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Effects of slug flow

During production of a reservoir sometimes slugs are produced. These may be oil or water slugs in a gas well. The different density of the slugs leads to a temporary change in flow rate through the ICD. Also after water or gas breakthrough flow changes as outlined below.

The ICD is simply a nozzle. It is well known that the pressure drop through a nozzle is proportional to the fluid density and also proportional to the flow rate squared. If we assume an ICD producing oil of rate Q and with oil density ρ, the change in flow rate when another fluid of different density is given by the following expression.

$$Q_{new} = Q_{old}\sqrt{\frac{\rho_{old}}{\rho_{new}}}$$

As an example assume that oil of density 0.8 sg is produced through the ICD. Suddenly water of density 1.0 sg enters the ICD. What is the new flow rate?

$Q_{new} = Q_{old}\sqrt{\frac{0.8}{1.0}} = 0.89Q$ Also, water slugs obtain an 11% reduction in flow rate as compared to the oil. A similar example can be devised assuming the same ICD suddenly is producing gas of density 0.55 sg. The flow now becomes:

$Q_{new} = Q_{old}\sqrt{\frac{0.8}{0.55}} = 01.20Q$ The gas flow is 20% higher that the initial oil flow.

The present version of the AFD also follows the pattern shown above. The difference is of course that in this case the flow remains constant with depletion. Figure 1a illustrates effects of slug flow for both the ICD and the AFD.

Effects of gas or water breakthrough

The same effect is present if we get a continuous production with a different fluid. Figure 1b illustrates the flow when the fluid type changes from oil to water. To keep simplicity we accept this behavior for the present AFD. However, if the density effect is wanted removed, we may redesign the AFD to eliminate this feature.

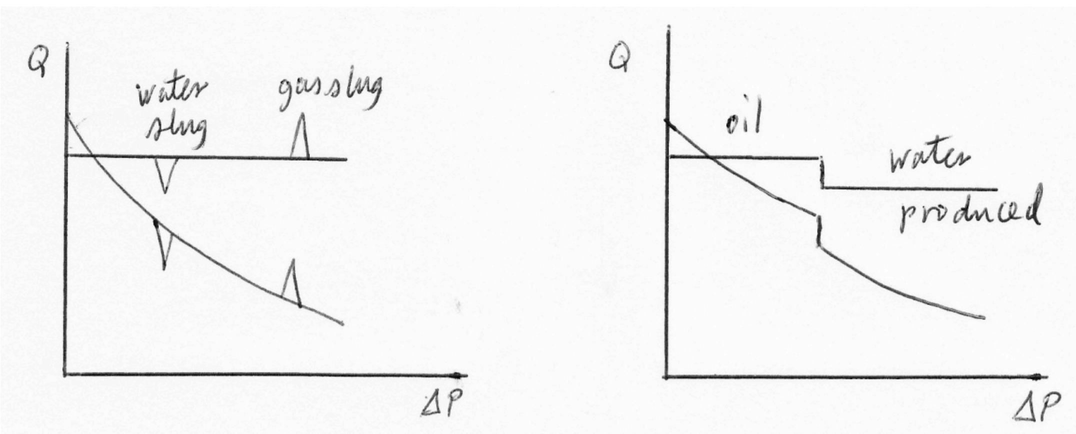

Figure 1. Change in flow if fluid of different density enters the ICD.