Note Title 1/23/2018

Components (Compounds) in Petroleum Mixtures

Non-HCs:

N_2

CO_2

H_2S

H_2O

Amounts of all components:

- mass (lab) } converted using M_i
- mole

$$M_i = \frac{m_i}{n_i}$$

HCs:

Sales Natural Gas { C_1 : LNG

C_2 } LPG

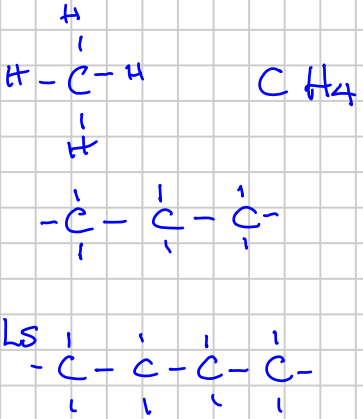
C_3 } LPG

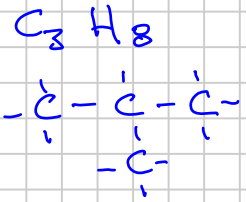
$i\text{-}C_4$ } LPG

$n\text{-}C_4$ } NGLs

$i\text{-}C_5$ } NGLs

$n\text{-}C_5$ } NGLs





SCN { C_{6s} : (not include C_6H_6)

"C_7" (includes C_6H_6)

C_8 } Surface (Stock Tank) Sales

:

C_{N+} } C_{7+} (1970s)

C_{10+}

C_{16+}

C_{21+}

C_{36+} (today)

~ SCN: Single Carbon Number

Alkanes (Paraffin)

$M_{C_1} = 16$

$C_n H_{2n+2}$

$M_{C_n} = 14 \cdot n + 2$

$14 \cdot 3 + 2 = 44$

$T_{b_{n-C_6}} < T_{b_i} \leq T_{b_{n-C_7}}$

Oil $69/STB — 42 gallons

6.28 barrel: 1 m^3

5.615 ft^3 = bbl

Sales Products:

(2) • Surface Gas (g) $C_1\text{-}C_2$ (+C_3-C_5)

(3) NGLs

(1) • Surface Oil (o) "C_{6+}"

> 95%

STO (SO) "Oil" "Crude" Oil

Widely varying "makeup"

Black - Green - Yellow - Clear
(heavier) (light)

API Gravity: Density 600 kg/m³ → 1000 kg/m³

American Petroleum Institute

$$\text{Liquid Gravity } (\gamma) \equiv \frac{\rho_L @ (P,T)_{ref}}{\rho_w @ (P,T)_{ref}} \sim \rho_L \left[\frac{g}{cc}\right]$$

