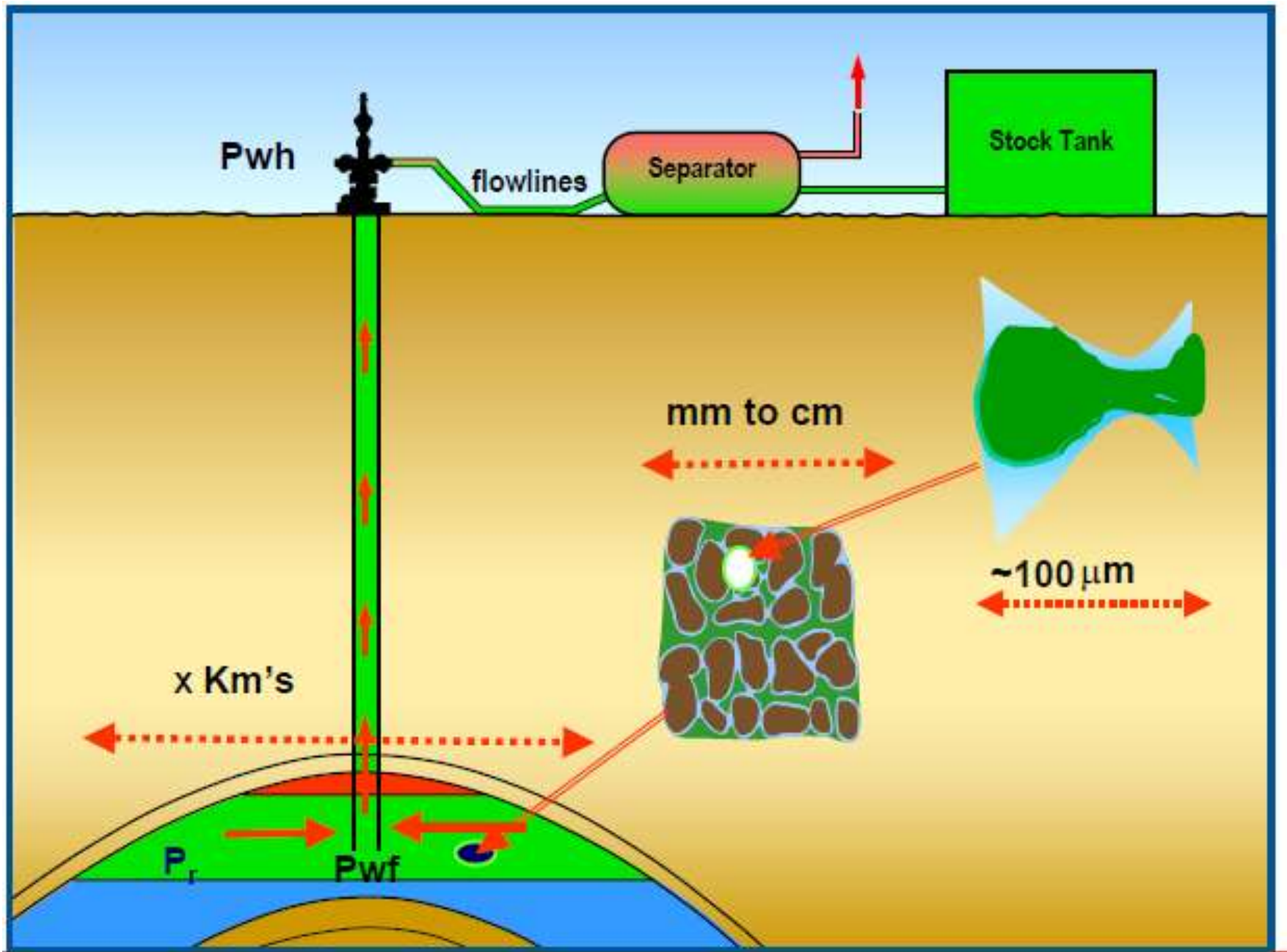# Flow in Porous Media

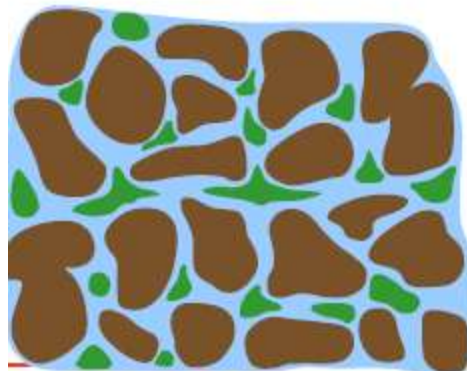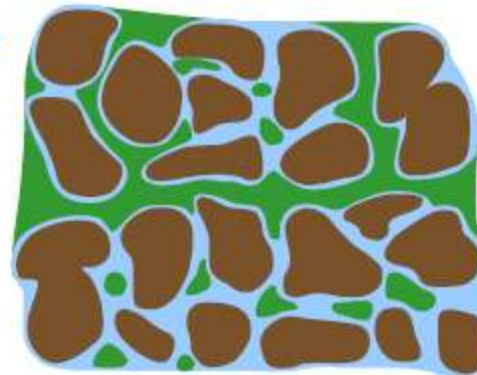**Module 0**
Introduction
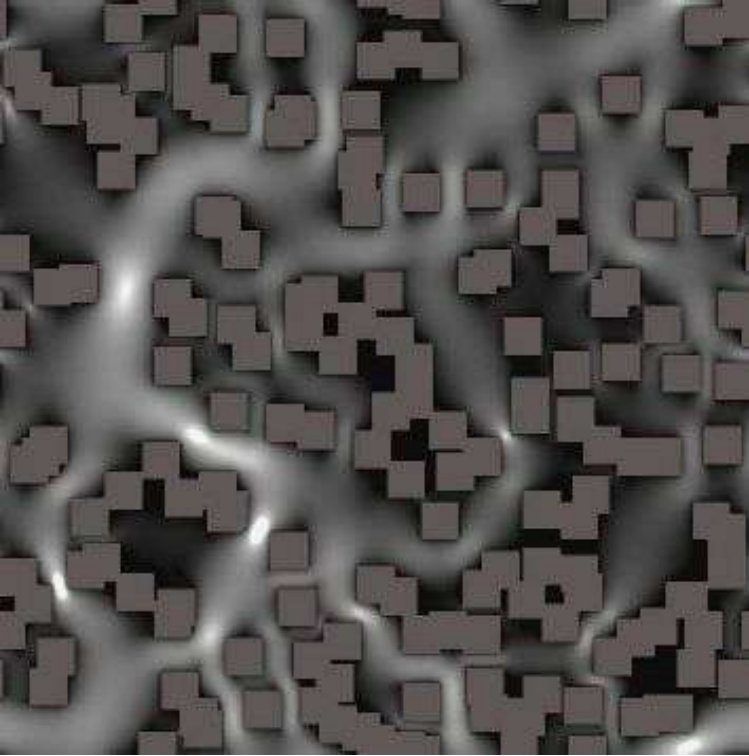
Initial state
Oil Sat. = S_{oi}
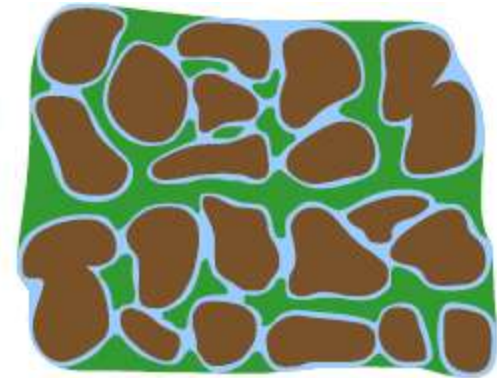
Intermediate

Final state
Oil Sat. = S_{orw}

Outline of the Course

- Fundamental Properties of Porous Media
- Mathematical Treatment of Engineering Problems
- Fundamental of Single Phase Flow in Porous Media
- Fundamental of Two Phase Flow in Porous Media
- Convective-Dispersive Flow in Porous Media
- References

Fundamental Properties of Porous Media

- Porosity
- Permeability
- Wettability and Capillary pressure
- Relative permeabilities
  - Mathematical Models for Predicting Two or Three-Phase Relative Permeability
  - Experimental Methods for Relative Permeability Measurements
    - Steady-state Methods
    - Unsteady-state (Displacement) methods
  - Factors Affecting Relative Permeability
    - Fluid saturation and saturation history
    - Viscous capillary and gravitational forces
    - Wettability
    - Temperature

Mathematical Treatment of Engineering Problems

- Step-1: The expression of the problem in mathematical language (called formulation)
- Step-2: The appropriate mathematical formulation
- Step-3: The interpretation of the results

- **Analysis of Important Oil and Gas Engineering Processes**
  - Diffusive and Convective Flow
  - Steady-State Flow
  - Time-Dependent Processes without Spatial Variation
  - Steady-state Processes Including Spatial Variation
  - Time-Dependent Processes Including Spatial Variation

Fundamental of Single Phase Flow in Porous Media

- Fundamental Equation of Filtration.
  - Differential Form of the Darcy-Law
  - Anisotropic Porous Media
- Equation of State
  - Incompressible Fluids
  - Low Compressibility Fluids
  - Formation Volume Factor
  - Ideal and Real Gases
- Equation of continuity
