

Special Purpose Reservoir Simulators

2-Compositional Simulators

Miscible displacement simulators

can be multi-component and multi-mechanistic models.

Multi-mechanism indicates that flow is taking place due to convection and dispersion.

The miscibility between two components can take place in two different ways: first-contact miscibility and multiple-contact miscibility.

In the first case, the displacing fluid is immediately miscible with the displaced fluid, while in the second, miscibility occurs after a series of equilibrium contact stages.

Compositional Simulators

- **Compositional reservoir simulators account for multiphase flow and interfacial mass transfer of each component in a hydrocarbon system.**
- **This implies that at any given time, the simulator tracks fluid movement and establishes the state of equilibrium of the reservoir fluids at the discrete points.**
- **At each node, phase pressure, phase saturation and overall composition are computed as a function of time.**

Phase Behavior Definitions

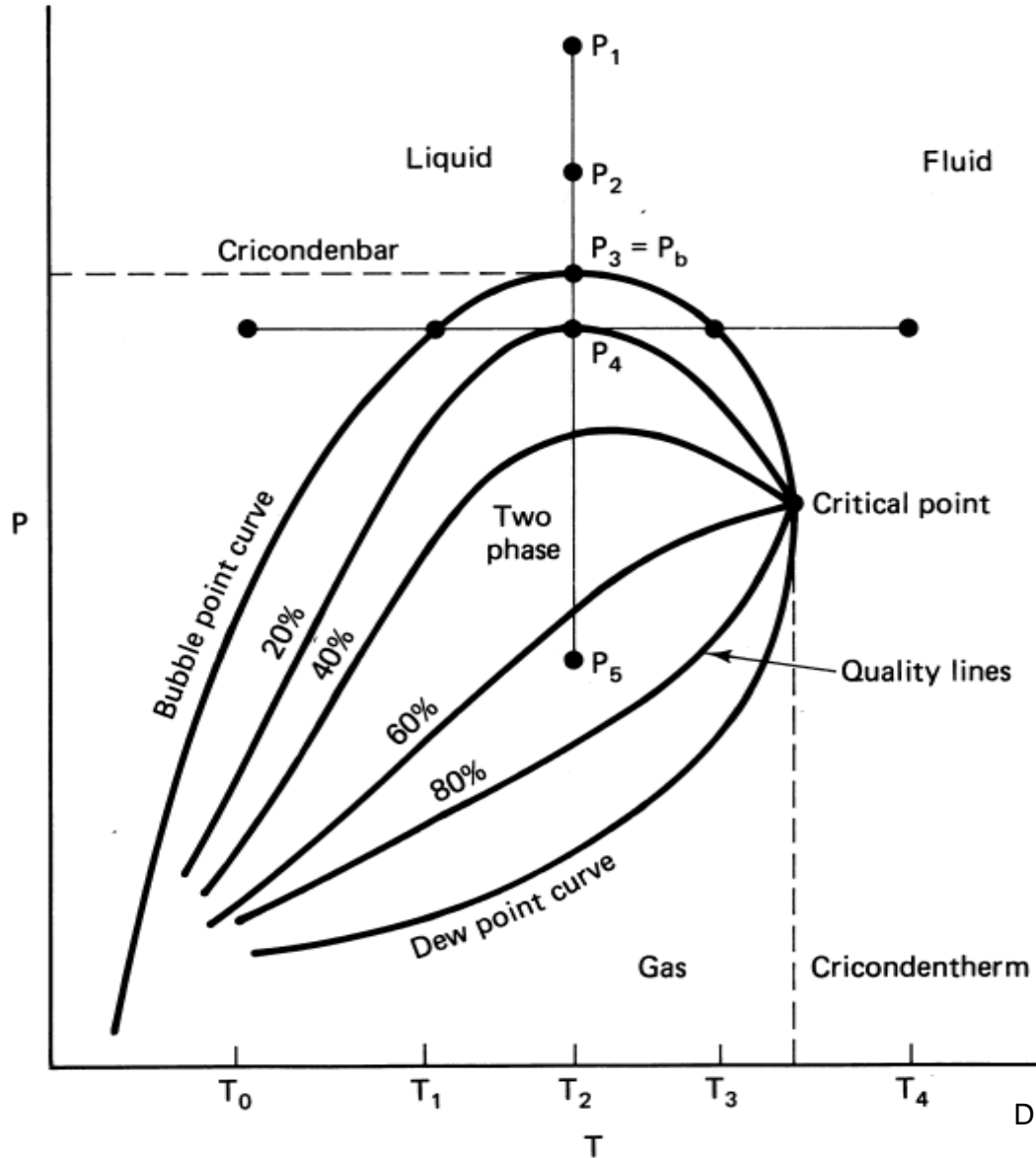
- **System** - quantity of mass under study
- **Property** - measurable attribute of system
 - Extensive** - depends on size (mass, volume, energy, ...etc)
 - Intensive** - independent of size (pressure, temp., comp...etc)
- **Phase(s)** - homogeneous regions of matter
- **Component** - identifiable chemical entity
- **Pseudo-component** - group of components that act as one component

