Superposition Time

Multi-rate drawdown test

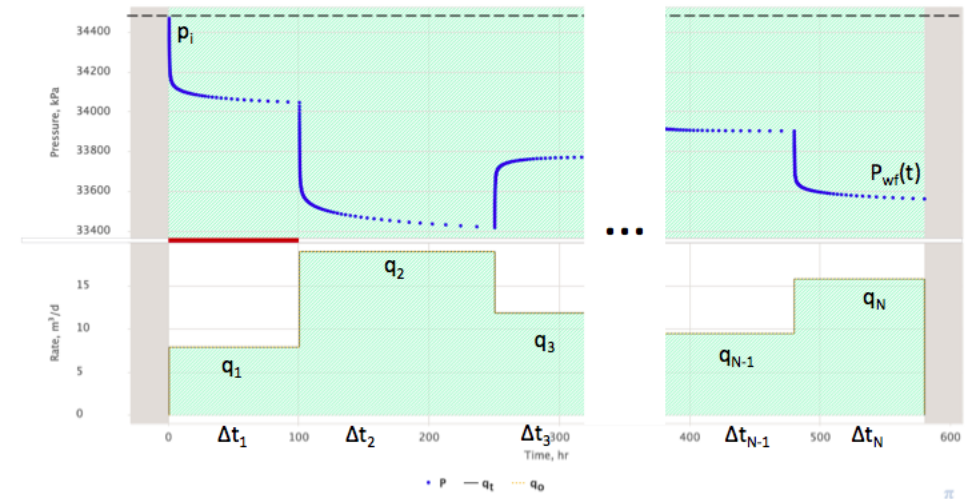

Fig. 1. Multi-rate drawdown test

Given:

- a discrete flowrate history $\{(\Delta t_1, q_1), (\Delta t_2, q_2), (\Delta t_3, q_3), (\Delta t_{N-1}, q_{N-1}), (\Delta t_N, q_N), \}$ (see Fig. 1)
- vertical well and homogeneous reservoir with no boundaries
- duration of the last drawdown interval Δt_N reaching radial flow regime

the superposition time t_s is defined as:

(1) $$\ln t_s = \ln(t - t_{N-1}) - \sum_{i=1}^{N-1} \frac{q_i - q_{i-1}}{q_{N-1}} \ln(t - t_{i-1}) = \ln \Delta t - \sum_{i=1}^{N-1} \frac{q_i - q_{i-1}}{q_{N-1}} \ln\left(\Delta t + \sum_{i=1}^{N-i} \Delta t_i\right)$$

The pressure response at time moment $t = t_N$ will be given by formula:

(2) $$p_{wf}(t_s) = p_i + \frac{q_N B}{4\pi\sigma} \ln t_s$$

which has the same format as for a single rate drawdown test with flowrate q_N, and duration t_s and can be interpreted using Type-Curve Matching.

Multi-rate build-up test

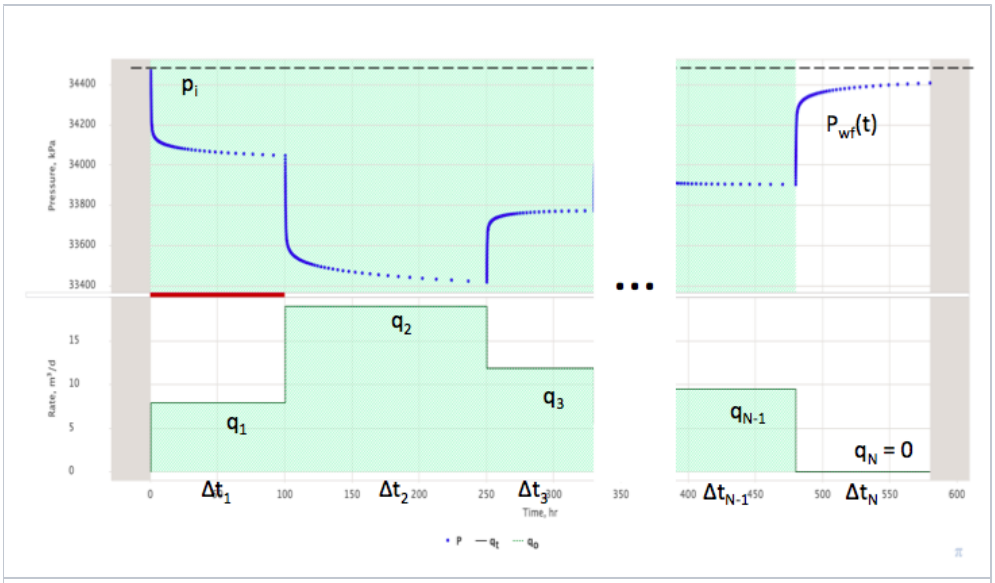

Fig. 2. Multi-rate build-up test

Given:

- a discrete flowrate history $\{(\Delta t_1, q_1), (\Delta t_2, q_2), (\Delta t_3, q_3), (\Delta t_{N-1}, q_{N-1})\}$ followed by a shut-in period $(\Delta t_N, q_N = 0)$ (see Fig. 2)
- vertical well and homogeneous reservoir with no boundaries
- duration of the last shut-in Δt_N reaching radial flow regime

the superposition time t_s is defined as:

(3) $$\ln t_s = \ln(t - t_{N-1}) - \sum_{i=1}^{N-1} \frac{q_i - q_{i-1}}{q_{N-1}} \ln(t - t_{i-1}) = \ln \Delta t - \sum_{i=1}^{N-1} \frac{q_i - q_{i-1}}{q_{N-1}} \ln\left(\Delta t + \sum_{i=1}^{N-i} \Delta t_i\right)$$

The pressure response at time moment $t = t_N$ will be given by formula:

(4) $$p_{wf}(t_s) = p_i + \frac{q_{N-1} B}{4\pi\sigma} \ln t_s$$

which has the same format as for a single rate drawdown test with flowrate q_{N-1}, and duration t_s and can be interpreted using Type-Curve Matching.

See Also

Petroleum Industry / Upstream / Subsurface E&P Disciplines / Well Testing / Pressure Testing / Pressure Transient Analysis (PTA) / PTA Diagnostic Plot

[Well & Reservoir Surveillance] [Pressure Diffusion] [Pressure log-log plot]