- Special Forms of the Equation of Filtration
  - Incompressible Fluids
  - Low Compressibility Fluids
- Real and Ideal Gases
- Boundary and Initial Conditions

Solutions of the Single-Phase Equation of Filtration

- Steady State Filtration
- Steady State Filtration of Low Compressibility Fluid
- Steady State Filtration in a Radial System
- Steady State Gas Filtration
- Non-Steady State Filtration in Infinite Acting Systems
  - Radial Systems with Constant Production Rate
  - Properties of the Ei-Function
  - Pressure Drop in Space and Time
  - The Spatial Distribution of Flow
- Dimensionless Variables
- The Infinite Radial System with Constant Pressure at the Interior Boundary
- Non-Steady State Filtration in a Finite System
  - Constant Production Rate
    - Closed Exterior Boundary
    - Boundary with Constant Pressure
  - Constant Pressure at the Interior Boundary and Closed Exterior Boundary
- Non-Steady State Filtration in Linear System
  - Linear Flow with Constant Production Rate
- The Principle of Superposition

Fundamental of Two Phase Flow in Porous Media

- The Equation of Two-Phase Filtration
- Vertical Two-Phase Filtration of Incompressible Fluids
- The BUCKLEY-LEVERETT Solution
  - The Welge-Method
- Influence of Gravity and Capillary Force
- The Capillary End-Effect
- Determination of Effective Capillary Pressures for Porous Media from Imbibition Data
- Imbibition in Naturally Fractured Reservoir
- Matrix-Fracture Gravity Drainage
- Two-phase flow in gas condensate reservoirs

Convective-Dispersive Flow in Porous Media

- Miscible Displacement in Porous Media

- Diffusion

- Diffusion in porous Media

- Theory of Dispersion in Porous Media

- Multi-Mechanistic Flow (Darcy & Fickian) Consideration- Dry Gas Injection in Depleted Gas Condensate Reservoirs

References

- Flow of Fluids through Porous Media- Colins
- FLUID FLOW IN POROUS MEDIA- HEINEMANN
- Technical Papers & Notes