Chemical Engineering Thermodynamics - Video course

COURSE OUTLINE

PREAMBLE

Chemical engineering thermodynamics is primarily concerned with the application of thermodynamics to phase equilibria and reaction equilibria in multi-component systems and to the calculation of extrema in the work involved in separation processes. Of secondary importance in this context is its application to heat-work inter-conversion devices, which are studied in detail by mechanical engineers. Phase and reaction equilibria involving two or more solid phases are of primary interest to metallurgists.

Thermodynamics plays a supervisory and often intangible role in engineering. Its applications are obvious in the design of Chemical engineering equipment in processes in which approach to equilibrium is nearly one hundred percent in practice. Even in those cases where the processes are governed by rate considerations, thermodynamics sets the boundaries of design. It plays a fundamental role in transport theory in which rate processes are treated as departures from equilibrium. The mathematical abilities required for applying thermodynamics to practical problems are generally of second year undergraduate level.

Classical thermodynamics is generally taught without reference to molecular structure of matter. The incorporation of concepts from molecular theory is indeed of great help in clarifying some of the concepts in classical thermodynamics. However the quantitative use of molecular theory is a skill that can be acquired only after considerable concerted effort on the part of the student. It is therefore impractical to try to include molecular theory for use as a quantitative tool as part of an undergraduate classical thermodynamics course.

A course on thermodynamics is logically divided into three parts: theory, properties of matter and applications. Thermodynamic theory is based on the two laws that represent un-contradicted experience and is elegant and rigorous. Every application of the theory requires the knowledge of the properties of the specific system of interest. Until now any mismatch between a theoretical prediction and the experimental observation has been attributable to our incomplete knowledge of the system properties.

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Chemical Engineering

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COURSE DETAIL

Lectures	Topics
1	Thermodynamics and the Chemical Industry
2	James Prescot Joule and the first law
3	Sadi Carnot and the second law
4	Equilibrium and Extrema in work
5	Illustrative Calculations I
6	Properties of pure substances
7	The p-h chart
8	Work calculation
9	Illustrative Calculations II
10	Heat-Work Interconversion Devices
11	Refrigeration/ Thermodynamics of mixtures
12	The Gibbs Duhem equation
13	Models for Excess Gibbs Free Energy
14	Van Laar model
15	Gaseous and liquid mixtures

16	Separation Work/ Equations of state	
17	Chemical potentials in gas and condensed phases	
18	Vapour Liquid Equilibria I	
19	Vapour Liquid Equilibria II	
20	Solvent-Solvent mixtures	
21	Solvent-solute mixtures	
22	Liquid-liquid equilibria	
23	An industrial example	
24	Liquid-liquid equilibria/ Reaction Equilibria	
25	Reaction Equilibria	
26	Illustrative Examples I	
27	Illustrative Examples II	
28	Illustrative Examples III	
29	Simultaneous Relations	
30	Thermodynamic Consistency/ Reverse Osmosis	
31	Miscellaneous topics in phase equilibria	
	Absorption Refrigeration	

32	
33	Summary of Classical Thermodynamics
34	Molecular basis of Thermodynamics I
35	Molecular basis of Thermodynamics II

References:

TEXT BOOKS

1. Smith, J.M. and Van Ness, H.C., `Introduction to Chemical Engineering Thermodynamics', McGraw Hill (1975). This is the most comprehensive book. The subsequent editions of this book (6th and 7th) have an additional author,M.M. Abbott and some additional topics, that are not normally part of an undergraduate course.
2. Denbigh, K., `The Principles of Chemical Equilibria with Applications¸¸ in Chemistry and Chemical Engineering', Cambridge University Press (1968).¸ This book has the best exposition of concepts. It has no explicit treatment of open systems

REFERENCE BOOKS

1. Prausnits, J.M., Lichtenthaler, R.N. and Azevedo, E.G., `Molecular Thermodynamics of Fluid-phase Equilibria', Ed. 2. Prentice Hall (1986).¸ The treatment in this book is basically a mix of classical thermodynamics and molecular theory. However some of the chapters are written in a refreshing style and can be used to advantage in a classical thermodynamics course. The material in chapters 1,2 and 3 as well as 5,6,8,9 and 10 is of interest to UG students.
2. Walas, S.M., 'Phase Equilibria in Chemical Engineering', Butterworths (1985) has a very detailed and comprehensive treatment of Phase Equilibria.
3. Sandler, H.P., 'Chemical Engineering Thermodynamics', Prentice-Hall (1988)