$$N_f = N_c - N_p + 2 - \text{No. of independent variables}$$

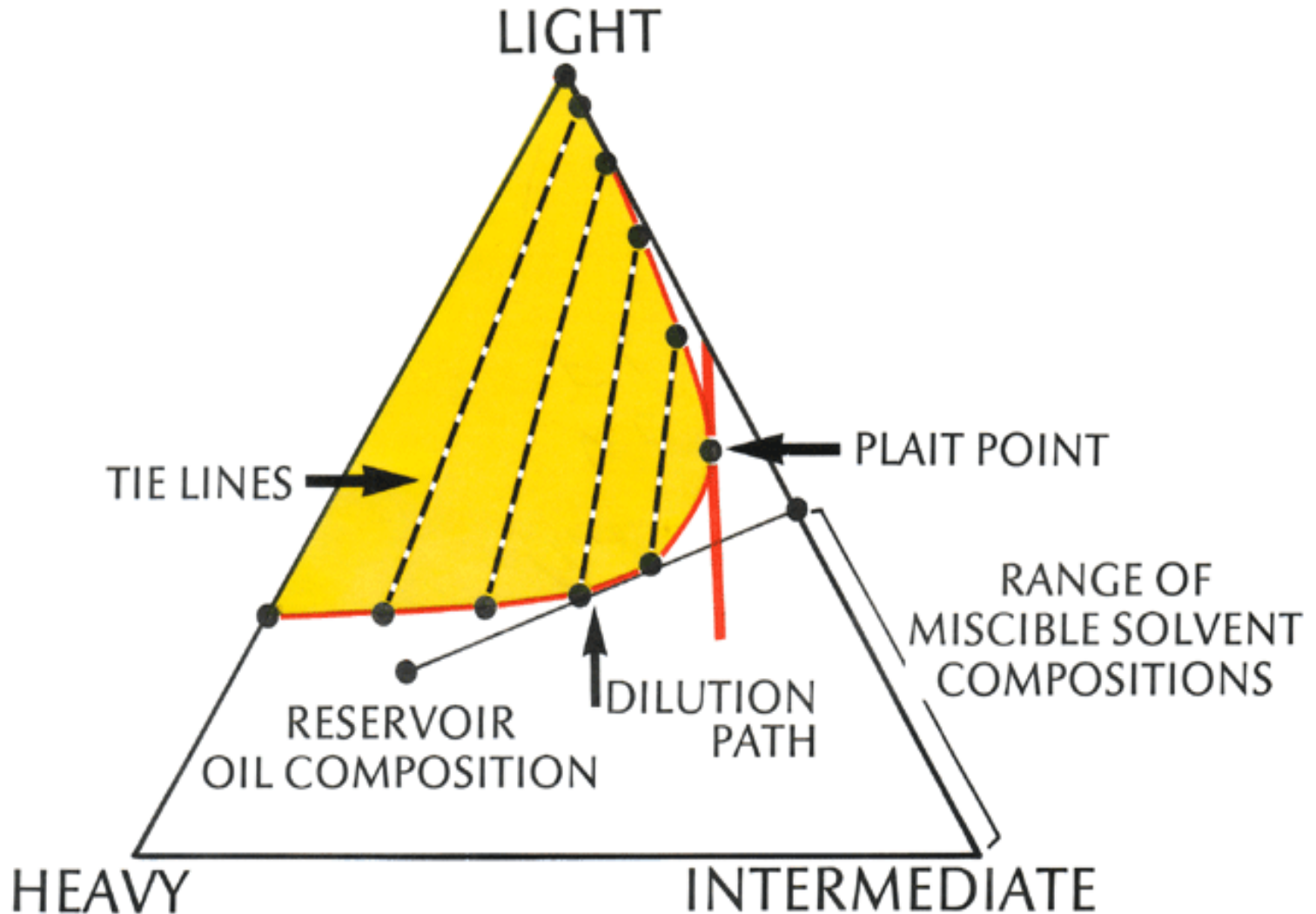
Phase Behavior Definitions (cont.)

