

Unit 13 - Week 11: Vapour - Liquid - Liquid Equilibria of Multicomponent Non-Ideal Systems

Course outline

How does an NPTEL online course work?

Week 0: Prerequisite

Week 1: Introduction of Phase Equilibria

Week 2: Estimation of Thermodynamic Properties

Week 3: Potential Energy Functions and Intermolecular Forces

Week 4: Molecular Theory of Corresponding States

Week 5: Intermolecular Interactions and E.o.S

Week 6: Gaseous Mixtures and Fugacity

Week 7: Liquid Mixtures and Fugacity

Week 8: Models for Activity Coefficients using Excess Gibbs Energy

Week 9: Vapour - Liquid Equilibria of Multicomponent Non-Ideal Systems

Week 10: Liquid - Liquid Equilibria of Multicomponent Non-Ideal Systems

Week 11: Vapour - Liquid - Liquid Equilibria of Multicomponent Non-Ideal Systems

Lec 1: Vapour - Liquid - Liquid Equilibrium

Lec 2: Vapour - Liquid - Liquid Equilibrium - 2

Quiz : Assessment 11

Weekly feedback form for week 11

Lecture Notes: Week 11

Solution: Assignment 11

Week 12: Solid - Liquid Equilibria of Non-Ideal Systems

Download Videos

Assessment 11

The due date for submitting this assignment has passed.
As per our records you have not submitted this assignment.

Due on 2020-04-15, 23:59 IST.

1) Consider a case where one vapor and two liquid phases (α and β) coexisting and at equilibrium. The vapor phase is ideal whereas the liquid phase nonideal behaviour is represented by two-suffix Margules equation. Then what is corresponding phase equilibrium equation for component "a" of the binary mixture consisting of components "a" and "b". **6 points**

$y_a P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

$y_a P = x_a^\alpha \exp\left\{\frac{A'}{\left[1+\frac{A'x_a^\alpha}{B'x_b^\alpha}\right]^2}\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A'}{\left[1+\frac{A'x_b^\beta}{B'x_b^\beta}\right]^2}\right\} P_a^{sat}$

$y_a \left[\exp\left\{\left(b_1 - \frac{a_1}{RT}\right) \frac{P}{RT}\right\} \left\{ \exp(\sqrt{a_1} - \sqrt{a_2})^2 \cdot \frac{y_a^2 P}{(RT)^2} \right\} \right] P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

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No, the answer is incorrect.

Score: 0

Accepted Answers:

$y_a P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

2) Consider a case where one vapor and two liquid phases coexisting and at equilibrium. The vapor phase nonideal behaviour is represented by van der Waals equation whereas the liquid phase nonideal behaviour is represented by two-suffix Margules equation. Then what is corresponding phase equilibrium equation for component "a" of the binary mixture consisting of components "a" and "b". **6 points**

$y_a P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

$y_a P = x_a^\alpha \exp\left\{\frac{A'}{\left[1+\frac{A'x_a^\alpha}{B'x_b^\alpha}\right]^2}\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A'}{\left[1+\frac{A'x_b^\beta}{B'x_b^\beta}\right]^2}\right\} P_a^{sat}$

$y_a \left[\exp\left\{\left(b_1 - \frac{a_1}{RT}\right) \frac{P}{RT}\right\} \left\{ \exp(\sqrt{a_1} - \sqrt{a_2})^2 \cdot \frac{y_a^2 P}{(RT)^2} \right\} \right] P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

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No, the answer is incorrect.

Score: 0

Accepted Answers:

$y_a \left[\exp\left\{\left(b_1 - \frac{a_1}{RT}\right) \frac{P}{RT}\right\} \left\{ \exp(\sqrt{a_1} - \sqrt{a_2})^2 \cdot \frac{y_a^2 P}{(RT)^2} \right\} \right] P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

3) Consider a case where one vapor and two liquid phases coexisting and at equilibrium. The vapor phase is ideal whereas the liquid phase nonideal behaviour is represented by van Laar equation. Then what is corresponding phase equilibrium equation for component "a" of the binary mixture consisting of components "a" and "b". **6 points**

$y_a P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

$y_a P = x_a^\alpha \exp\left\{\frac{A'}{\left[1+\frac{A'x_a^\alpha}{B'x_b^\alpha}\right]^2}\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A'}{\left[1+\frac{A'x_b^\beta}{B'x_b^\beta}\right]^2}\right\} P_a^{sat}$

$y_a \left[\exp\left\{\left(b_1 - \frac{a_1}{RT}\right) \frac{P}{RT}\right\} \left\{ \exp(\sqrt{a_1} - \sqrt{a_2})^2 \cdot \frac{y_a^2 P}{(RT)^2} \right\} \right] P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

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No, the answer is incorrect.

