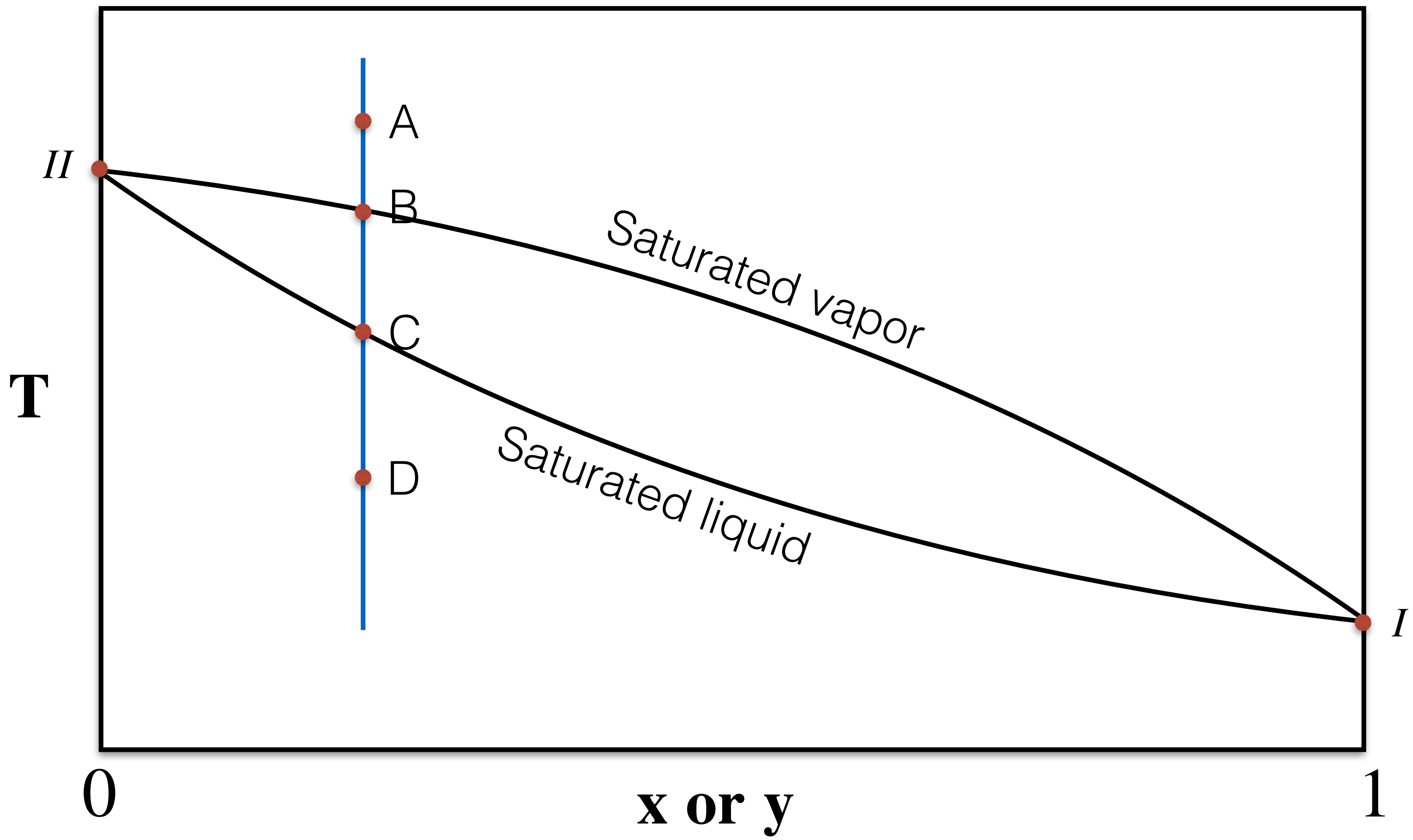
In-class quiz and exercise

Review quiz

Where is the dew point in the blue line
A)
B)
C)
D)



