Textbook: J. M. Smith, H. C. Van Ness, M.M. Abbott, **Introduction to Chemical Engineering Thermodynamics,** Seventh Edition, McGraw-Hill International Editions, 2005.

Supplementary References

Stanley I. Sandler, **Chemical and Engineering Thermodynamics,** Third edition John Wiley & Sons Inc, 1998.

J. Richard Elliott, Carl T. Lira, **Introductory Chemical Engineering Thermodynamics,** 2nd edition Prentice Hall International Series in the Physical and Chemical Engineering Sciences, 1999.

Course Contents

1. **Introduction:** The Scope of Thermodynamics, The First, Second and Third Laws of Thermodynamics, Reversible and Irreversible Processes, Enthalpy and Internal Energy etc.
2. **Production of Power from Heat :** The Steam Power Plant, The Gas-Turbine Power Plant, Internal-Combustion Engines,
3. **Refrigeration and Liquefaction:** The Carnot Refrigerator, The Vapour-Compression Cycle, Comparison of Refrigeration Cycles, The Choice of Refrigerant, The Heat Pump, Liquefaction Processes
4. **Solution Thermodynamics and Applications:** Fundamental Property Relation, Chemical Potential as a Criterion for Phases Equilibria, Partial Properties, Ideal-Gas Mixtures, Fugacity and Fugacity Coefficient for a Pure Species, Fugacity and Fugacity Coefficient for Species in Solution, The Ideal Solution, Excess Properties, Behaviour of Excess Properties of Liquid Mixtures, Liquid-Phase Properties from VLE Data, Models for Excess Gibbs Energy, Property Changes of Mixing, Heat Effects of Mixing Processes.

5.VLE at Low to Moderate Pressures : The Nature of Equilibrium, The Phase Rule. Duhems Theory,

6.Thermodynamic Properties and VLE from Equations of State: Properties of Fluids from the Virial Equations of State, Properties of Fluids from Cubic Equations of State, VLE from Cubic Equations of State

7. Topics in Phase Equilibria: Equilibrium and Stability, Liquid/Liquid Equilibrium (LLE), Vapour/Liquid/Liquid Equilibrium (VLLE), Solid/Liquid Equilibrium (SLE), Solid/Vapour Equilibrium (SVE), Equilibrium Absorption of Gases on Solids

8.Chemical-Reaction Equilibria: The Reaction Coordinate, Application of Equilibrium Criteria to Chemical Reactions, The Standard Gibbs Energy Change and the Equilibrium Constant, Effect of Temperature on the Equilibrium Constant, Evaluation of Equilibrium Constants

9. Thermodynamic Analysis of Processes: Calculation of Ideal Work, Lost Work, Thermodynamic Analysis of Steady-State Flow Processes

Refrigeration is a process and requires continuous absorption of heat,

its use in

the air conditioning of buildings,

the treatment, transportation, and preservation of foods and beverages,

the manufacture of ice,

the dehydration of gases,

Applications:

-lubricating-oil purification,

-low-temperature reactions,

-separation of volatile hydrocarbons,

-gas liquefaction.

THE CARNOT REFRIGERATOR

Basically, a refrigeration cycle is a reversed heat-engine cycle.

In a continuous refrigeration process,

the heat adsorbed (| Qc |) at a low temperature (T_C) is continuously rejected **(| Q_H |)** to **the surrounding at a higher temperature** (T_H)**.**

requires external source of energy.

- The ideal refrigerator (like ideal heat engine) operates on a Carnot cycle,

Consist of

two isothermal steps and

two adiabatic steps

- The cycle requires the addition of **net work W** to the system. Since **ΔU of the working fluid** is zero for the cycle, the first law gives

$$W = |Q_H| - |Q_C|$$

THE VAPOUR-COMPRESSİON CYCLE

Due to some difficulties using reversed Carnot cycle

The vapour-compression cycle is emerged

COMPARISON OF REFRIGERATION CYCLES

- For given values of T_C and T_H, the **highest possible value of ω** is attained for **Carnot cycle refrigeration**.

- The **vapour-compression cycle with reversible compression** and expansion approaches this upper limit.

- A **vapour-compression cycle** with expansion in **a throttle valve** has a somewhat lower value, and this is reduced **further** when **compression is not isentropic**