# Water-Oil Rate Plot = qOW

The plot of water production rate $q_W$ (along y-axis) against the oil production rate $q_O$ (along x-axis).

It can be used for express Watercut Diagnostics of thief water production.

The mathematical model of the thief water production from aquifer is based on the following equation:

| | | |
|---|---|---|
| (1) $q_W = a \cdot q_O + b$ | (2) $a = J_{1O}^{-1} \cdot (J_{1W} + J_{2W})$ | (3) $b = J_{2W} \cdot (p_2^* - p_1^*)$ |

where

| | | | | | |
|---|---|---|---|---|---|
| | | $q_W$ | water production rate | $q_O$ | oil production rate |
| $p_1^*$ | formation pressure in petroleum reservoir | $J_{1W}$ | water productivity index of petroleum reservoir | $J_{1O}$ | oil productivity index of petroleum reservoir |
| $p_2^*$ | formation pressure in aquifer | $J_{2W}$ | water productivity index of aquifer | | |

For the case of aquifer pressure is higher than that of petroleum reservoir: $b > 0 \Leftrightarrow p_2^* > p_1^*$

For the case of aquifer pressure is lower than that of petroleum reservoir: $b < 0 \Leftrightarrow p_2^* < p_1^*$

In practical applications, the equation (1) is often considered through the weighted average values:

(4) $$\langle q_W \rangle = a \cdot \langle q_O \rangle + b$$

where

| | |
|---|---|
| $\langle q_W \rangle, \langle q_O \rangle$ | are weighted average of $q_W$ and $q_O$ |

There are different ways to calculate weighted average of the dynamic variable, for example:

| t-weighted average | q-weighted |
|---|---|
| $\langle A \rangle_t = \frac{1}{t} \int_o^t A(t)\, dt$ | $\langle A \rangle_q = \frac{1}{Q(t)} \int_o^t A(t)\, q(t)\, dt$ |

## See Also

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