Review quiz

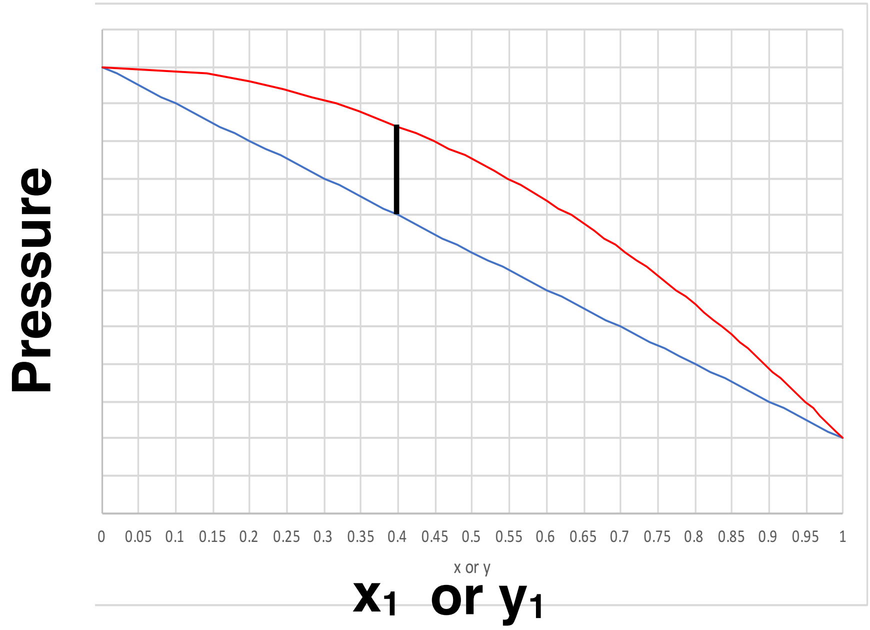
Why does the vertical line in the figure below not represent a tie line?

A) It is a tie line but for mechanical equilibrium.

B) For phase equilibrium, tie line can only be drawn in T-x-y diagram.

C) For phase equilirium, pressure must be equal in two phases.

D) None of the above.

