Instantaneous PIR

Ratio of field-wide oil production rate q_O to the water injection rate q_{WI}:

(1) $$\mathrm{PIR} = \frac{q^{\uparrow}_O}{q^{\downarrow}_{WI}}$$

It measures how efficiently waterflood supports the oil production and represent one of the key Waterflood Diagnostics.

When gas injection is not present ($q^{\downarrow}_{GI} = 0$) the PIR can be related to the current Instantaneous Voidage Replacement Ratio (IVRR) as:

(2) $$\mathrm{PIR} = \frac{1}{\mathrm{IVRR}} \cdot \frac{1 - Y_w}{Y_w + (1 - Y_w) \left[\frac{B_o}{B_w} + \frac{B_g}{B_w} (\mathrm{GOR} - R_s) \right]} = \frac{1}{\mathrm{IVRR}} \cdot \frac{1}{\mathrm{WOR} + \left[\frac{B_o}{B_w} + \frac{B_g}{B_w} (\mathrm{GOR} - R_s) \right]}$$

(see (Instantaneous Voidage Replacement Ratio = IVRR:3) for derivation).

For the Balanced waterflood:

(3) $$\mathrm{PIR} = \frac{1}{\mathrm{WOR} + \left[\frac{B_o}{B_w} + \frac{B_g}{B_w} (\mathrm{GOR} - R_s) \right]}$$

and for those above bubble point pressure ($p > p_b \Leftrightarrow GOR = R_s$):

(4) $$\mathrm{PIR} = \frac{1}{\mathrm{WOR} + \frac{B_o}{B_w}}$$

The equation (4) is often used for predicting the upper limit of oil production increase in response to the water injection:

(5) $$q^{\uparrow}_O = \mathrm{PIR} \cdot q^{\downarrow}_{WI} = \frac{q^{\downarrow}_{WI}}{\mathrm{WOR} + \frac{B_o}{B_w}}$$

For the waterless period of Balanced waterflood project $\mathrm{WOR} = 0$ and:

(6) $$q^{\uparrow}_O = \mathrm{PIR} \cdot q^{\downarrow}_{WI} = \frac{B_w}{B_o} \cdot q^{\downarrow}_{WI}$$

See Also

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

[Cumulative PIR]