- Miscible
 - Mix without interface
 - Property of components
- Interface - surface of discontinuous change
- Semi-miscible, etc.
- Equilibrium - a state of matter in which properties do not change

Schematic P-T diagram for hydrocarbon mixtures (constant composition)

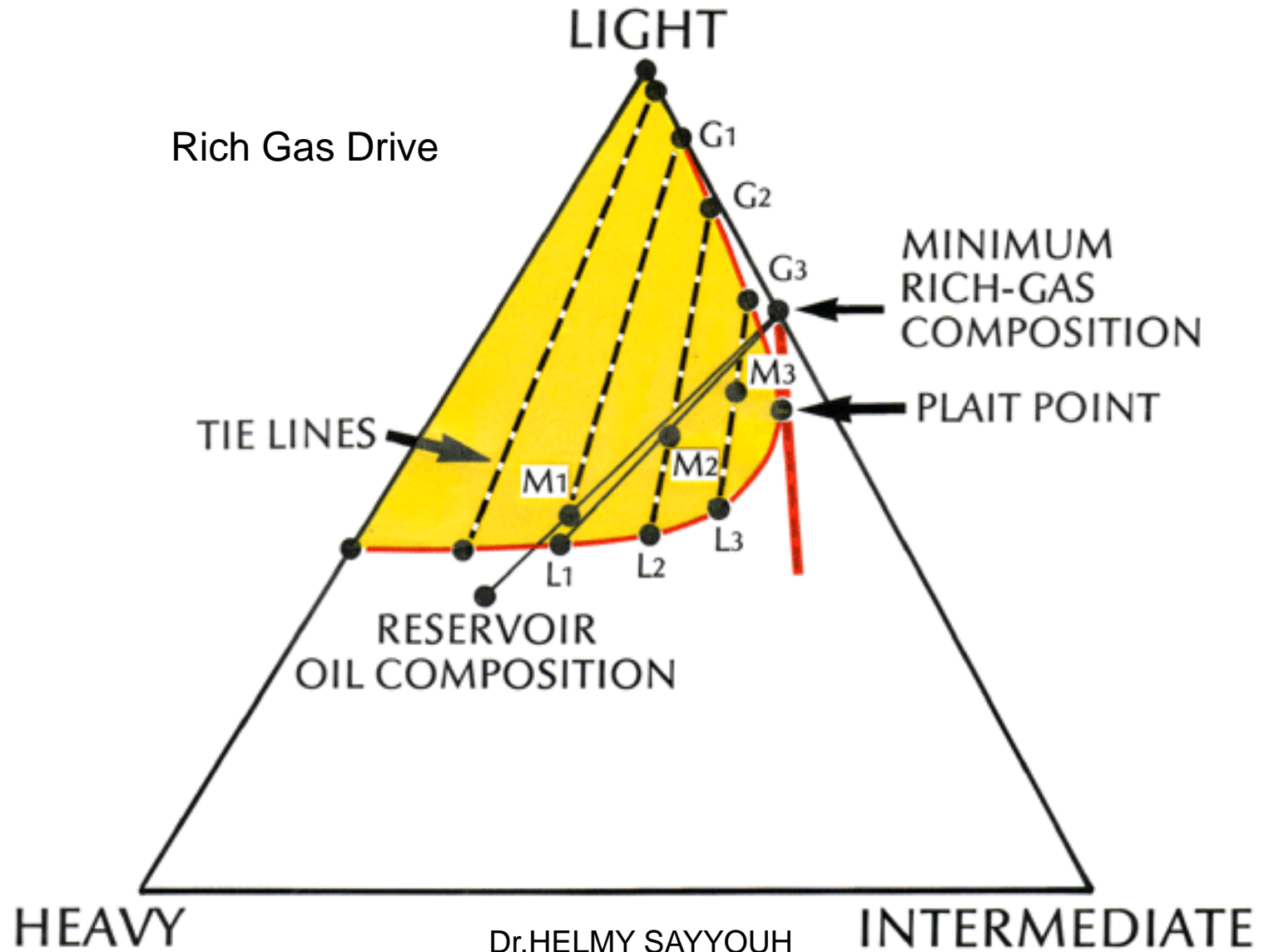


First Contact Miscibility

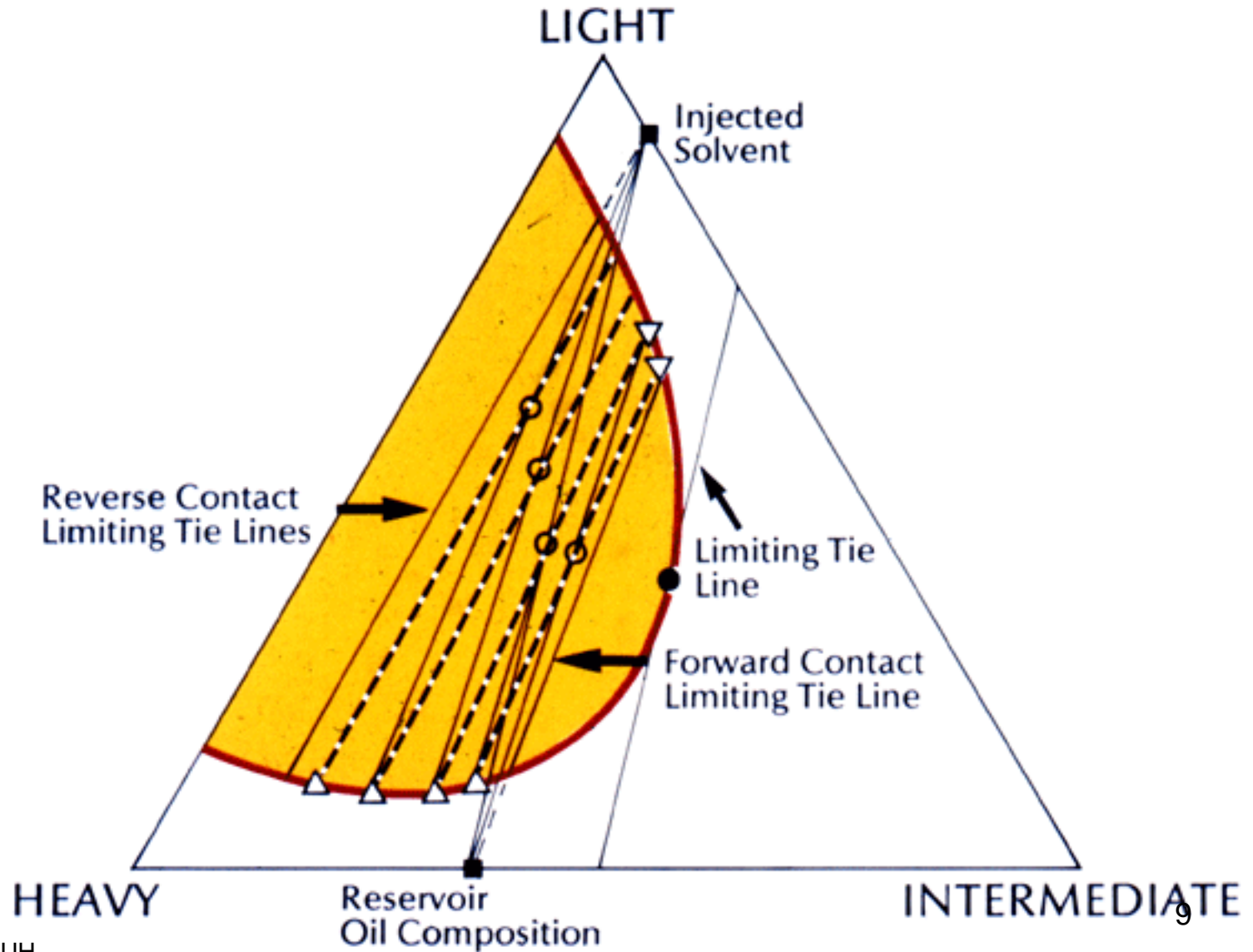


One-dimensional displacement of crude oil by solvent