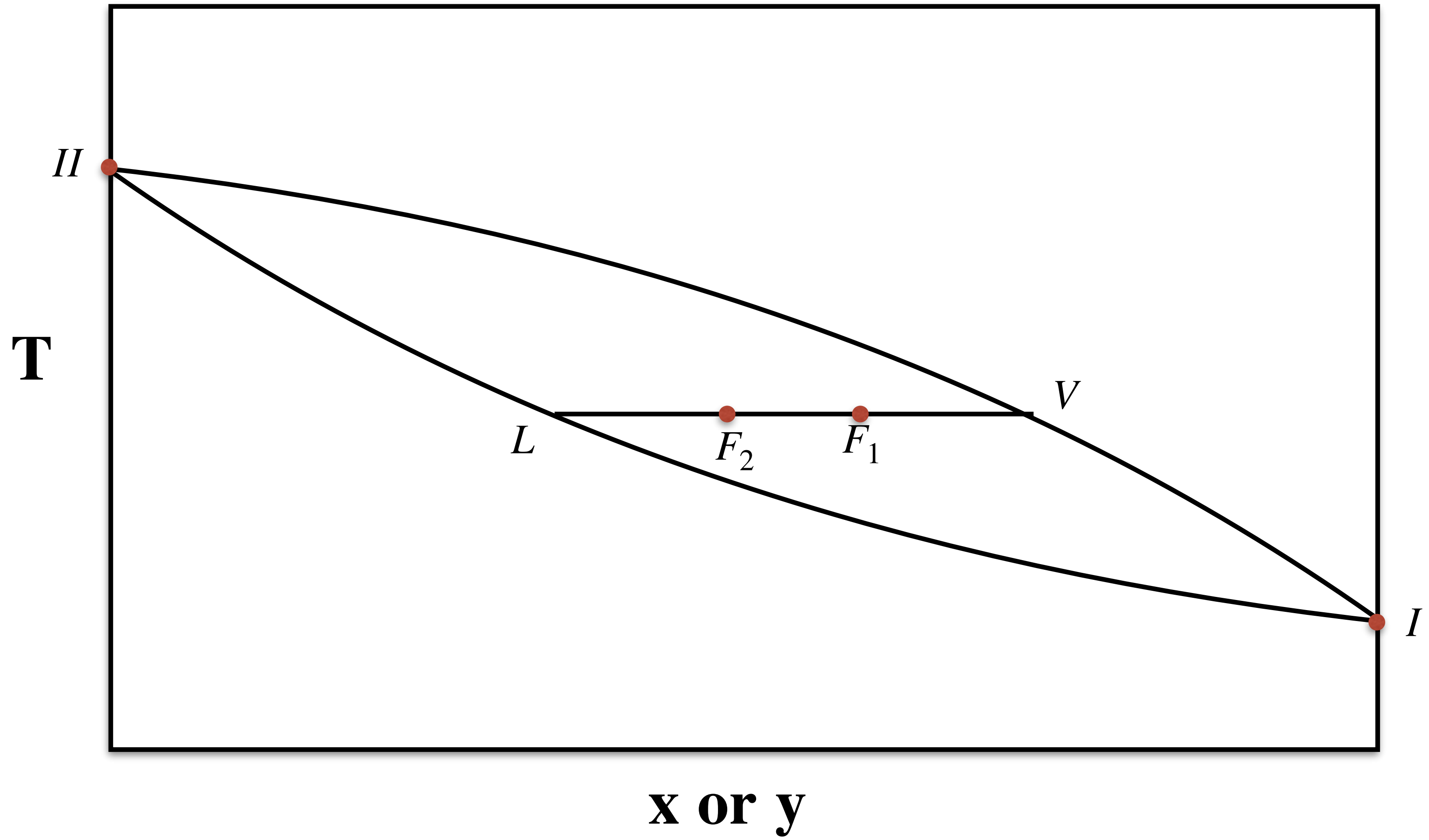


EPFL

Review quiz

Study the scenario. Which of the following is true

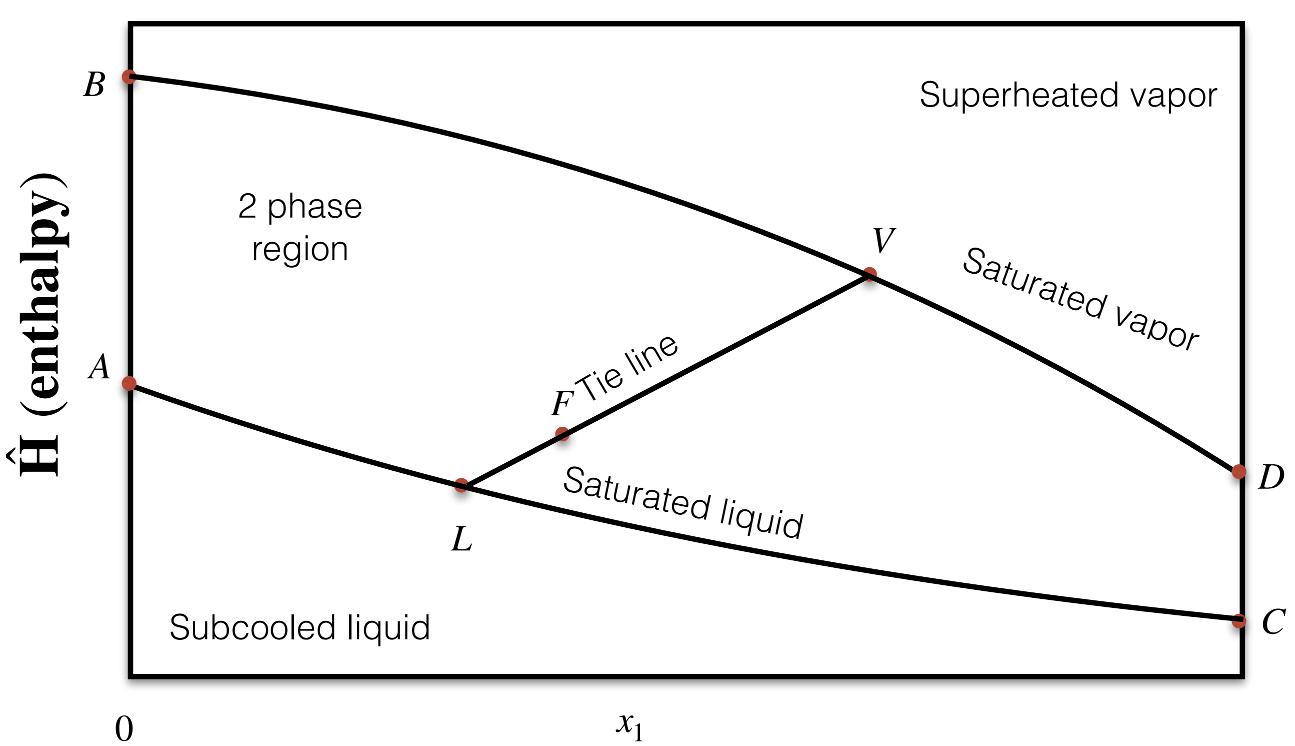
a. F1 and F2 will lead to same amount of saturated liquid
b. F1 and F2 will lead to same amount of saturated vapor
c. F2 will lead to more saturated liquid than F1
d. F2 will lead to more saturated vapor than F1



