Cairo University, Faculty of Engineering
Petroleum & Petrochemicals Engineering Department (CHS)
Module name: Reservoir Rock & Fluid Properties (PEN 202)

Reservoir Fluid Properties

The Five Reservoir Fluids

by

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Objectives

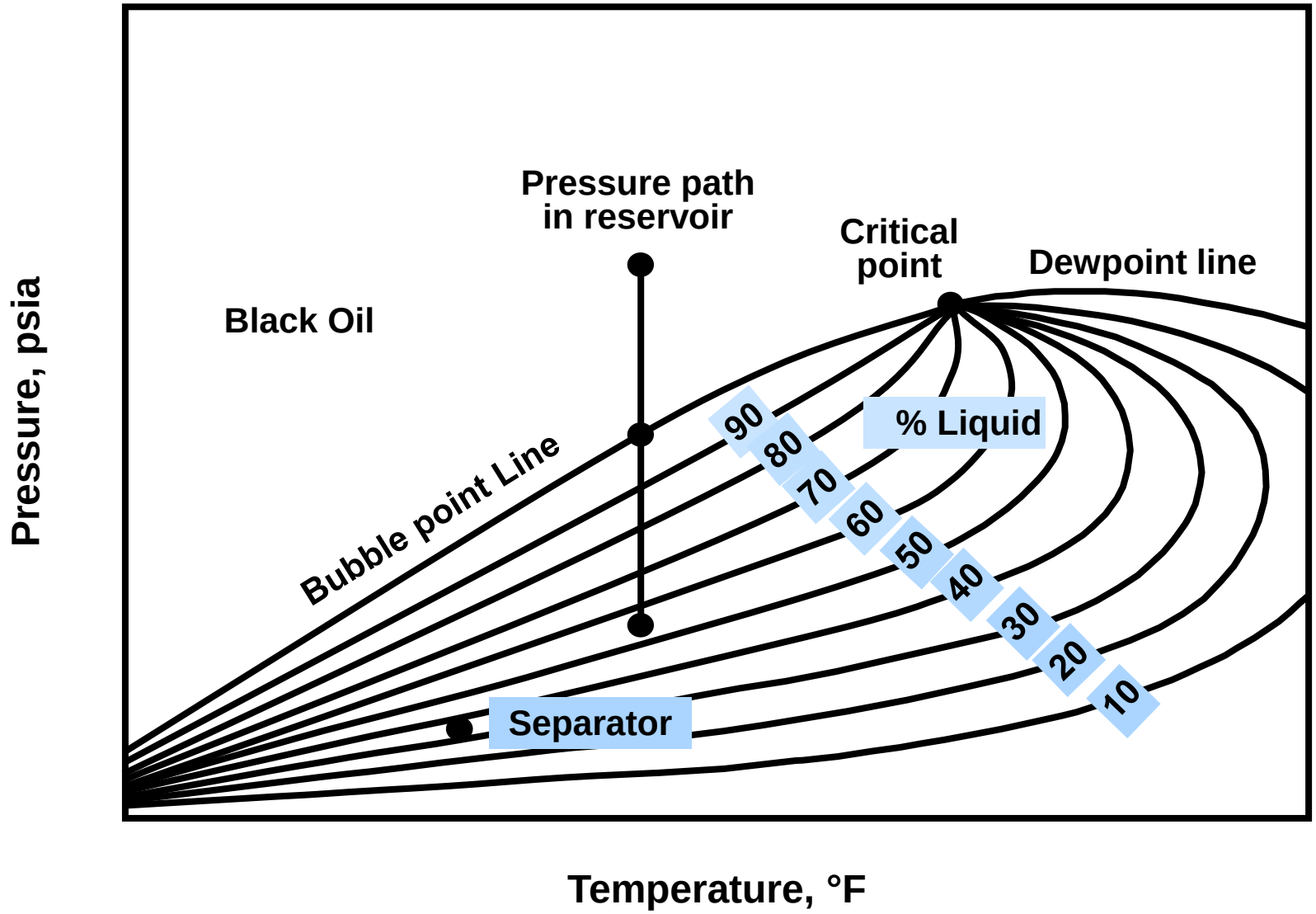
- List the five types of reservoir fluids.
- Explain the difference between reservoir oils and reservoir gases.
- Explain the differences between black oils and volatile oils.
- Explain how to distinguish between black oils and volatile oils using initial production data, laboratory data, or production history.
- Explain how to distinguish between volatile oils and retrograde gas condensates using
- initial production data, laboratory data, or production history.
- Discuss wet gases, their occurrence in nature, the usefulness of the concept of wet gas in engineering calculations, and the identification of a wet gas using field data.
- Discuss the unique feature of dry gases.

Types of Reservoir Fluids

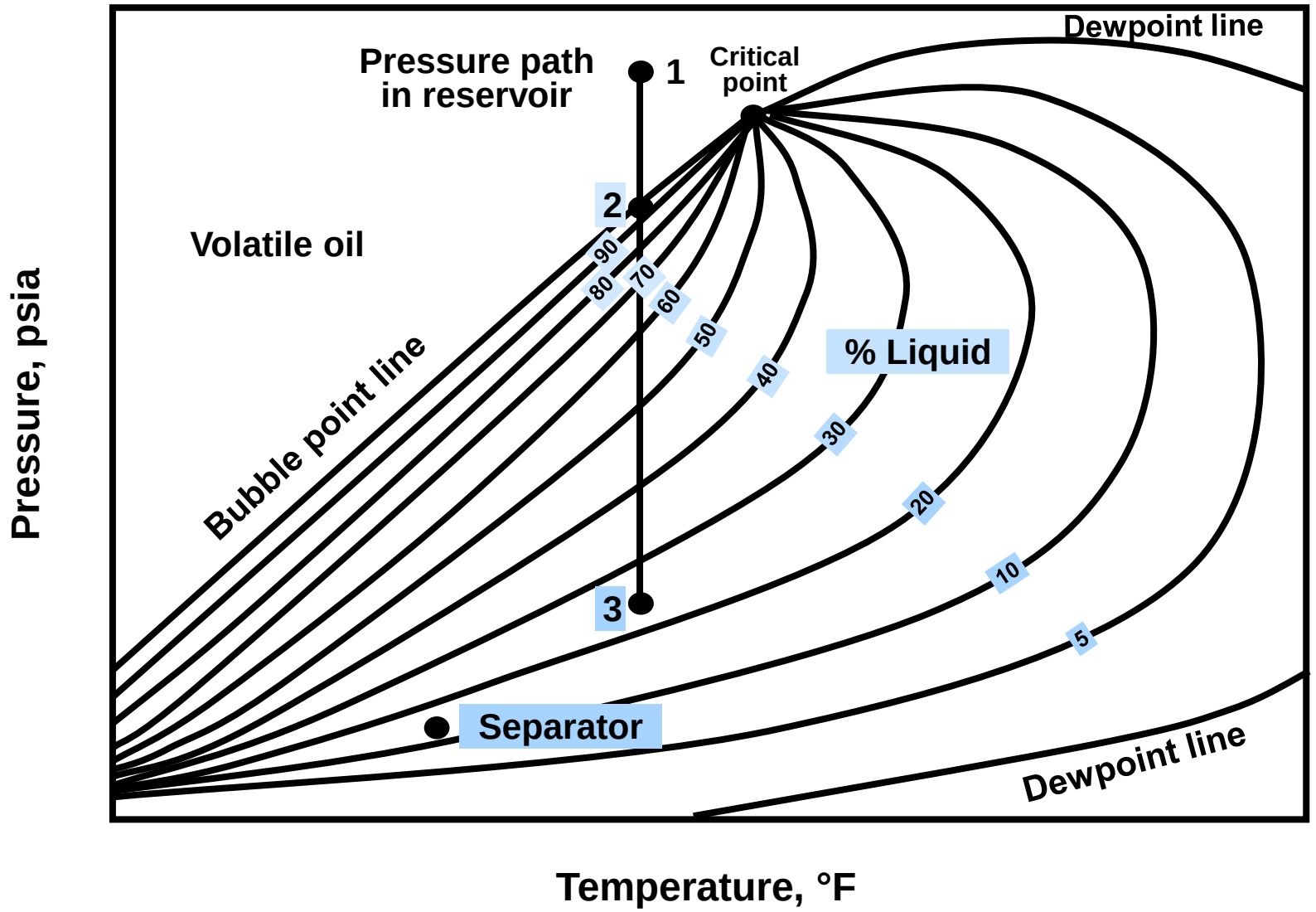
There are five main types of reservoir fluids as follows