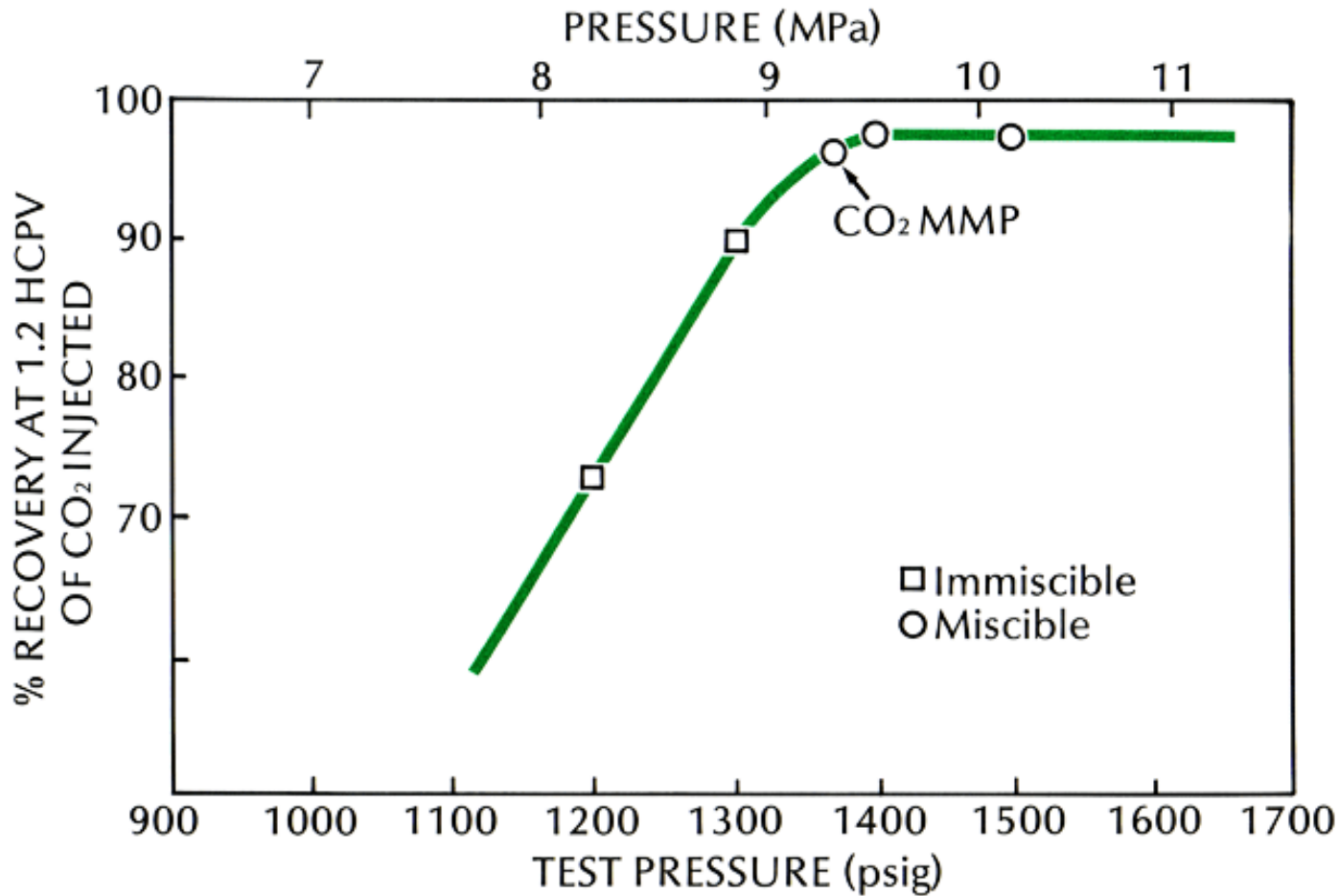
Developed Miscibility Condensing Gas Drive...



Immiscible Displacement Process...

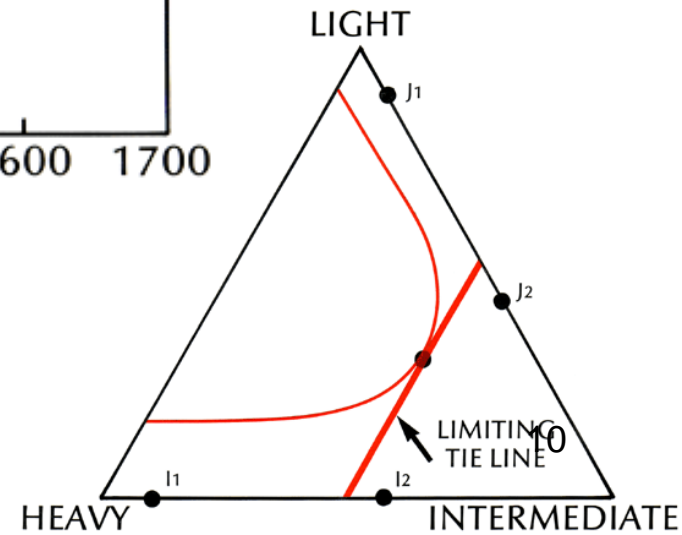


Defining Minimum Miscibility Pressure...