Review quiz

Which of the following represents enthalpy of vaporization of pure component I

a. The line LV
b. The line that connects CD
c. The line that connects AB
d. The line that connects VD

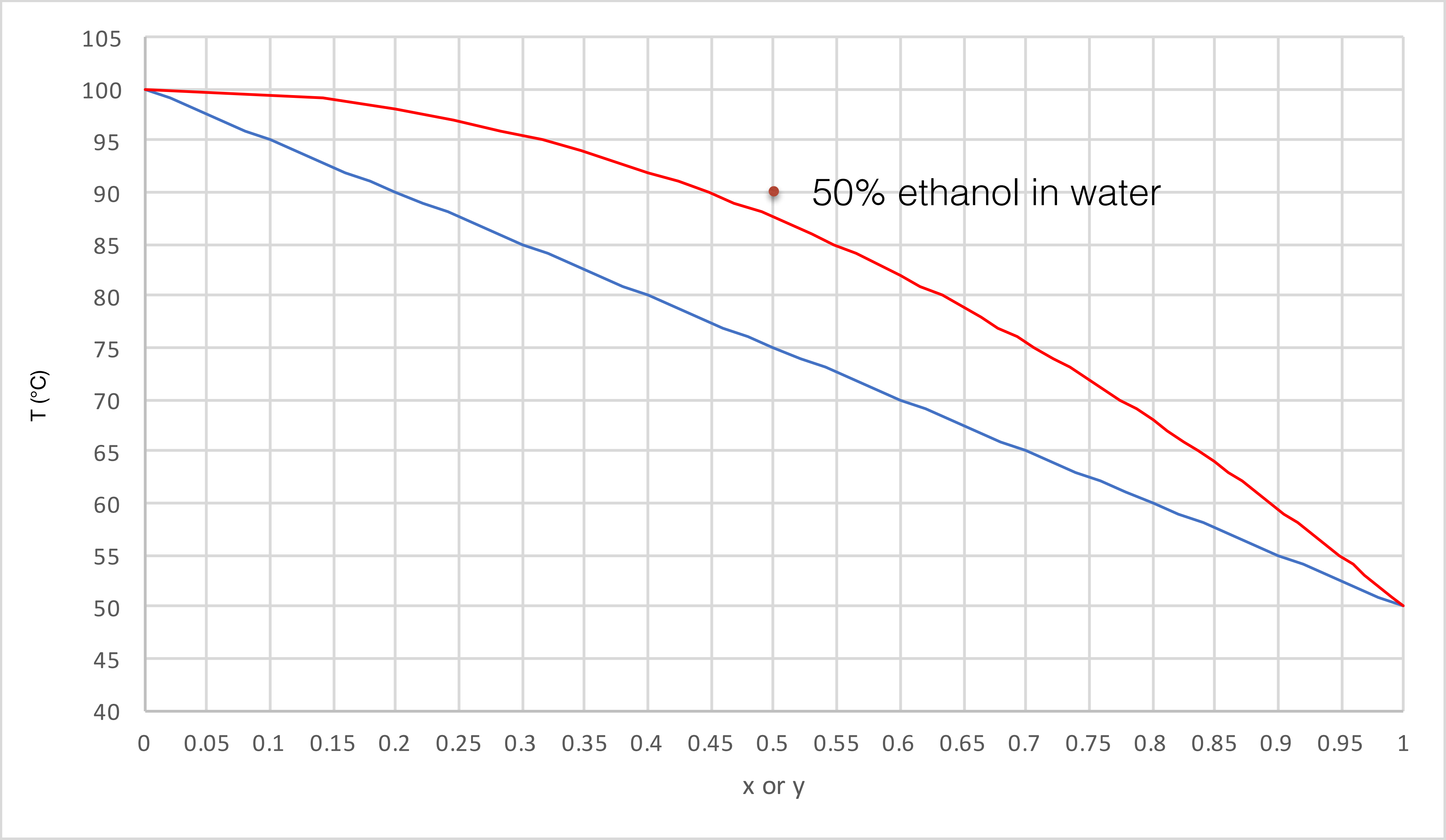


x_1 or y_1

Review quiz

To increase the concentration of biofuel in a solution that contains 50% biofuel in