1. Black oil.
2. Volatile oil.
3. Retrograde gas condensate.
4. Wet gas.
5. Dry gas.

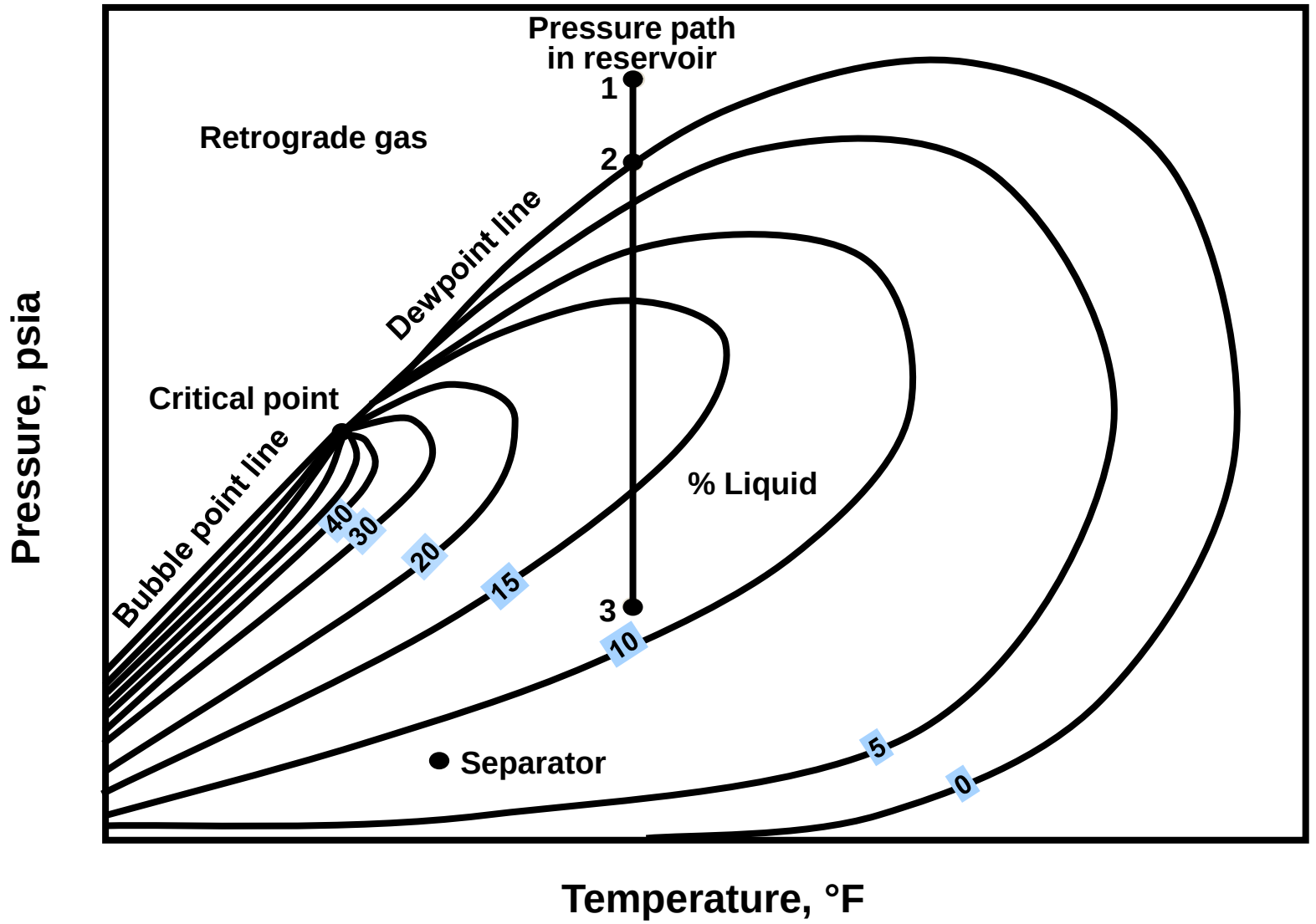
Black Oil



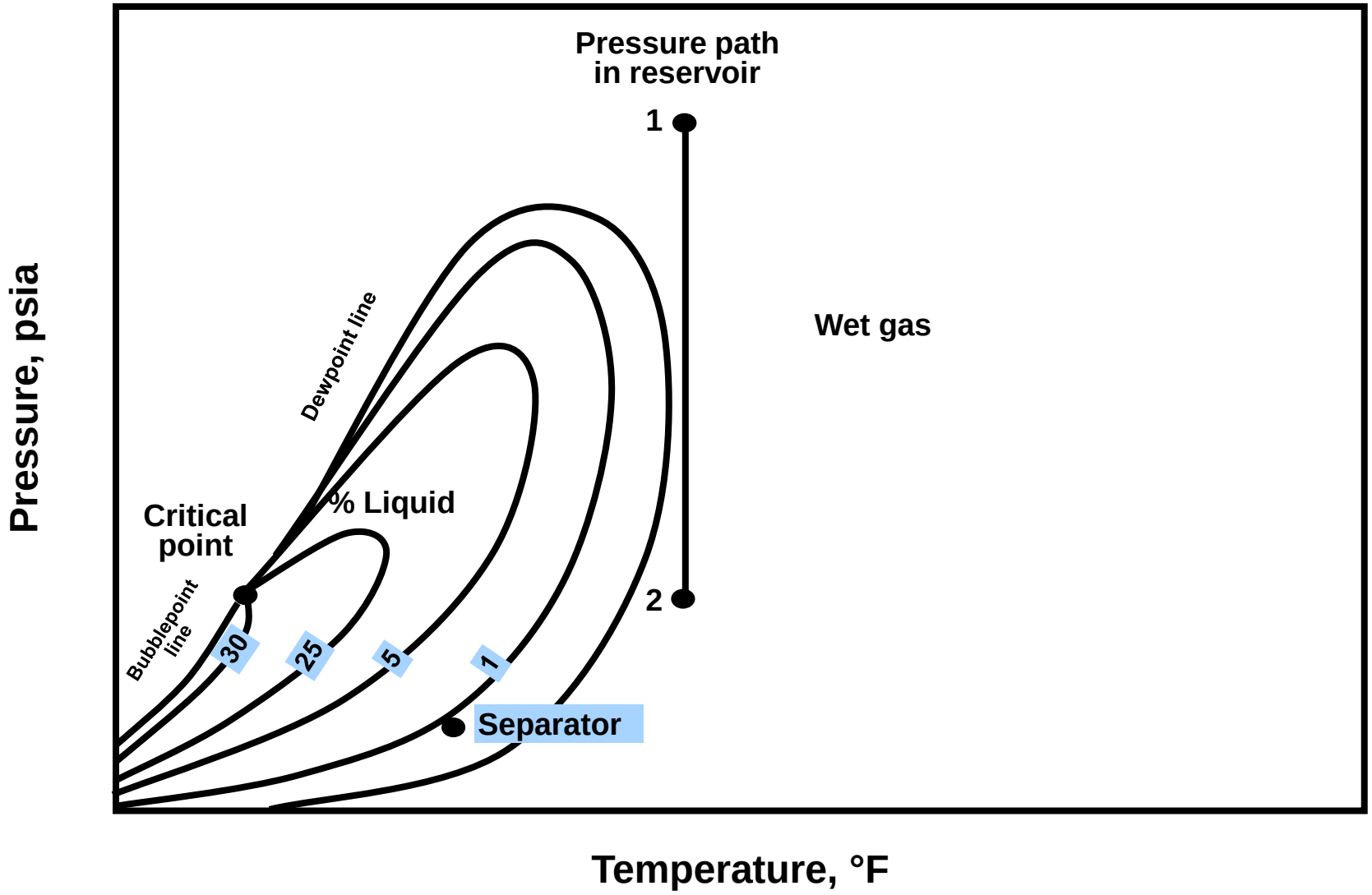
Volatile Oil



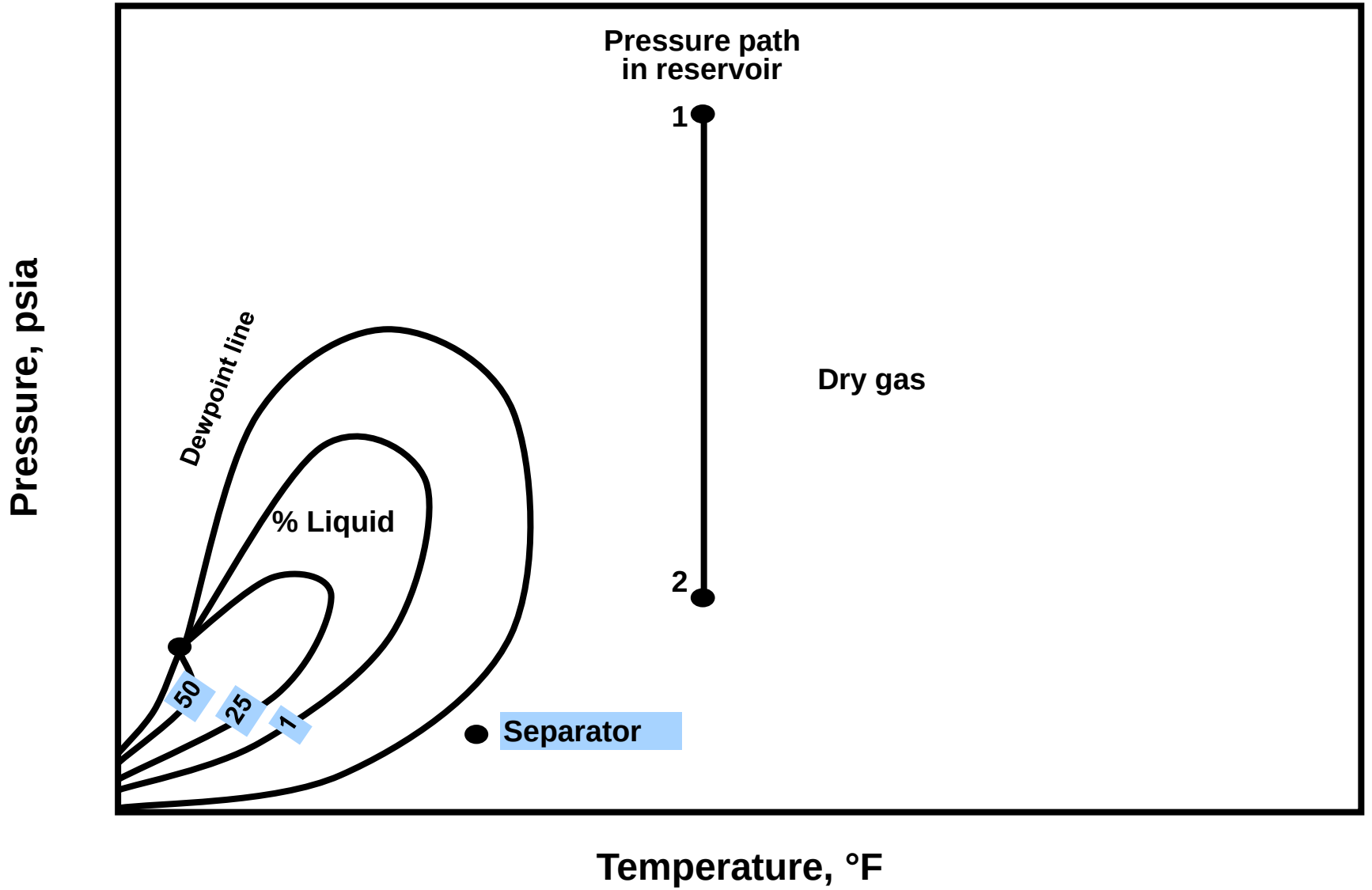
Retrograde Gas



Wet Gas

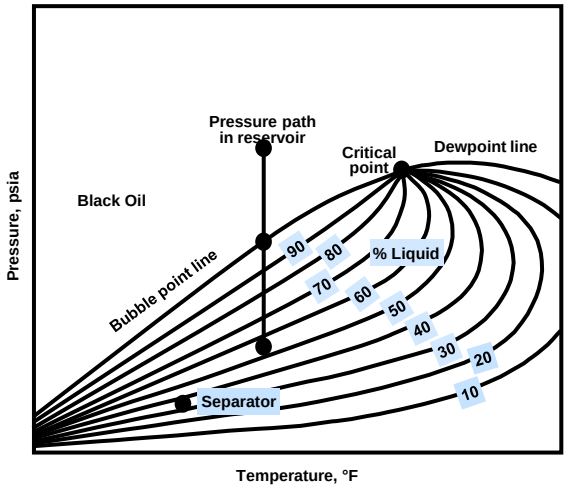


Dry Gas

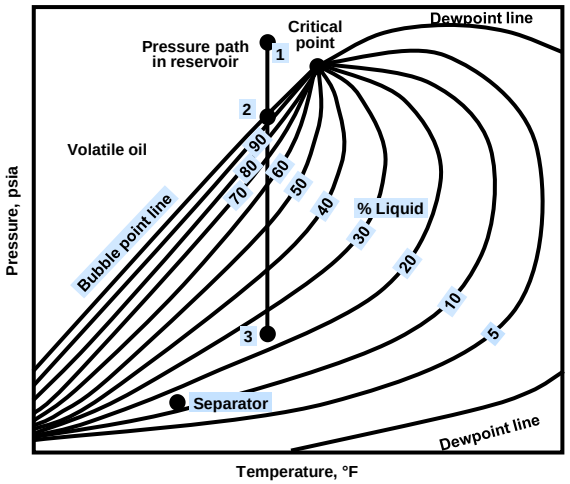


