Kimia Fisika-TKG 1108

Fenomena multifase

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Application of relative permeability functions

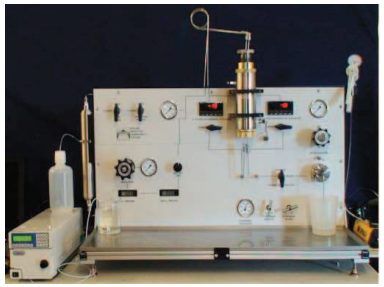
- Relative permeability is unique for different rocks and fluids
- Relative permeability affects the flow characteristics of reservoir fluids.
- Relative permeability affects the recovery efficiency of oil and/or gas.

Absolute permeability

- Absolute permeability: is the permeability of a porous medium saturated with a single fluid (e.g. S_w=1)
- Absolute permeability can be calculated from the steady-state flow equation (1D, Linear Flow; Darcy Units):

$$q = \frac{k\,A\,\Delta p}{\mu\,L}$$

Permeability measurement



Multiphase flow in reservoirs

Commonly, reservoirs contain 2 or 3 fluids

- Water-oil systems
- Oil-gas systems
- Water-gas systems
- Three phase systems (water, oil, and gas)

To evaluate multiphase systems, must consider the effective and relative permeability

Effective permeability

Effective permeability: is a measure of the conductance of a porous medium for one fluid phase when the medium is saturated with more than one fluid.

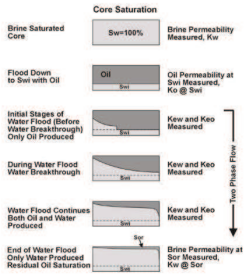
- The porous medium can have a distinct and measurable conductance to each phase present in the medium
- Effective permeabilities: (ko, kg, kw)

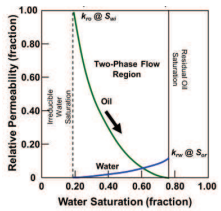
Relative permeability

Relative Permeability is the ratio of the effective permeability of a fluid at a given saturation to some base permeability

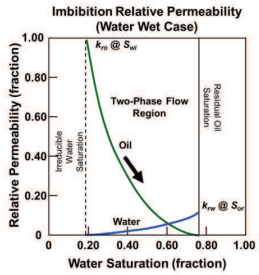
- Permeability is typically defined as:
  - absolute permeability, k
  - effective permeability to non-wetting phase at irreducible wetting phase saturation [e.g. $k_o(S_w=S_{wi})$]
  - because definition of base permeability varies, the definition used must always be:
    - confirmed before applying relative permeability data
    - noted along with tables and figures presenting relative permeability data

Relative permeability measurement



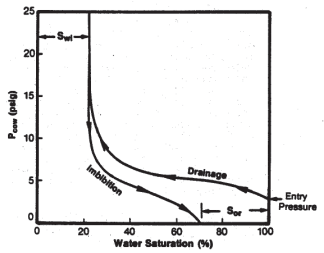


Relative permeability function

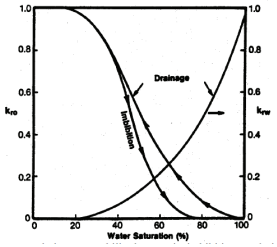


- Wettability and direction of saturation change must be considered
  - drainage
  - imbibition
- Base used to normalize this relative permeability curve is k_{ro} @ S_{wi}
- As S_w increases, k_{ro} decreases and k_{rw} increases until reaching residual oil saturation

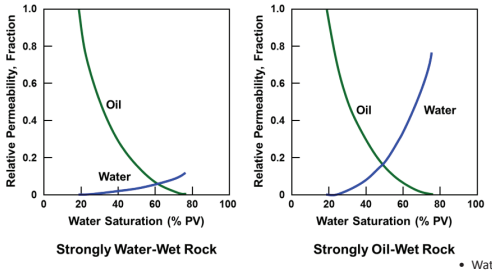
Imbibition and drainage capillary pressure curves



Relative permeability hysteresis, imbibition vs. drainage

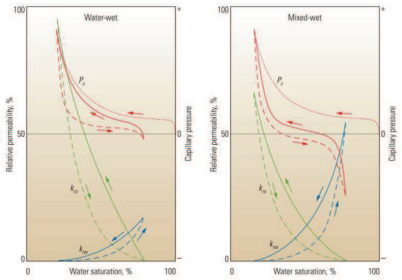


Effect of wettability for increasing Sw



- Water flows more freely
- Higher residual oil saturation

Relative permeability and wettability



Factor affecting relative permeability

- Fluid saturations
- Geometry of the pore spaces and pore size distribution
- Wettability
- Fluid saturation history (i.e., imbibition or drainage)

Characteristics of relative permeability functions

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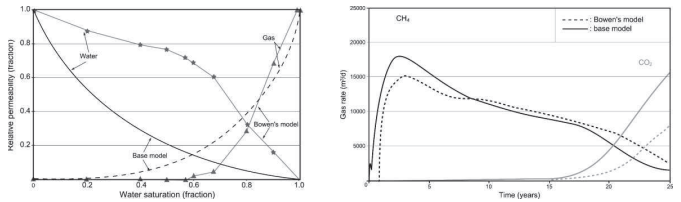
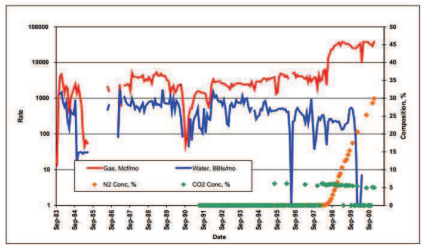
Relative permeability



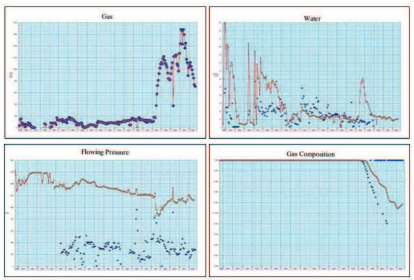
Anggara et al, 2014

Producing History



Reeves and Oudinot, 2004

Comparison of prediction to actual well-performance-1



Reeves and Oudinot, 2004

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