water at 90 °C (see red point in the plot below), you would need to

a. Heat the solution above 100 ° C (water boiling point).
b. Heat the solution above the boiling point of biofuel.
c. Cool the solution to 60 °C
d. Cool the solution to 80 °C



Review quiz

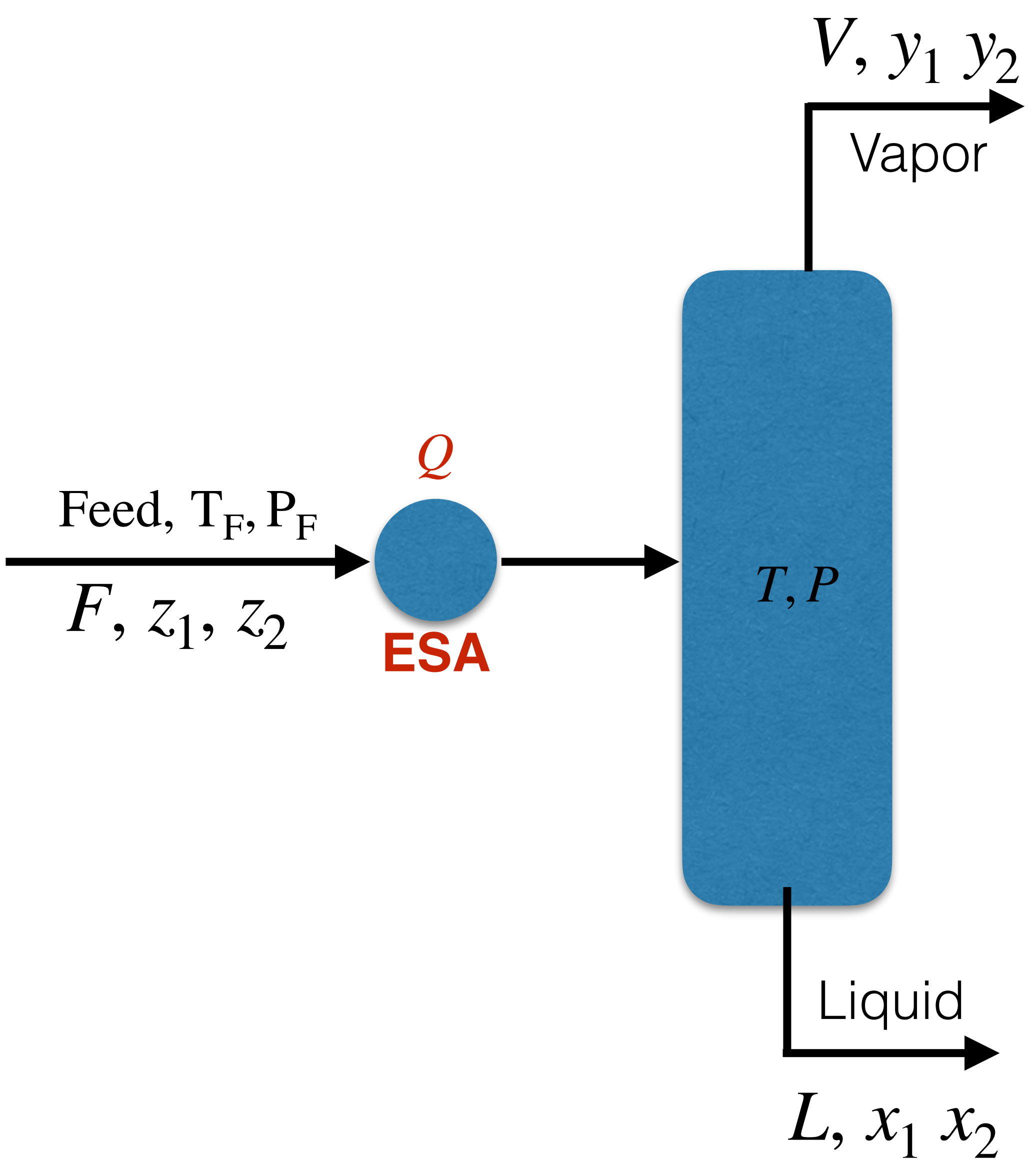
How should mass balance for component 1 look like