$\rho_w \simeq 1$ g/cc

$P_{ref} = 1$ atm

$T_{ref} = 60°F$ 15.56 °C SPE

$\gamma_{20/15}$

20°C

25°C

$$\text{API Gravity: } \gamma_{API} \equiv \frac{141.5}{\gamma} - 131.5$$

= 10 for water

Heavy — Heavy Oils 10-20 — N.S. — $/bbl

25-30

35-40

45-55

Light 60

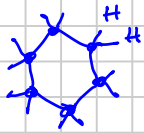
80

"Oil Type" PNA

Relative Amounts of Paraffinic $C-C-C\cdots C-$

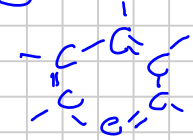
vs

Naphthenes saturated rings C_nH_{2n}

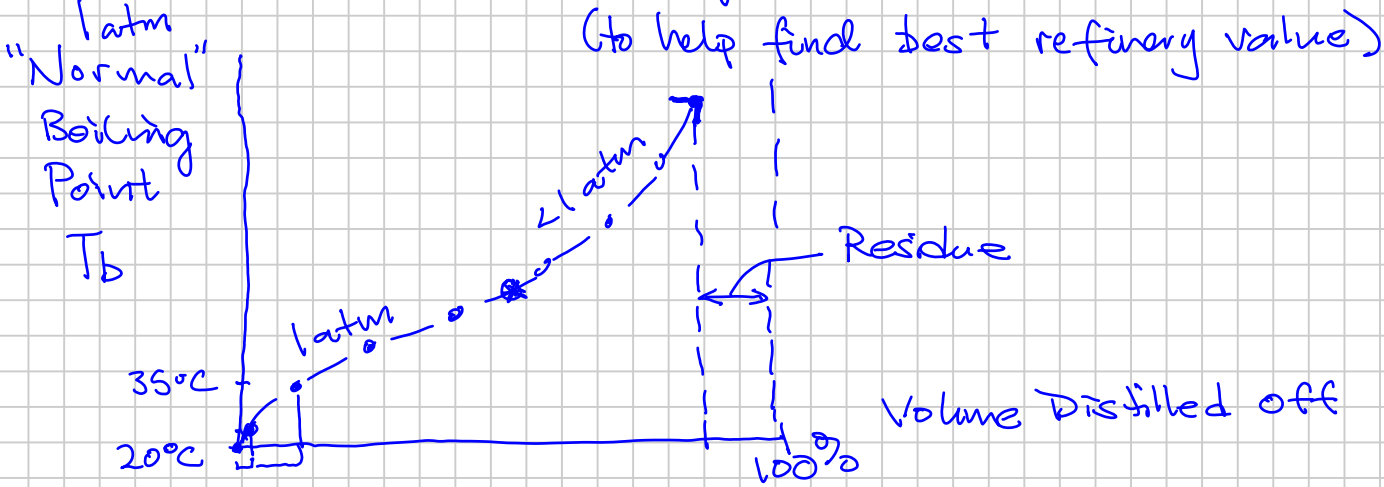


vs

Aromatics: Benzene Rings



CRUDE ASSAYS "Makeup" of a crude oil (to help find best refinery value)



