

Waterflooding

@wikipedia

Synonym: [Waterflood Recovery \(WF\)](#) = [Waterflooding](#)

One of the [Reservoir flow drive mechanisms](#) and [Recovery Methods](#) based on [injecting water](#) in the [petroleum reservoir](#) in order to support [formation pressure](#) and production rates in [oil producers](#) and improve oil recovery.

The Expected Ultimate Recovery during the waterflood sweep can be assessed with the following formula:

$$(1) \quad EUR_{WF} = E_S E_D + (1 - E_S) \cdot EUR_{ND}$$

where E_D – [displacement efficiency](#), E_S – [sweep efficiency](#).

Voidage Replacement

One of the key principle of [Waterflooding](#) is to maintain [Instantaneous Voidage Replacement Ratio \(IVRR\)](#) above unit value at all times:

$$(2) \quad IVRR = \frac{B_w q_{WI}^\downarrow}{B_w q_W^{uparrow} + [B_o + B_g (GOR - R_s)] q_O^{uparrow}} \geq 1$$

which is equivalent to maintainign the surface water injection to liquid production ratio as:

$$(3) \quad \frac{q_{WI}^\downarrow}{q_L^\uparrow} \geq Y_W + (1 - Y_W) \cdot \left[\frac{B_o}{B_w} + \frac{B_g}{B_w} (GOR - R_s) \right]$$

This ensures maintaining the formation pressure at initial value.

Due to numerous reasons this condition is very difficult to implement in practise.

Sweep efficiency

A part of the reservoir pore volume subjected to displacement by invaded fluid (aquifer, injected water, injected gas or injected chemicals):

Total sweep	Areal sweep	Vertical sweep
(4) $E_S = \frac{V_{sweep}}{V_\phi}$	(5) $E_{SA} = \frac{A_{sweep}}{A_\phi}$	(6) $E_{SV} = \frac{h_{sweep}}{h_\phi}$
V_{sweep} – sweep volume	A_{sweep} – sweep area	h_{sweep} – sweep thickness
V_ϕ – pore volume	A_ϕ – pore area	h_ϕ – pore thickness

The total sweep efficiency is a product of areal and vertical sweep efficiencies:

$$(7) \quad E_S = E_{SV} E_{SA}$$

Water-Oil displacement efficiency

$$E_{Dow} = 1 - \frac{V_{o, LEFT}}{V_{o, INITIAL}} = \frac{1 - s_{wi} - s_{orw}}{1 - s_{wi}}$$

where s_{wi} – initial water in oil pay, s_{orw} – residual oil to water sweep.

See also

[Petroleum Industry](#) / [Upstream](#) / [Production](#) / [Subsurface Production](#) / [Reserves Depletion](#) / [Recovery Methods](#)

[[Waterflood Recovery Quality](#)][[Instantaneous Voidage Replacement Ratio \(IVRR\)](#)] [[Cumulative Voidage Replacement Ratio \(CVRR\)](#)]

[[Field Development Plan](#)][[Natural Depletion Recovery \(NDR\)](#)]

[Physics](#) / [Fluid Dynamics](#) / [Percolation](#) / [Reservoir flow](#) / [Reservoir flow drive mechanisms](#)

[[Aquifer](#)] [[Aquifer Drive @model](#)]

[[Subsurface E&P Disciplines](#)][[Field Study & Modelling](#)]

[[Gasflood Recovery \(GF\)](#)]

References

James T. Smith, William M. Cobb, Waterflooding (2010)