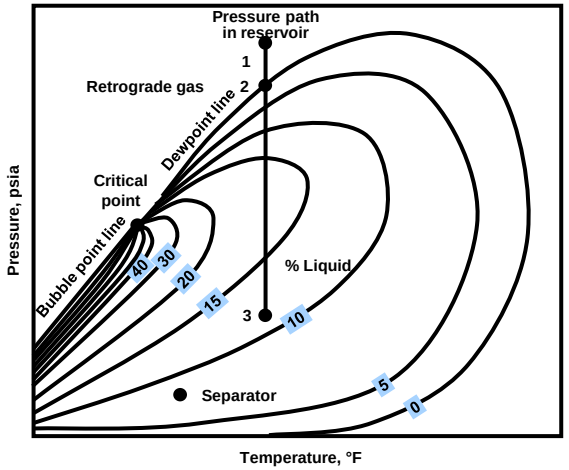
The Five Reservoir Fluids

Black Oil

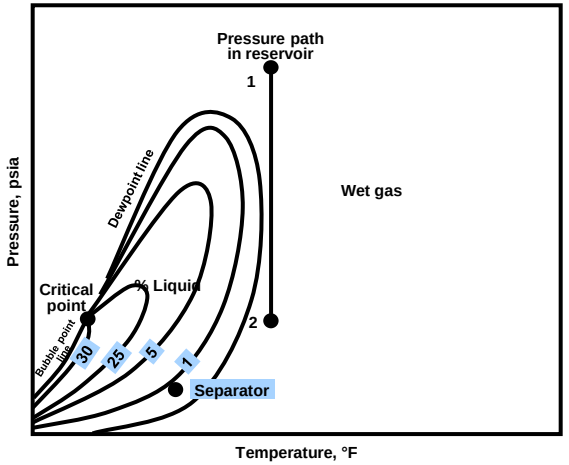


Volatile Oil

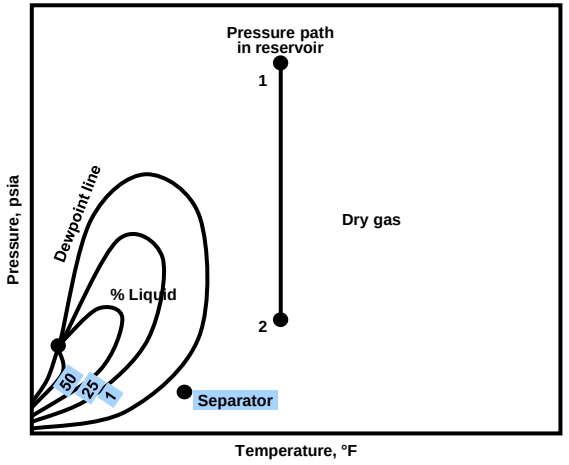




Retrograde Gas



Wet Gas



Dry Gas

Components of Naturally Occurring Petroleum Fluids

The petroleum fluids are composed of hydrocarbon components with some impurities such as hydrogen sulfide and carbon dioxide.