A) $Fz_1 = Lx_1 + Vy_1$

B) $Fz_1 = Ly_1 + Vx_1$

C) $F = L + V$

D) $Fz_1 = L + V$



$$Q = Lh_L + Vh_v - Fh_F$$

Review quiz

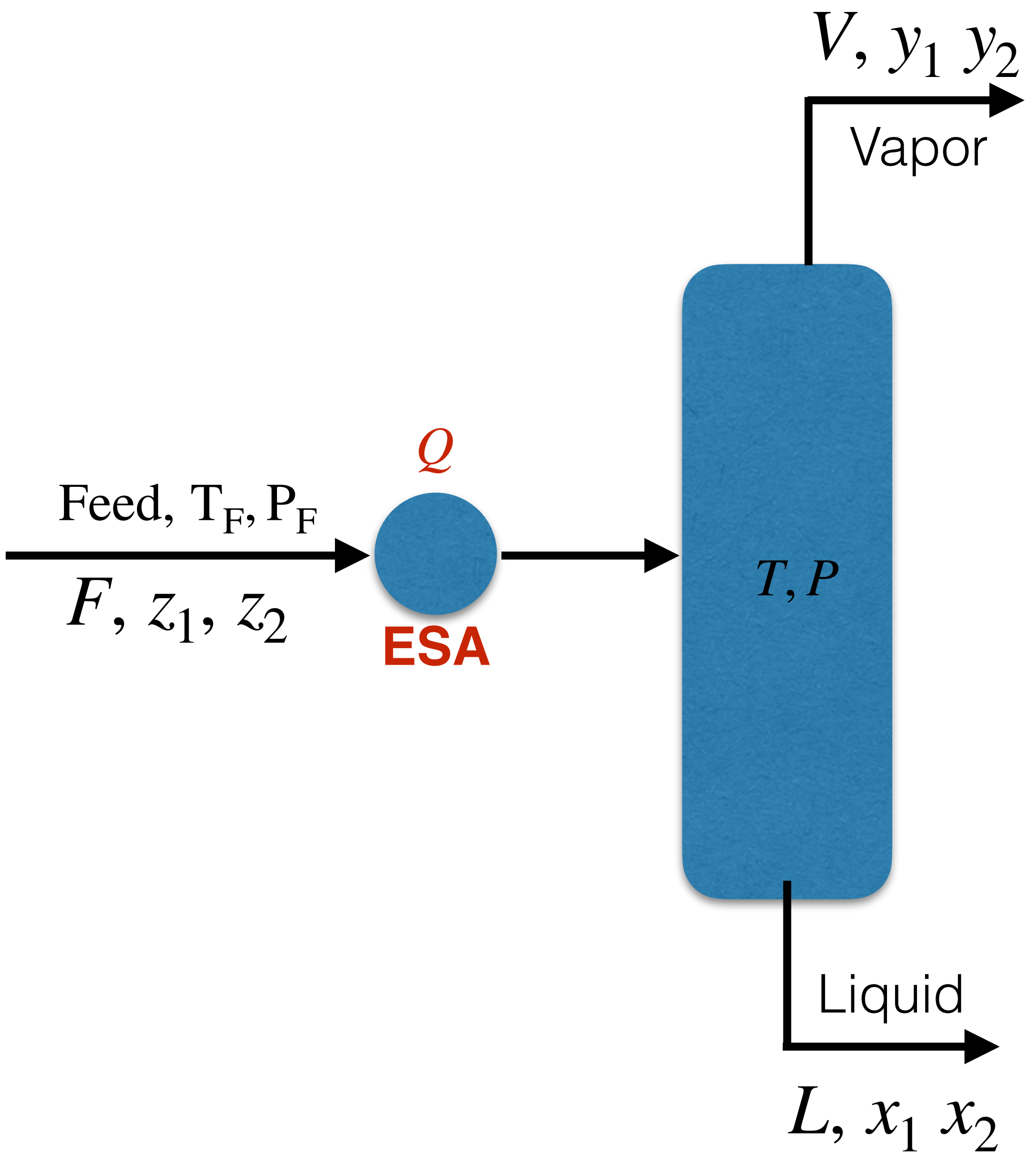
What should be the expression for the energy input

