

CHEMICAL PROCESS CALCULATIONS

Course Code: 19CH1104

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Course Outcomes:

At the end of the course the student shall be able to

CO1 Express the composition and density of a given mixture in different ways

CO2 Explain vapor pressure, vapor pressure plots, Raoult's law and humidity

CO3 Solve material balance problems without chemical reactions.

CO4 Solve material balance problems involving chemical reactions

CO5 Calculate enthalpy, heat of reaction and theoretical flame temperature.

UNIT-I

12 Lectures

STOICHIOMETRIC RELATION AND BEHAVIOR OF IDEAL GASES

Basis of calculations, methods of expressing compositions of mixtures and solutions, density and specific gravity, Baume and API gravity scales. Application of ideal gas law, gaseous mixtures, gases in chemical reactions.

Learning outcomes:

After the completion of the Unit I, the student will be able to

1. Express the compositions of mixtures in different ways. (L2)
2. List different scales used to measure specific gravity (L1)
3. Predict the ideal behavior of gases and vapors. (L3)

UNIT-II

8 Lectures

VAPOR PRESSURE:

Vaporization, boiling point, effect of temperature on vapor pressure, vapor pressure plots and Raoult's law.

HUMIDITY AND SATURATION

Relative and percentage saturation, dew point, wet bulb and dry bulb temperature, use of humidity charts for engineering calculations.

Learning outcomes:

After the completion of the Unit II, the student will be able to

1. Describe the effect of temperature on vapor pressure. (L2)
2. Illustrate how to get vapor pressure data from vapor pressure plots. (L3)
3. Define relative saturation, percentage saturation, dew point, wet bulb & dry bulb temperatures.(L1)
4. Calculate the percent saturation and relative saturation of vapour-gas mixtures. (L3)

UNIT-III

10 Lectures

MATERIAL BALANCE WITHOUT CHEMICAL REACTION

Tie substance, steps for solving material balance problems, Material balance on single unit process– Mixing, Evaporation, Drying, Distillation, Solubility and Crystallization; Material balance on Multi unit process –Bypass, Recycle, Purge,

Learning outcomes:

After the completion of the Unit III, the student will be able to

1. Explain steps for solving material balance problems for a given system. (L2)
2. Perform material balances on chemical processes/equipment without chemical reactions.(L3)

UNIT-IV

10 Lectures

MATERIAL BALANCE WITH CHEMICAL REACTION

Conversion, Yield, Limiting reactant and excess reactant, Processes involving Chemical Reactions, Processes involving recycle and purge.

Learning outcomes:

After the completion of the Unit IV, the student will be able to

1. Define Conversion, Yield, limiting reactant and excess reactant. (L1)
2. Perform material balances on chemical processes/equipment with reactions. (L3)
3. Solve material balance problems involving recycle, purge and bypass.(L3)

THERMOPHYSICS:

Heat capacity of gases, liquid and mixture solutions. Kopp's rule, latent heat, heat of fusion and heat of vaporization, Trouton's rule, Kistyakowsky equation for non polar liquids, enthalpy and its evaluation.

THERMOCHEMISTRY:

Calculation and applications of heat of reaction, combustion and formation, Kirchhoff's equation, theoretical and actual flame temperatures.

Learning outcomes:

After the completion of the Unit V, the student will be able to

1. Define heat capacity, Kopp's rule, latent heat, Trouton's rule, heat of reaction, heat of combustion and heat of formation (L1)
2. Evaluate thermal effects associated with chemical reactions. (L5)
3. Estimate theoretical and actual flame temperature. (L2)

Text Books:

1. Hougen. O. A, Watson K.M. and Ragatz R.A., *Chemical Process Principles, Part -I, Material and Energy Balance*, 2nd Edition, John Wiley and Sons Inc, New York, 2004.

References:

1. Narayanan K.V., Lakshmikutty B., *Stoichiometry and Process Calculations*, PHI Learning Pvt. Ltd., 2014.
2. Bhatt, B. I., Thakore S. B., *Stoichiometry*, 5th Edition, Tata McGraw Hill publishing company, Ltd. New Delhi, 2010
3. Richard M. Felder, Ronald W. Rousseau, Lisa G. Bullard, *Felder's Elementary Principles of Chemical Processes* 3rd Edition, Wiley India Pvt. Ltd., 2008
4. Himmelblau D.H., *Basic Principles and Calculations in Chemical Engineering*, 8th Edition, PHI, 2012.