With the increase in the carbon number of the heavy components, many forms (isomers) are possible.

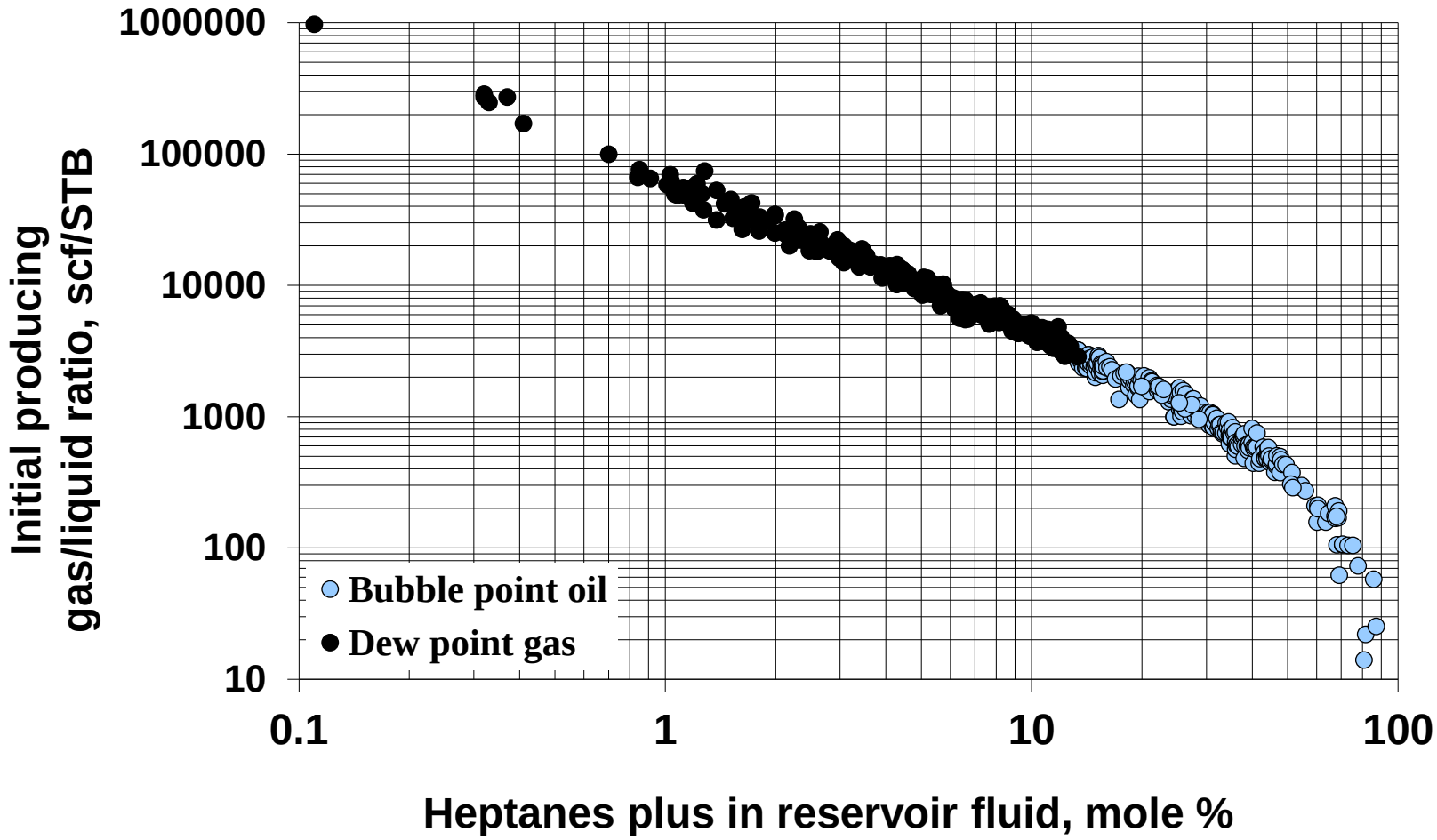
The compositional analysis in the laboratory of a fluid sample can identify the components up to a certain level.

The heavier components are usually lumped in a plus fraction.

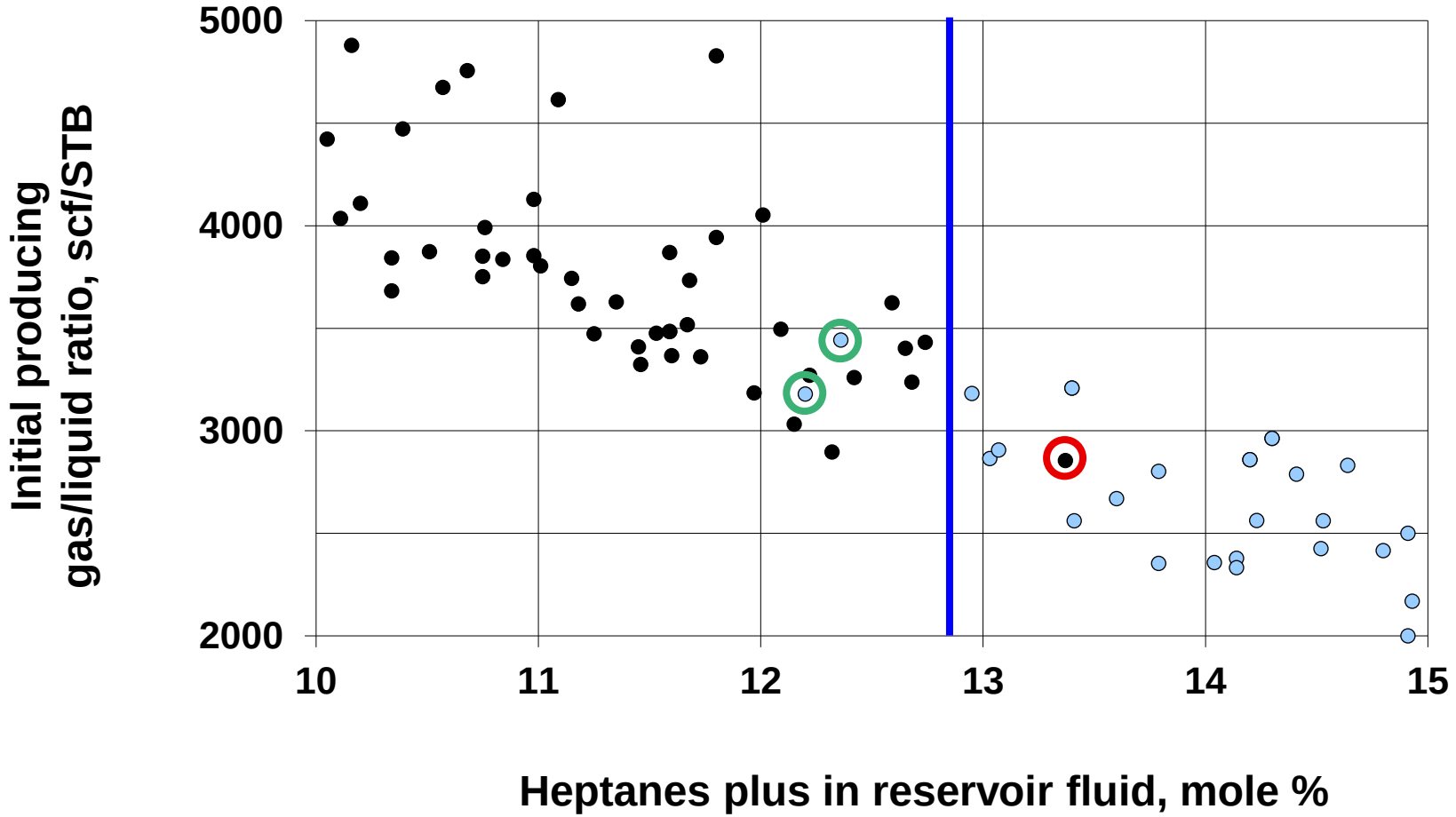
Component	Composition, mole percent
Hydrogen sulfide	4.91
Carbon dioxide	11.01
Nitrogen	0.51
Methane	57.70
Ethane	7.22
Propane	4.45
i-Butane	0.96
n-Butane	1.95
i-Pentane	0.78
n-Pentane	0.71
Hexanes	1.45
Heptanes plus C7+	8.35
	100.00