Score: 0

Accepted Answers:

$y_a P = x_a^\alpha \exp\left\{\frac{A'}{\left[1+\frac{A'x_a^\alpha}{B'x_b^\alpha}\right]^2}\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A'}{\left[1+\frac{A'x_b^\beta}{B'x_b^\beta}\right]^2}\right\} P_a^{sat}$

4) Consider a case where one vapor and two liquid phases coexisting and at equilibrium. The vapor phase nonideal behaviour represented by van der Waals equation whereas the liquid phase nonideal behaviour is represented by van Laar equation. Then what is corresponding phase equilibrium equation for component "a" of the binary mixture consisting of components "a" and "b". **6 points**

$y_a P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

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No, the answer is incorrect.

Score: 0

Accepted Answers:

$y_a \left[\exp\left\{\left(b_1 - \frac{a_1}{RT}\right) \frac{P}{RT}\right\} \left\{ \exp(\sqrt{a_1} - \sqrt{a_2})^2 \cdot \frac{y_a^2 P}{(RT)^2} \right\} \right] P = x_a^\alpha \exp\left\{\frac{A'}{\left[1+\frac{A'x_a^\alpha}{B'x_b^\alpha}\right]^2}\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A'}{\left[1+\frac{A'x_b^\beta}{B'x_b^\beta}\right]^2}\right\} P_a^{sat}$

5) Consider a case where one vapor and two liquid phases coexisting and at equilibrium. The vapor phase nonideal behaviour represented by virial equation whereas the liquid phase nonideal behaviour is represented by two suffix equation. Then what is corresponding phase equilibrium equation for component "a" of the binary mixture consisting of components "a" and "b". **6 points**

$y_a P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

$y_a P = x_a^\alpha \exp\left\{\frac{A'}{\left[1+\frac{A'x_a^\alpha}{B'x_b^\alpha}\right]^2}\right\} = x_a^\beta \exp\left\{\frac{A'}{\left[1+\frac{A'x_b^\beta}{B'x_b^\beta}\right]^2}\right\}$

$y_a \left[\exp\left\{\frac{2}{v}(y_a B_{aa} + y_b B_{ab}) + \frac{3}{2v^2}(y_a^2 C_{aaa} + 2y_a y_b C_{aab} + y_b^2 C_{abb}) - \ln z_{mixt}\right\} \right] P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

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No, the answer is incorrect.

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Accepted Answers:

$y_a \left[\exp\left\{\frac{2}{v}(y_a B_{aa} + y_b B_{ab}) + \frac{3}{2v^2}(y_a^2 C_{aaa} + 2y_a y_b C_{aab} + y_b^2 C_{abb}) - \ln z_{mixt}\right\} \right] P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

6) Consider a case where one vapor and two liquid phases coexisting and at equilibrium. The vapor phase nonideal behaviour represented by virial equation whereas the liquid phase nonideal behaviour is represented by van Laar equation. Then what is corresponding phase equilibrium equation for component "a" of the binary mixture consisting of components "a" and "b". **6 points**

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$y_a P = x_a^\alpha \exp\left\{\frac{A'}{\left[1+\frac{A'x_a^\alpha}{B'x_b^\alpha}\right]^2}\right\} = x_a^\beta \exp\left\{\frac{A'}{\left[1+\frac{A'x_b^\beta}{B'x_b^\beta}\right]^2}\right\}$

$y_a \left[\exp\left\{\frac{2}{v}(y_a B_{aa} + y_b B_{ab}) + \frac{3}{2v^2}(y_a^2 C_{aaa} + 2y_a y_b C_{aab} + y_b^2 C_{abb}) - \ln z_{mixt}\right\} \right] P = x_a^\alpha \exp\left\{\frac{A}{RT}(x_b^\alpha)^2\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A}{RT}(x_b^\beta)^2\right\} P_a^{sat}$

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No, the answer is incorrect.

Score: 0

Accepted Answers:

$y_a \left[\exp\left\{\frac{2}{v}(y_a B_{aa} + y_b B_{ab}) + \frac{3}{2v^2}(y_a^2 C_{aaa} + 2y_a y_b C_{aab} + y_b^2 C_{abb}) - \ln z_{mixt}\right\} \right] P = x_a^\alpha \exp\left\{\frac{A'}{\left[1+\frac{A'x_a^\alpha}{B'x_b^\alpha}\right]^2}\right\} P_a^{sat} = x_a^\beta \exp\left\{\frac{A'}{\left[1+\frac{A'x_b^\beta}{B'x_b^\beta}\right]^2}\right\} P_a^{sat}$