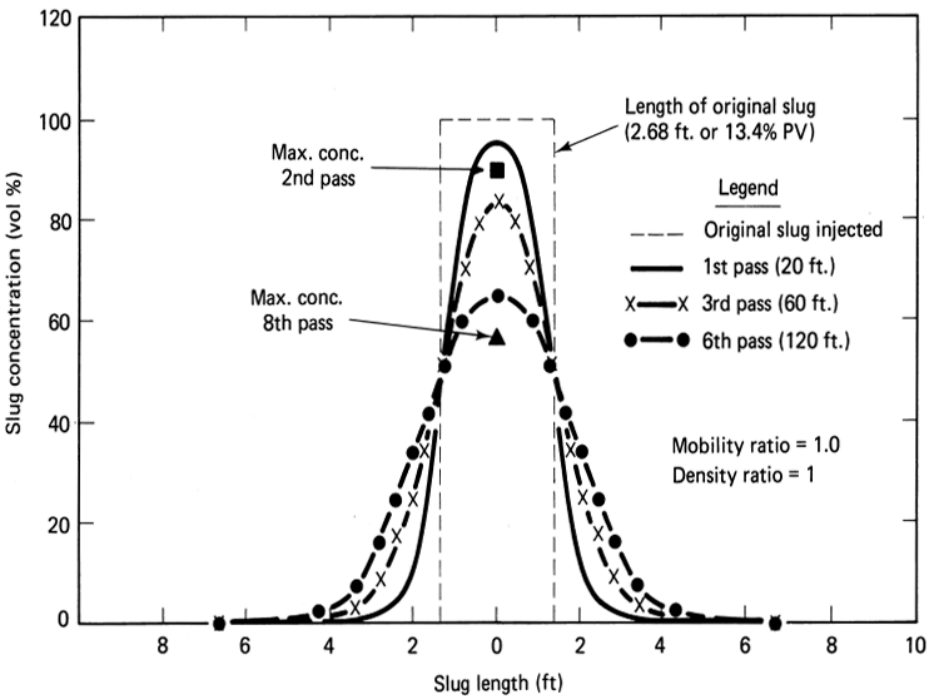
MMP corresponds to the pressure at which the critical tie line passes through the crude oil composition

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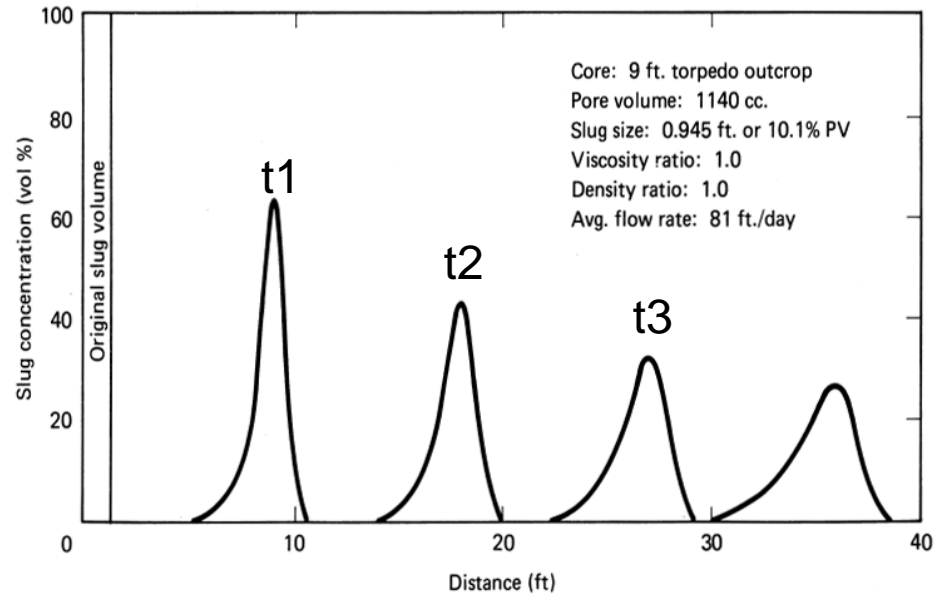


Miscible Slug Concentration Profiles

Concentration profiles from miscible slug displacement at different throughputs



(a) Slug concentration profiles normalized to slug midpoint



(b) Slug concentration profiles at various times