Properties of Heptanes plus	
Specific Gravity	0.807
Molecular Weight	142 lb/lb mole

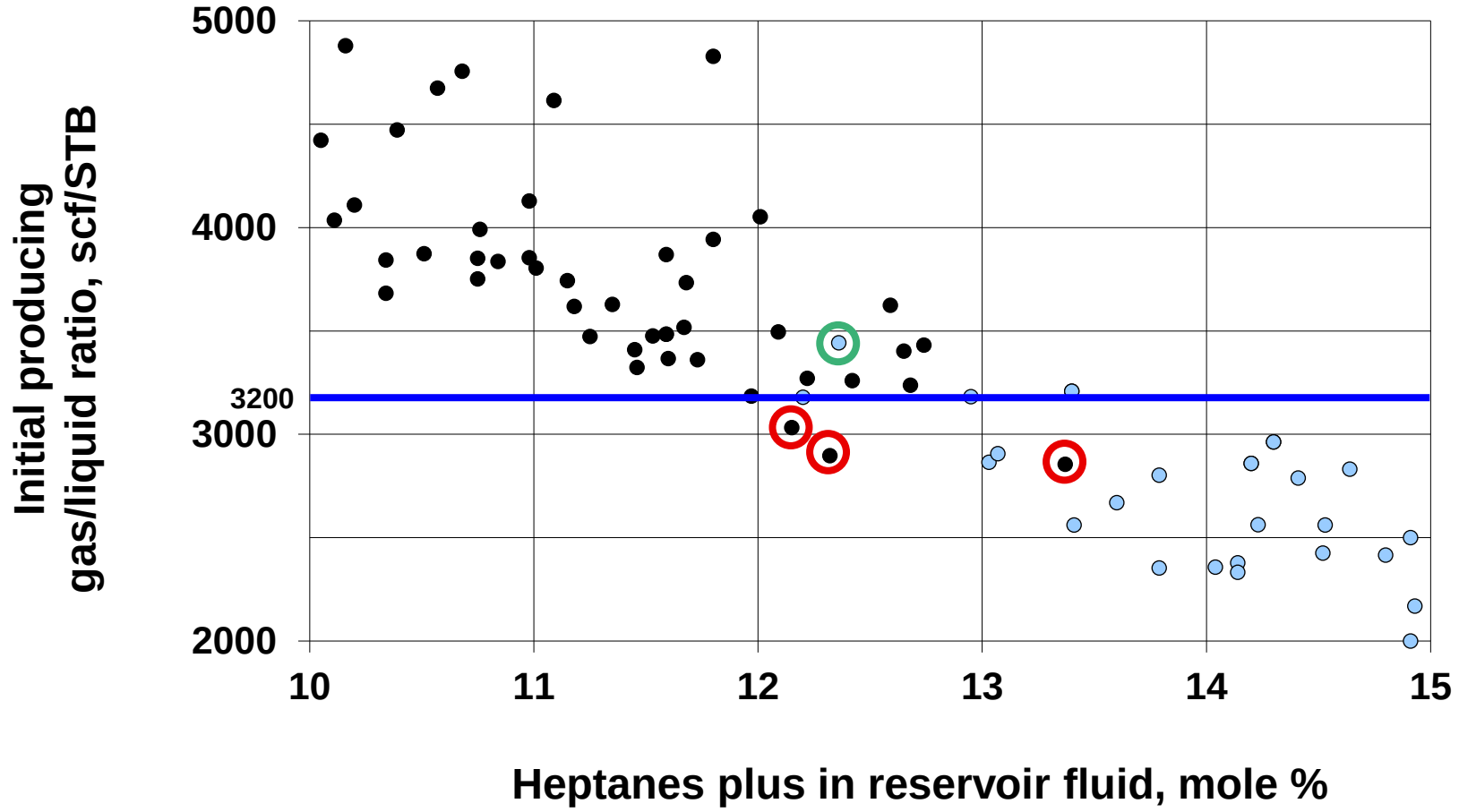
Differences between Fluid Types



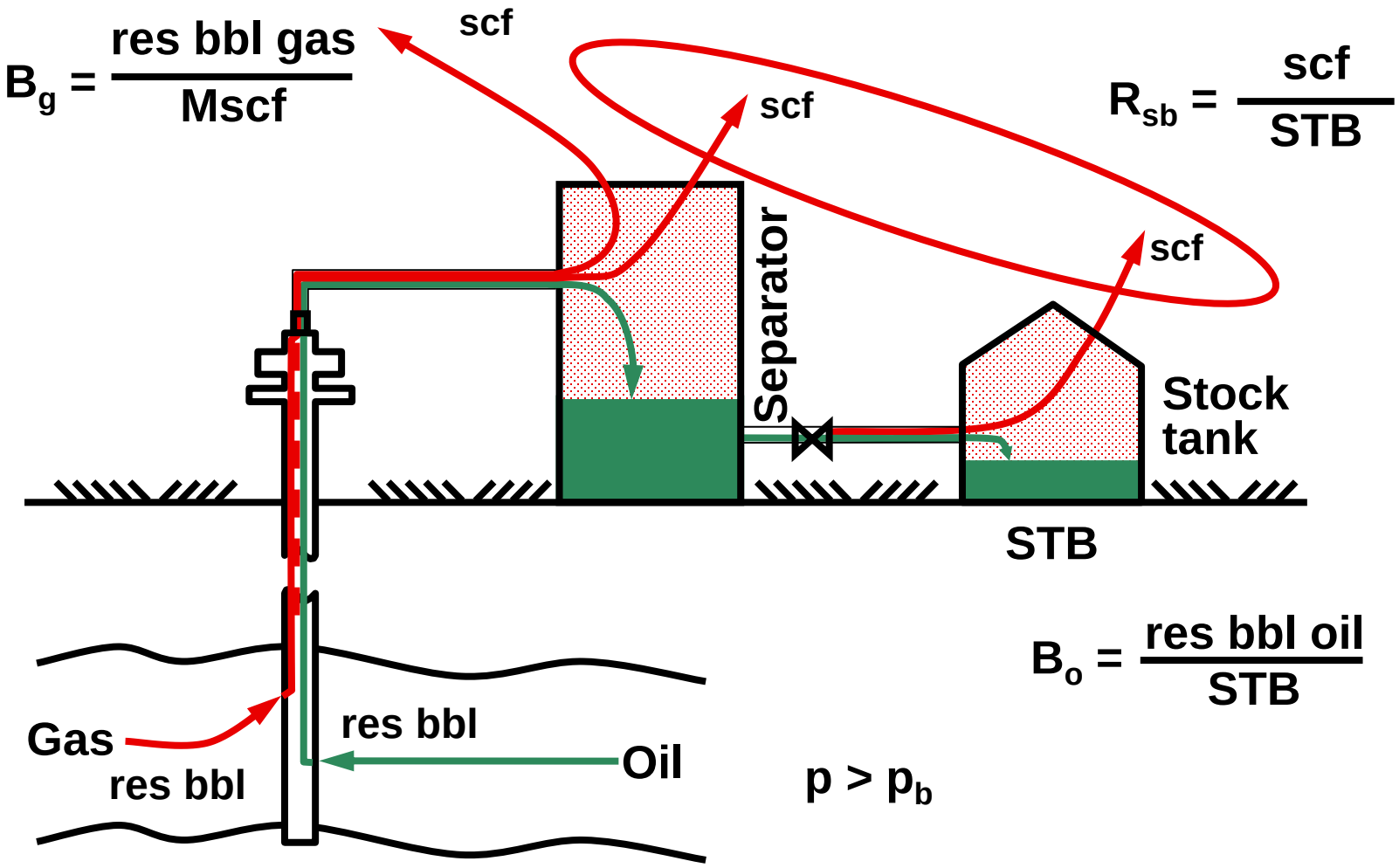
Differences between Fluid Types



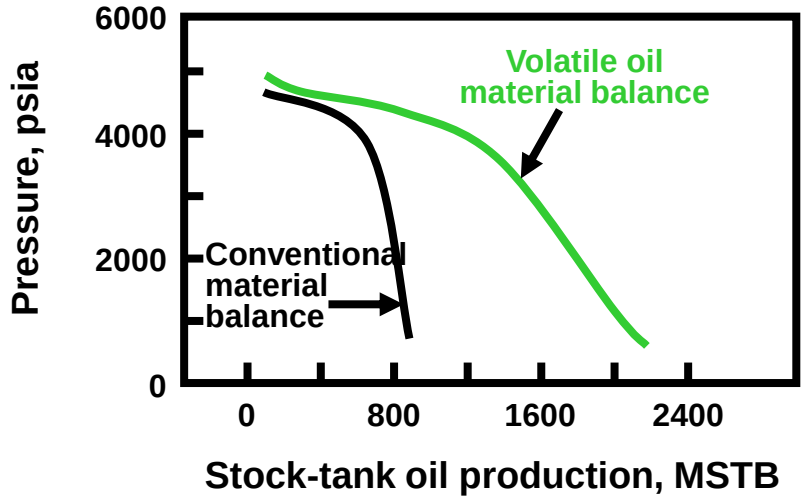
Differences between Fluid Types

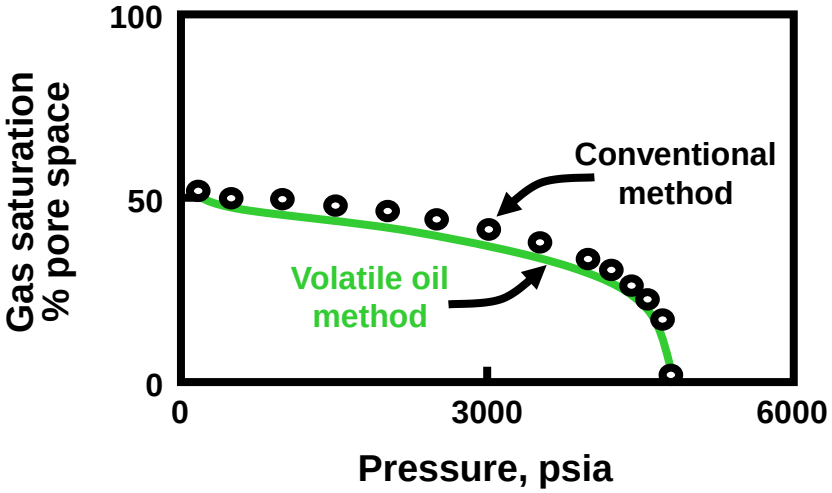