A) $Q = Lh_L + Vh_v$

B) $Q = Lh_L + Vh_v - Fh_F$

C) $Q = h_L + h_v - h_F$

D) $Q = h_L + h_v - h_F + RT_F$



Review quiz

What is the correct definition of relative volatility α_{12}

$A)\ \ \alpha_{12} = k_2/k_1$

$B)\ \alpha_{12} = \frac{y_1 x_2}{y_2 x_1} + 1$

$C)\ \ \alpha_{12} = \frac{P_1^{sat}}{P_2^{sat}}$ assuming Rault's law is valid

D) None of the above

Review quiz

Generally, we can write $y_1 = k_1 x_1$. However, k_1 is a function of temperature.

Is the following equations also a function of temperature for ideal solution ?

$$x_1 = \frac{y_1}{\alpha_{12}(1 - y_1) + y_1} \qquad y_1 = \frac{\alpha_{12} x_1}{(1 - x_1 + \alpha_{12} x_1)}$$

A) Yes, they are function of temperature.
B) No, they are independent of temperature

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In-class exercise problem

Consider a two-component ideal solution with boiling point of component 1 and 2 being 80 and 150 ^{o}C, respectively. In the T-x-y plot (plotted for more volatile component), the saturated liquid line is a straight line described by $T = mx_1 + c$

1) Calculate m and c.

2) You are separating this binary component in a flash column at 115 ^{o}C with feed flow rate of 100 moles/second and z_1 of 0.6. Given that it is a ideal solution, relatively volatility is constant and has value of 2. Calculate liquid and vapor composition.

3) Also calculate liquid and vapor flow rates.