S_{cut} (μ_{cut} @ 100°F 212°F) M_{cut}

Single Component Phase & Volumetric Behavior

(1) H_2O

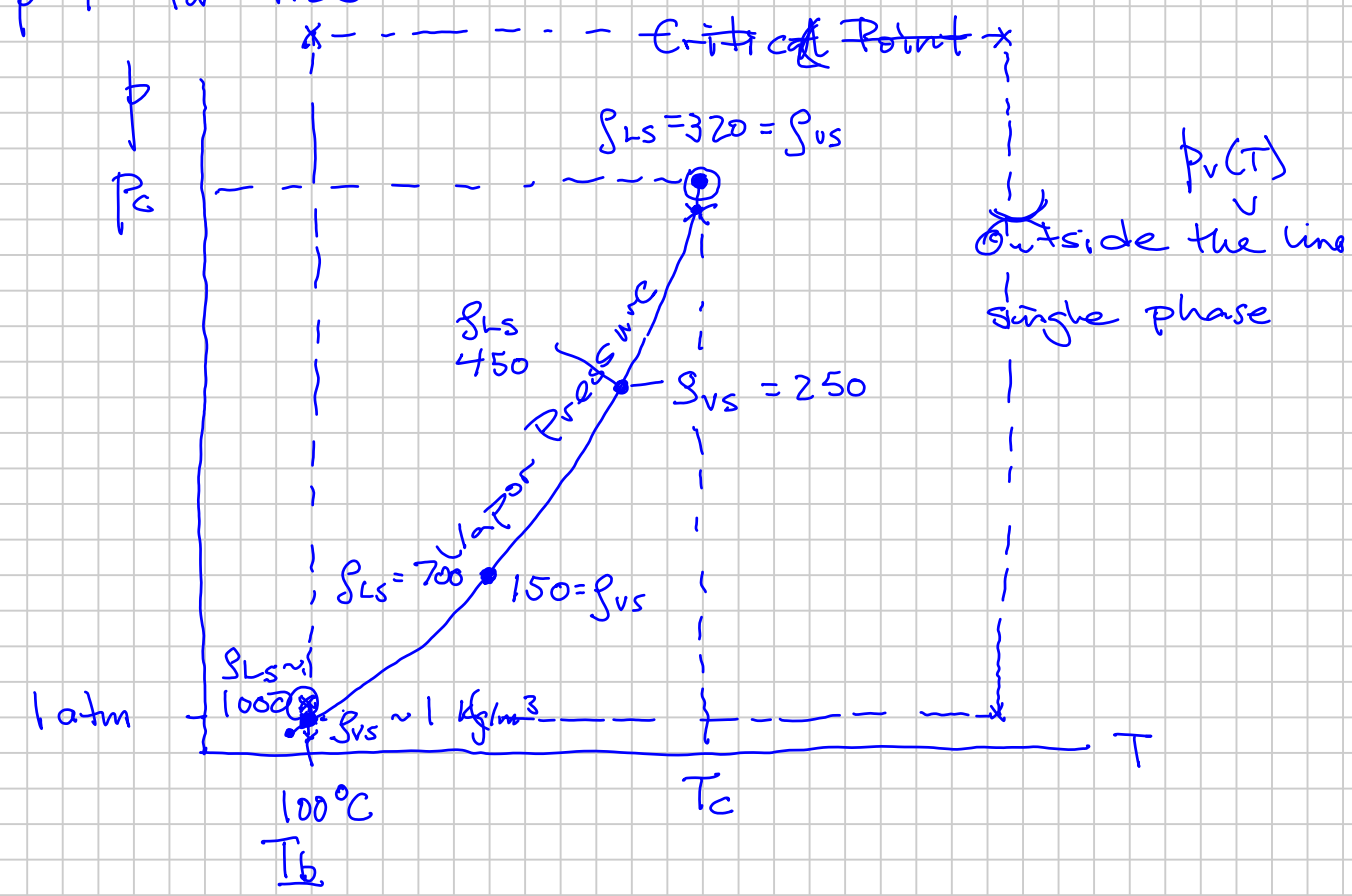
(3) Propane

Phase Diagrams: p-T

map out 1-phase region & 2-phase region
undersaturated phase (states) saturated states