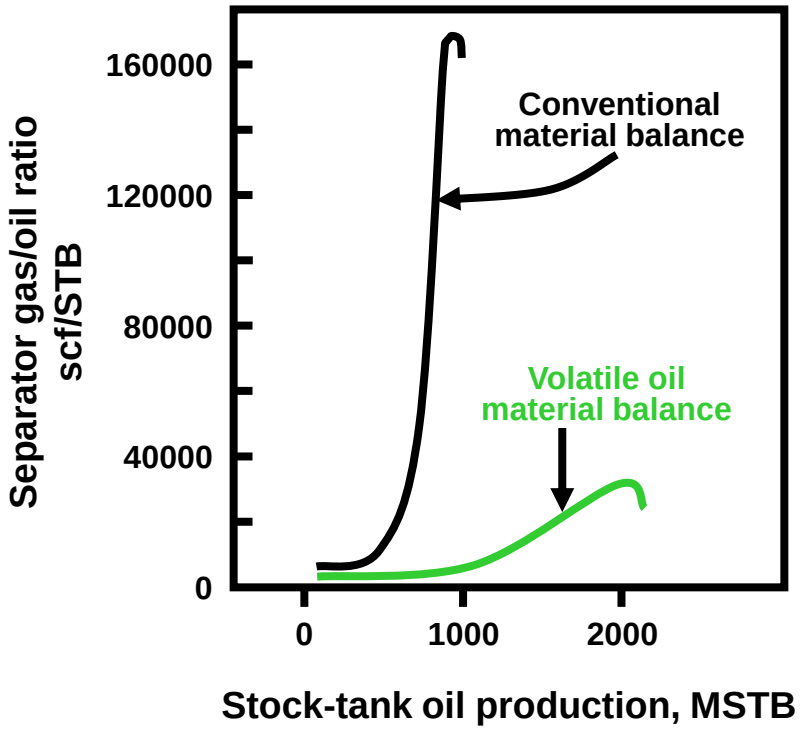
Differences between Black-Oils and Volatile Oils:



Jacoby and Berry Calculations







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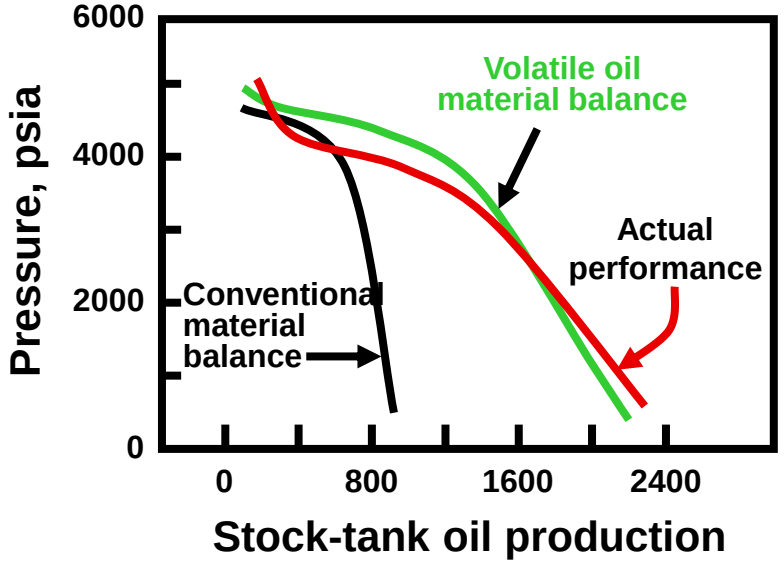
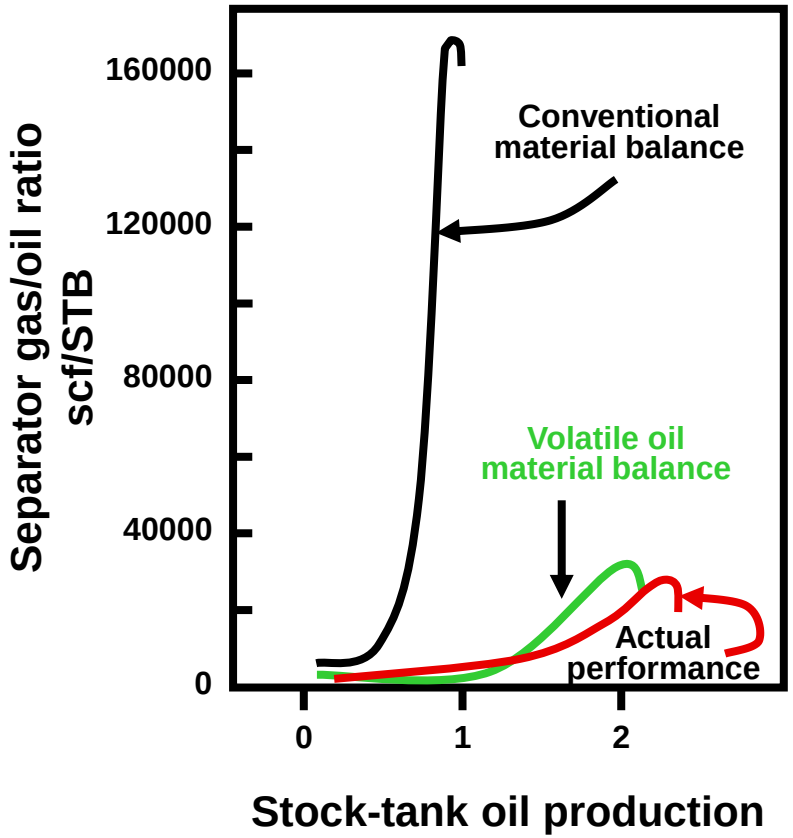




Differences between the Three Gases

Dry gas

Gas at surface is same as gas in reservoir.

