const$ both methods are equivalent because $w(t) = \frac{q_t}{Q} = \frac{1}{t}$.

The q-weighted J-plot provides the same accuracy of productivity index estimation as Hall Plot but additionally provides a useful insight into the ranges of historically averaged flowrates and drawdowns.

See Also

Petroleum Industry / Upstream / Production / Subsurface Production / Field Study & Modelling / Production Analysis / Productivity Diagnostics