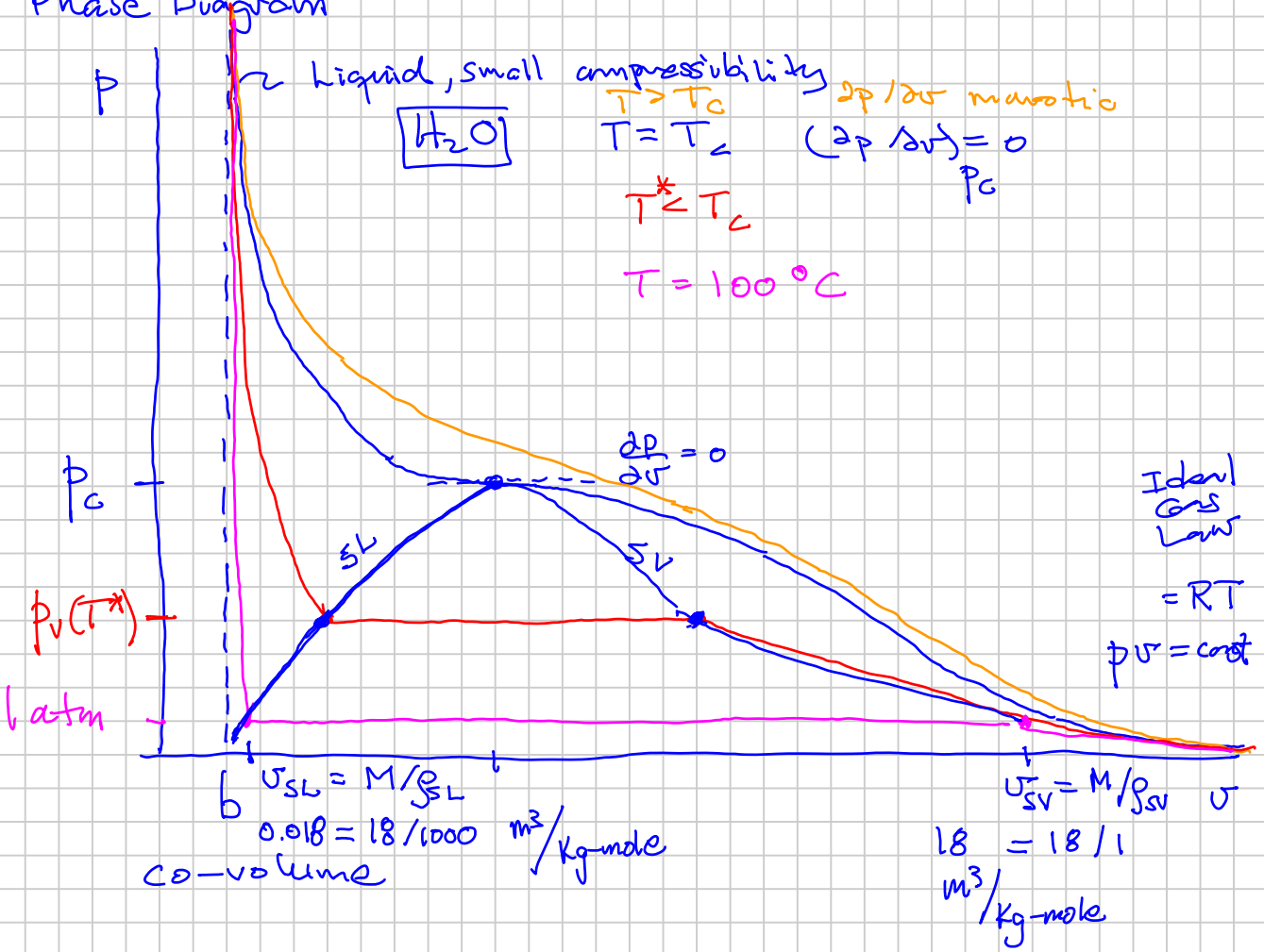
H_2O: 1 atm 100°C

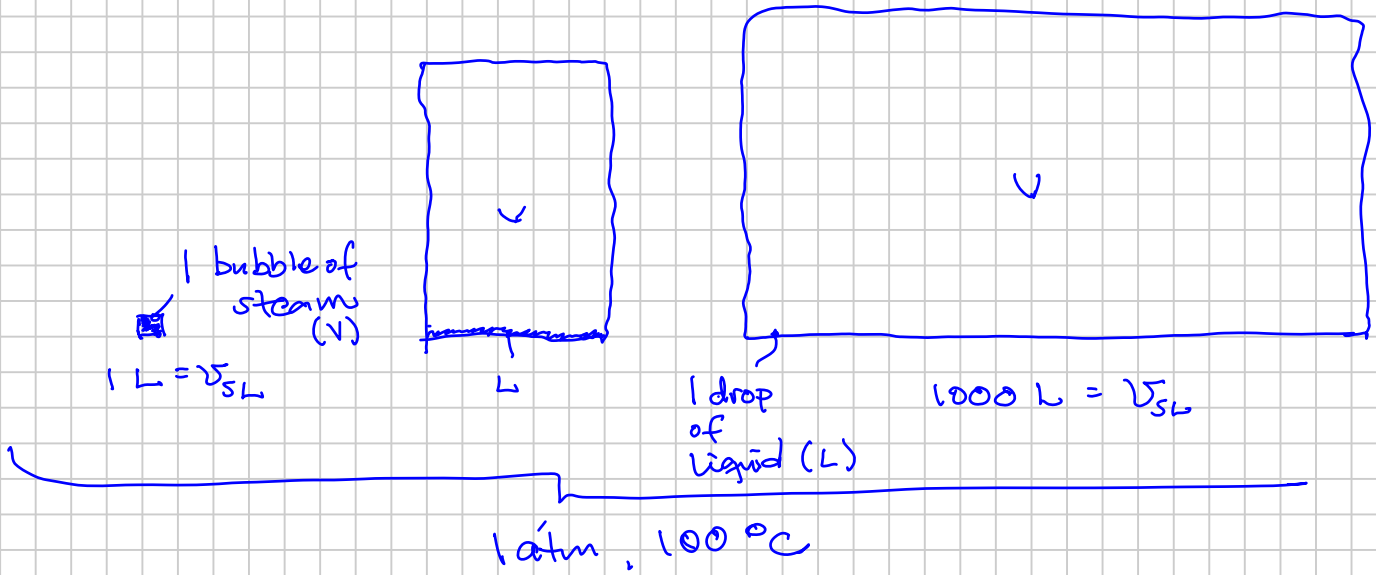