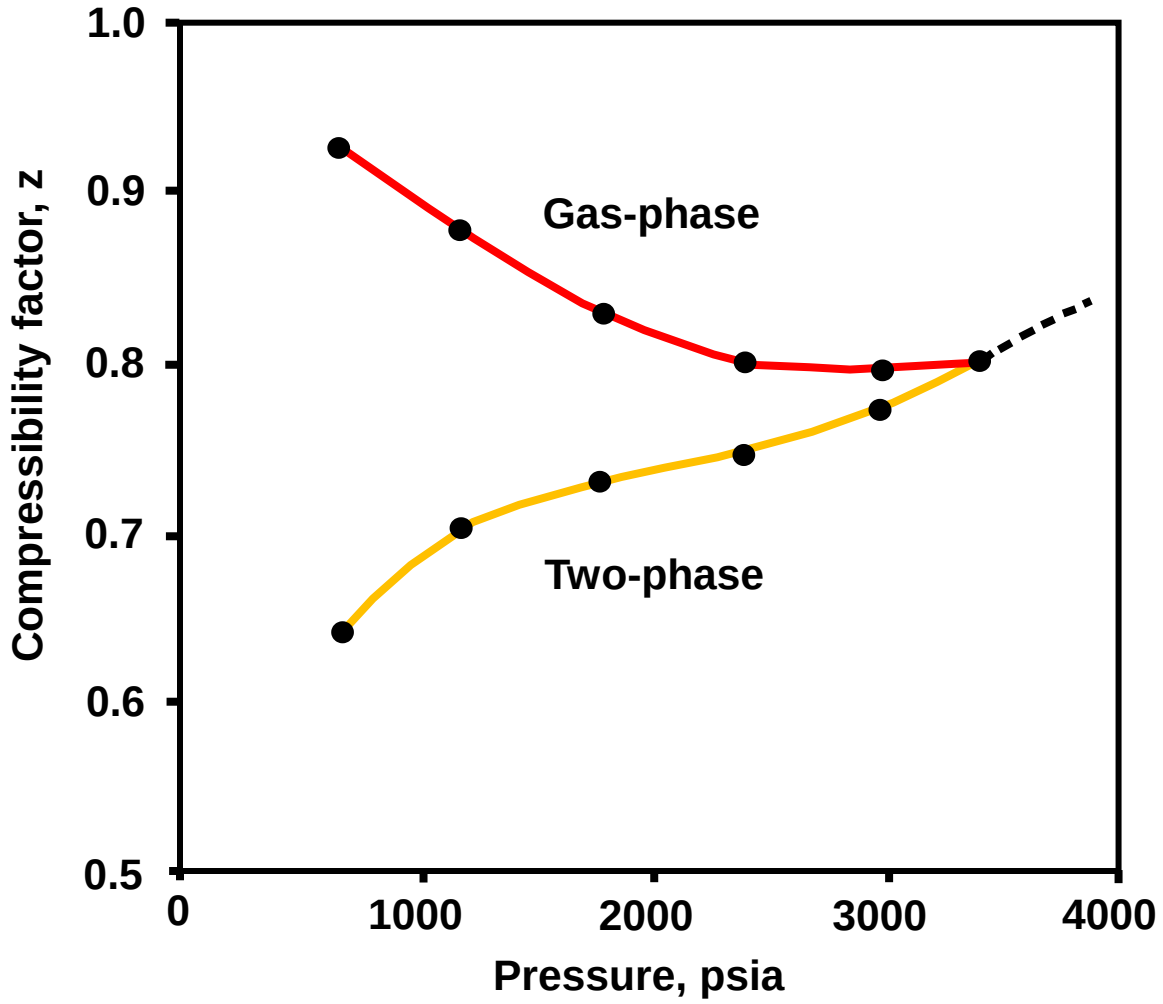
Wet gas

Recombined surface gas and condensate represents gas in reservoir.

Retrograde gas

Recombined surface gas and condensate represents the gas in the reservoir, but **not** the total reservoir fluid (retrograde **condensate** **stays in reservoir**).

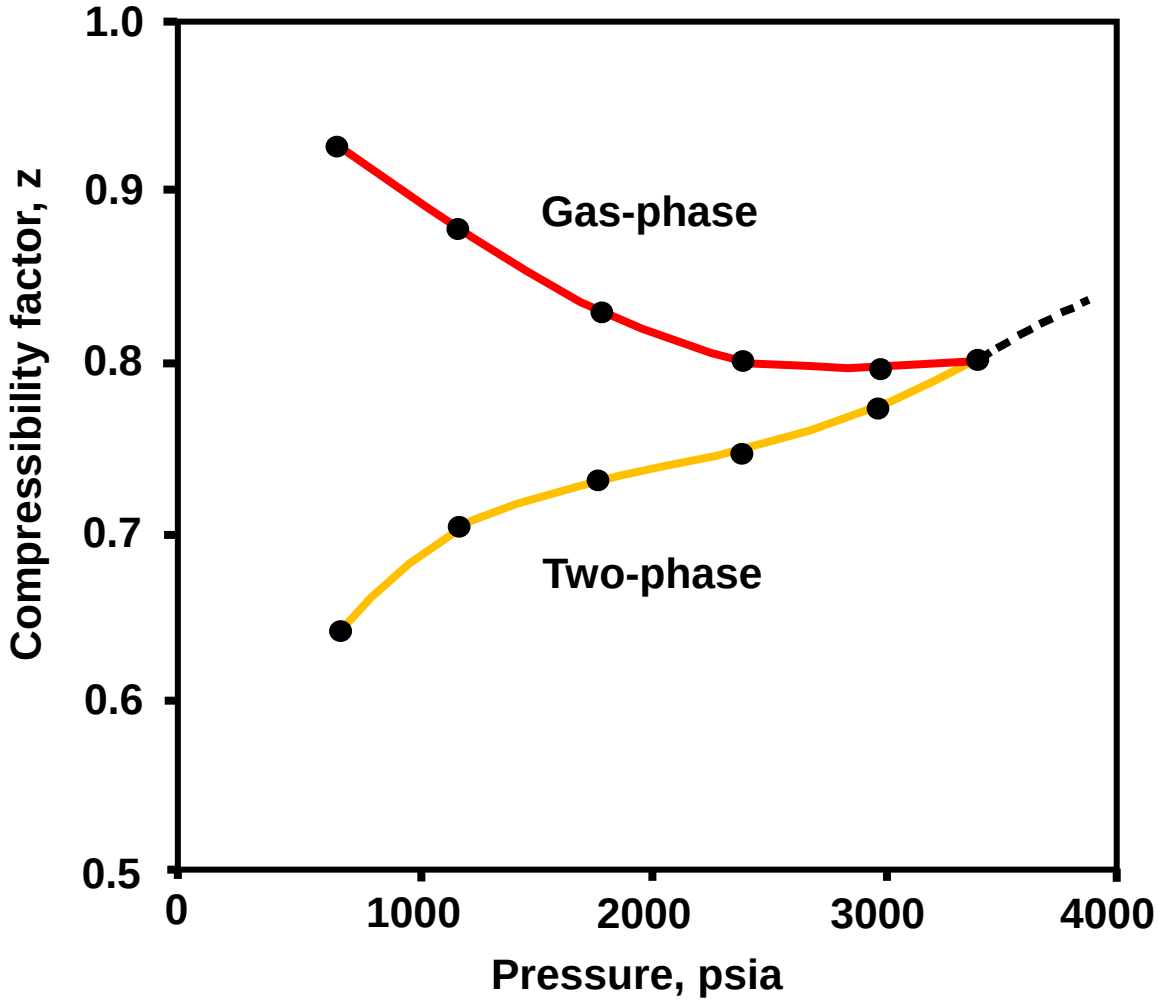
Compressibility Factors of a Rich Gas-Condensate



Compressibility Factors of a Rich Gas-Condensate

The z-factor is the ratio of the volume actually occupied by a gas at given pressure and temperature to the volume the gas would occupy at the same pressure and temperature if it behaved like an ideal gas.

Two-phase z-factor is determined from the constant volume depletion experiment for gas condensate fluids.