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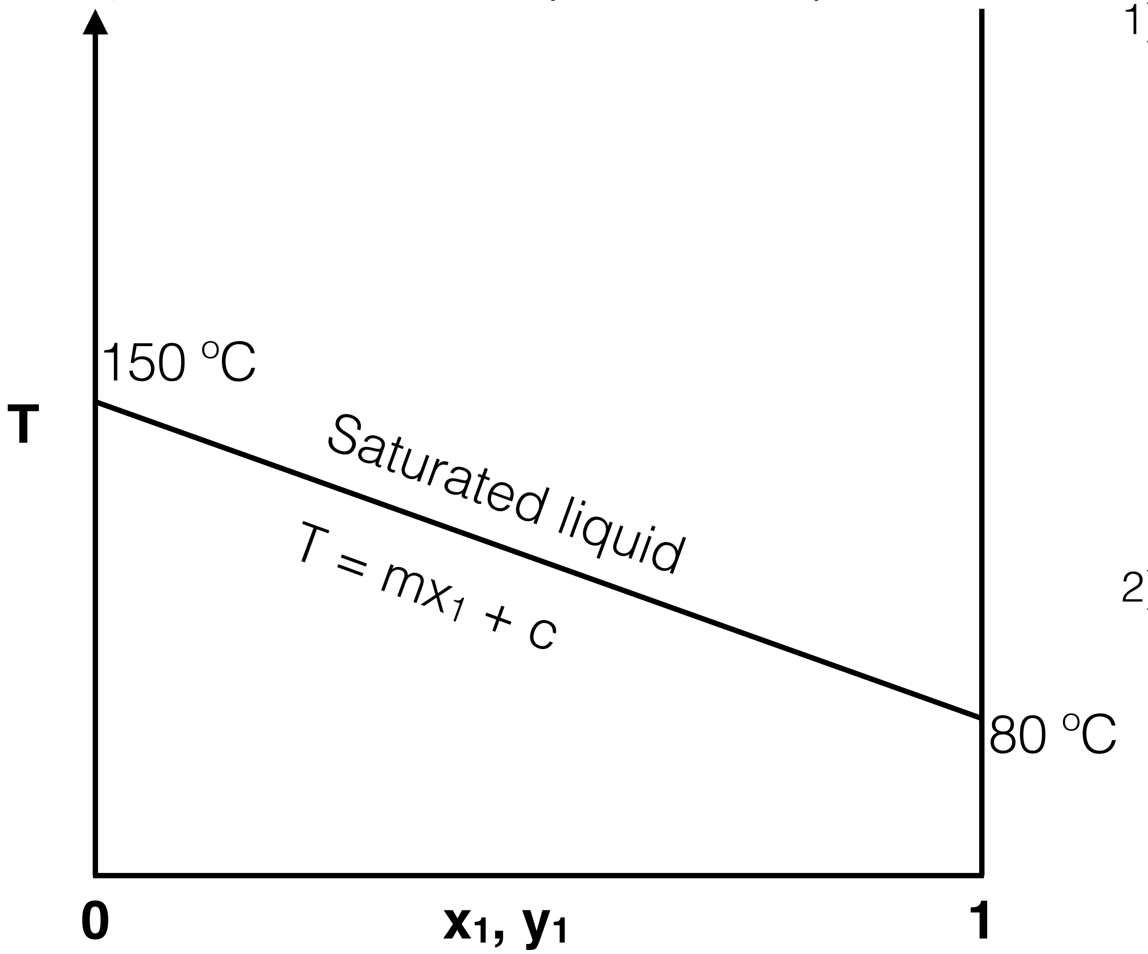

1) We have a straight line with values known at x1 = 0 and 1

At $x_1 = 0, T = 150$ °C

At $x_1 = 1, T = 80$ °C

$T = -70x_1 + 150$

2) At T = 115°C, $x_1 =$ (150-115)/70 = 0.5, x_2 =0.5

$$y_1 = \frac{\alpha_{12}x_1}{(1 - x_1 + \alpha_{12}x_1)} = 0.67, \quad y_2 = 0.33$$

3) $$\frac{L}{V}(\alpha_{12} - 1)x_1^2 + \left(\frac{L}{V} - \frac{F}{V}(\alpha_{12} - 1)z_1 + \alpha_{12}\right)x_1 - \frac{F}{V}z_1 = 0$$

$$\Rightarrow \frac{L}{V} * 0.25 + \left(\frac{L}{V} - \frac{F}{V}0.6 + 2\right)0.5 - \frac{F}{V}0.6 = 0$$

$$F = L + V \qquad \frac{F}{V} = \frac{L}{V} + 1$$

Lets call L/V as r

$$\Rightarrow r * 0.25 + (r - (r+1)0.6 + 2)0.5 - (r+1)0.6 = 0$$

$$\Rightarrow 0.25r + (0.4r + 1.4)0.5 - 0.6r - 0.6 = 0$$

$$\Rightarrow 0.25r + 0.2r + 0.7 - 0.6r - 0.6 = 0$$

$$\Rightarrow -0.15r + 0.1 = 0 \qquad \Rightarrow r = \frac{L}{V} = 0.67$$

$$\Rightarrow V = \frac{F}{1.67} = 60 \text{ moles/s}, \; L = 40 \text{ moles/s}$$

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