p-T for H_2O



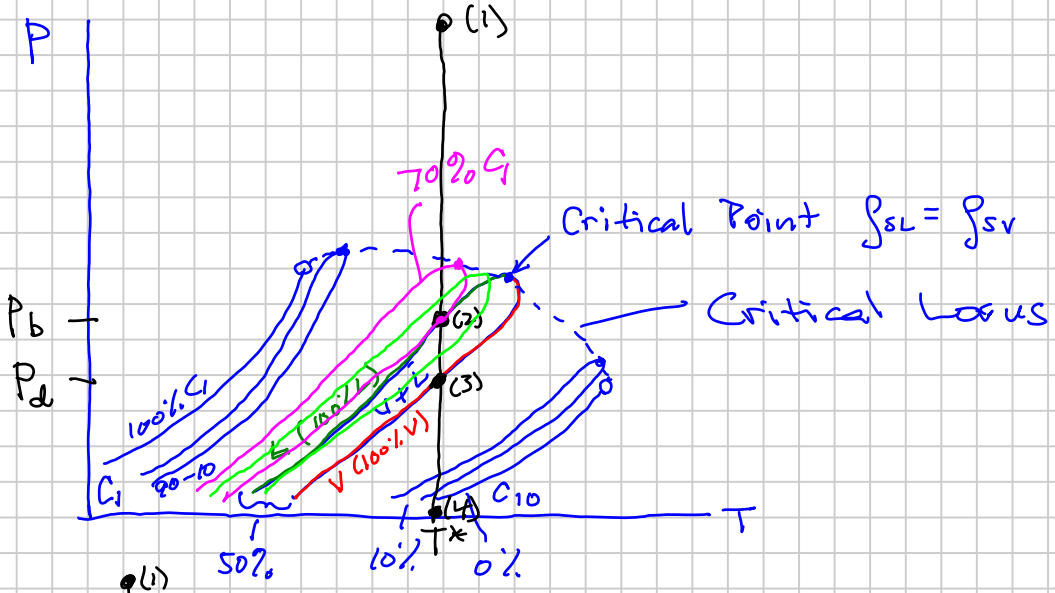
p-V p-v $\quad v \equiv \frac{V}{n}$ = molar volume