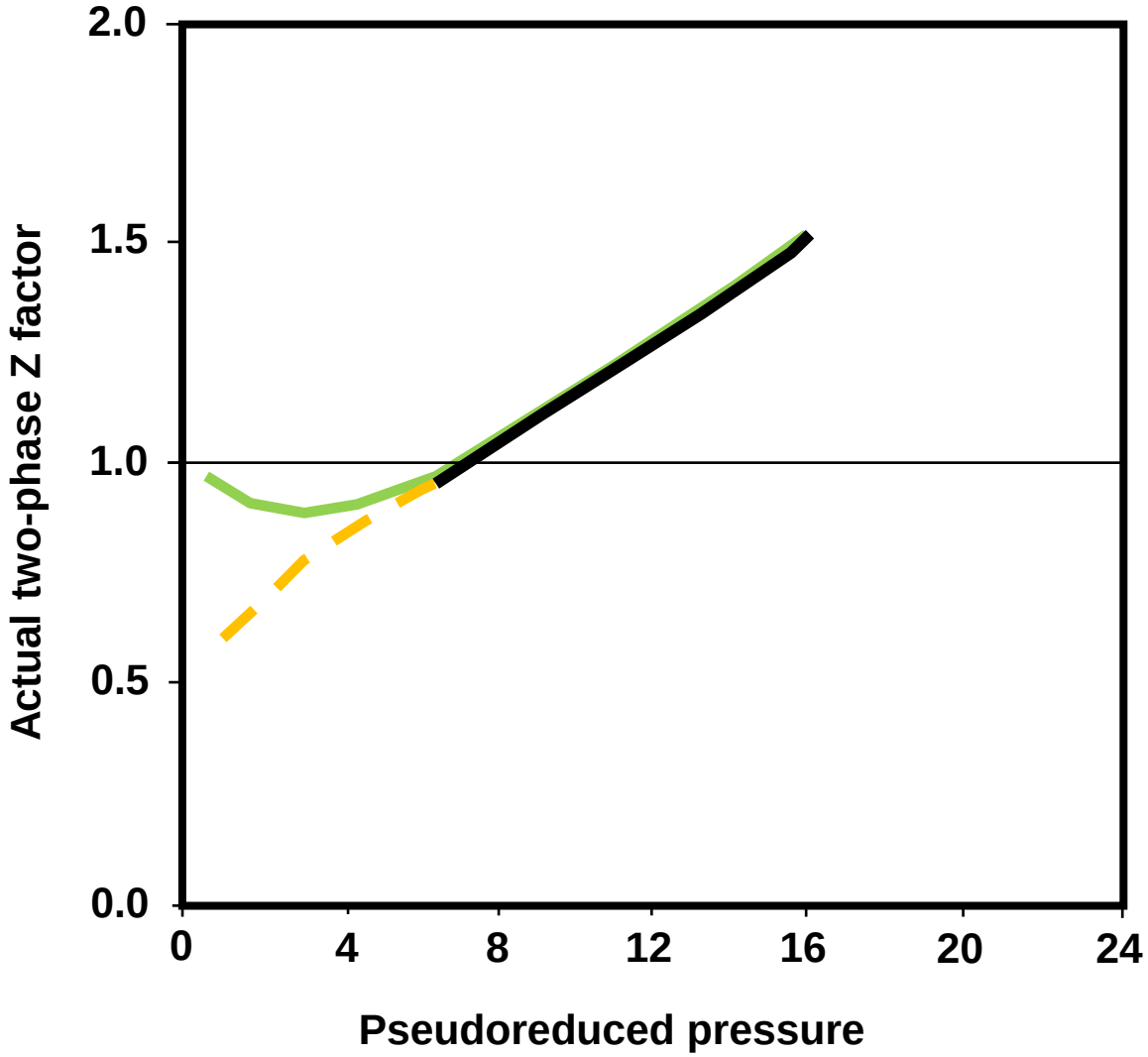


Two-Phase Compressibility Factor of a Rich-Gas

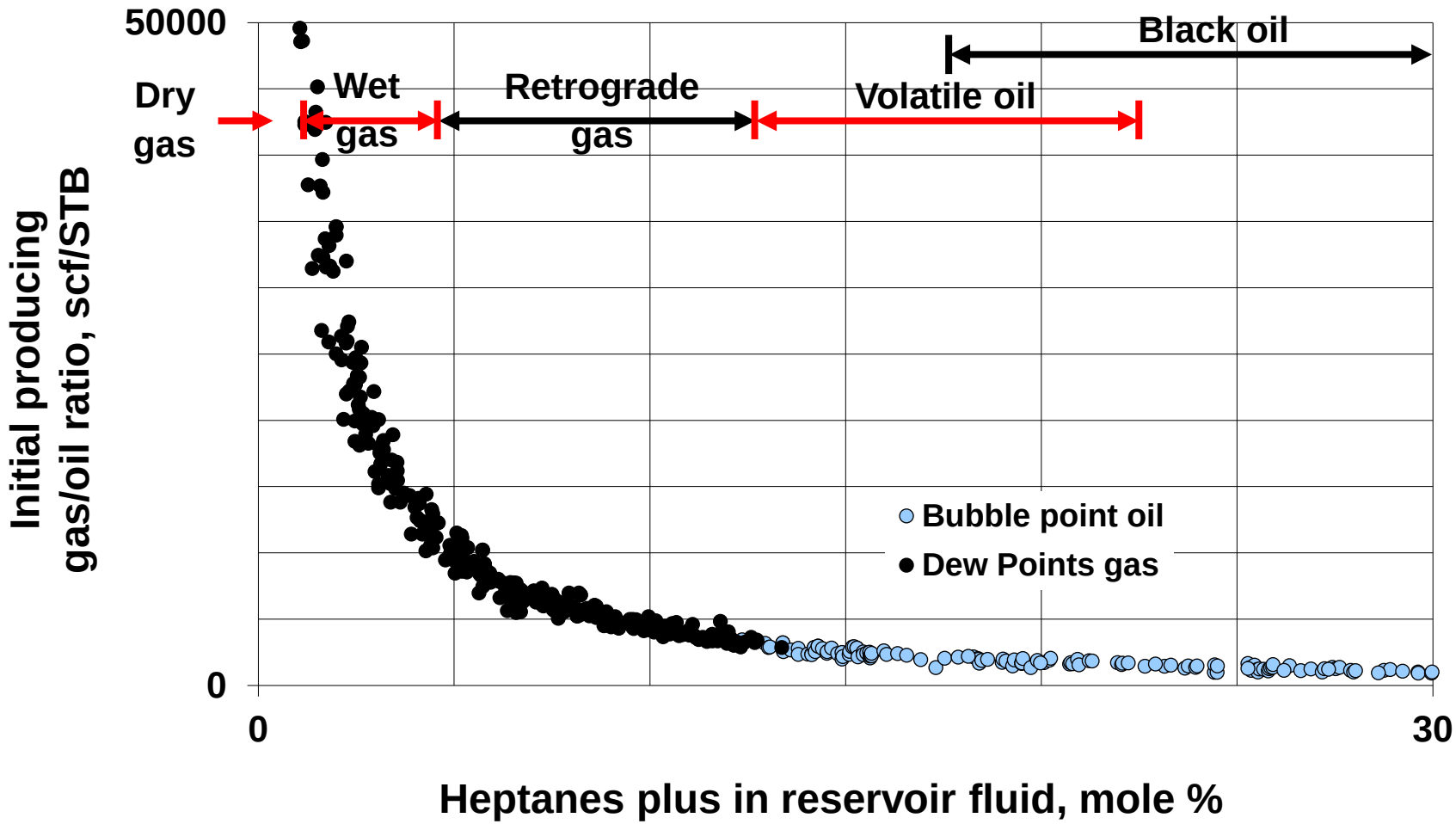
It was found that the typical shape of 2-phase z-factor (bending downward curve at low pressure) is obtained for hydrocarbon gases with C7+ mole percent higher than 4%.

This implies that the gas has to be treated as **retrograde gas condensate**.

However, for hydrocarbon gases with C7+ mole percent less than 4%, 2-phase z-factor behaves similarly to single-phase z-factor.
This implies that the gas can be treated as **wet gas**.



Identification of Fluid Type



Identification of Fluid Type from Field Data

	Black Oil	Volatile Oil	Retrograde Gas	Wet Gas	Dry Gas
Initial Producing Gas/Liquid Ratio, scf/STB	<1750	1750 to 3200	> 3200	> 15,000*	100,000*
Initial Stock-Tank Liquid Gravity, °API	< 45	> 40	> 40	Up to 70	No Liquid
Color of Stock-Tank Liquid	Dark	Colored	Lightly Colored	Water White	No Liquid

*For Engineering Purposes

Identification of Fluid Type from Laboratory Analysis

	Black Oil	Volatile Oil	Retrograde Gas	Wet Gas	Dry Gas
Phase Change in Reservoir	Bubble point	Bubble point	Dewpoint	No Phase Change	No Phase Change
Heptanes Plus, Mole Percent	> 20%	20 to 12.5	< 12.5	< 4*	< 0.8*
Oil Formation Volume Factor at Bubble point	< 2.0	> 2.0	-	-	-

Identification of Fluid Type from Primary Production Trends