Phase Diagram



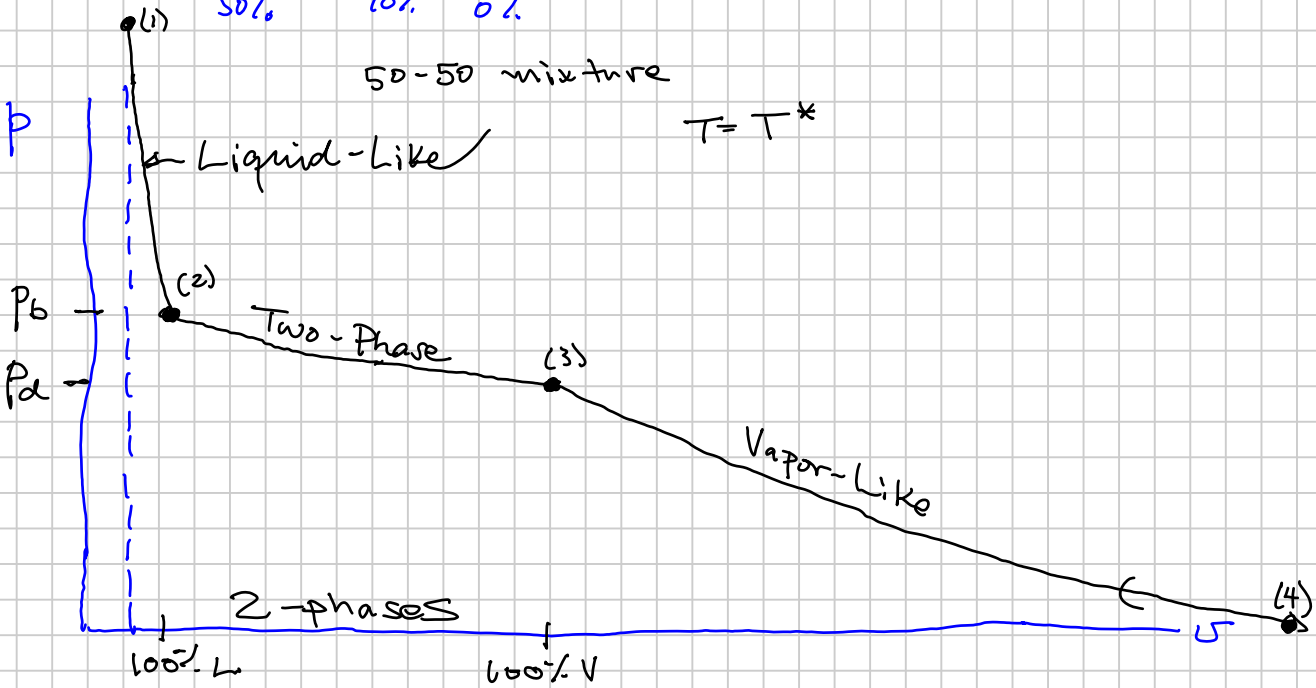


BINARY SYSTEM $(CO_2-H_2O \mid C_1-C_{10} \cdots)$



50-50 mixture

$T = T^*$



At (2) $P_b(T^*)$ At B.P. $x_i = z_i$

At D.P. $y_i = z_i$

$z_{C_1} = 0.5$ $z_{C_{10}} = 0.5$

$x_{C_1} = 0.5$ $x_{C_{10}} = 0.5$

At (2) $P_d(T^*)$

$z_{C_1} = 0.7$ $z_{C_{10}} = 0.3$

$y_{C_1} = 0.7$ $y_{C_{10}} = 0.3$

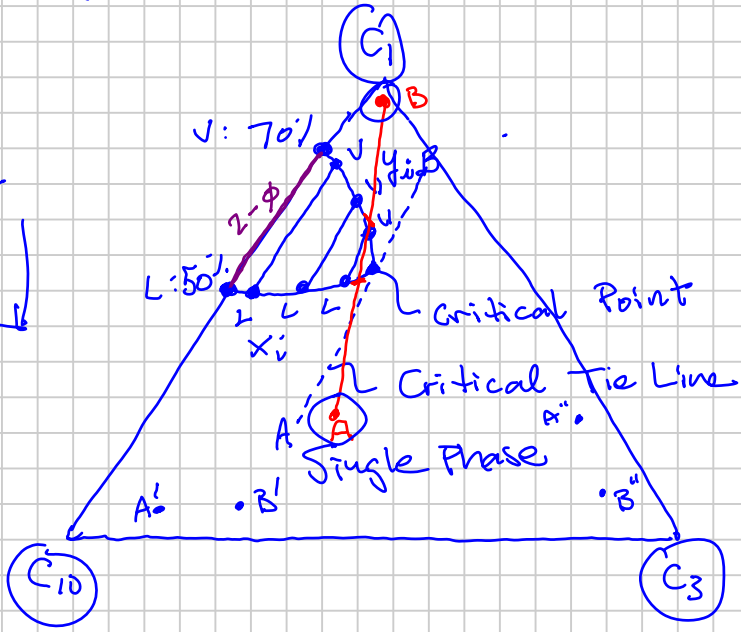
$P_{(2)} \xi T^*$: $\begin{cases} y_{C_1} = 0.7 & y_{C_{10}} = 0.3 \\ x_{C_1} = 0.5 & x_{C_{10}} = 0.5 \end{cases}$

ALL z_i that yield 2-phases at $P_{(2)} \xi T^*$

$$0.5 \leq z_{C_1} \leq 0.7$$

Ternary System: $C_1 - C_3 - C_{10}$

Ternary Phase Diagram $P_{(2)} \xi T^*$



Miscibility