國立臺北大學自然資源與環境管理研究所
115 學年度第一學期『環境工程科學概論』

課程講義(04)：物質與能量平衡
Conservation of Material and Energy

- INTRODUCTION – UNIFYING THEORIES
  - □ Conservation of Matter => Chemical Reactions (Bio-Sensor)
  - □ Conservation of Energy => Laws of Thermodynamics (Entropy)
  - □ Conservation of Matter and Energy => The Theory of Relativity ($E=MC^2$)
    ⇒ $E = (2.2\times10^{13})(m)$: conversion of 1 g of matter to energy => 2.2×10^{13} calories.
- MATERIAL BALANCE
  - □ Control Volume, Control Mass, and System
  - □ Steady State vs. Transit or Dynamic => Rate of Change => Sink/Source
    (Accumulation Rate) = (Input Rate) – (Output Rate) ± (Transformation Rate)
    ⇒ 入流率、出流率、源與匯 => 碳匯 (綠碳、黃碳、藍碳)
    ⇒ Balance = deposit – withdrawal => 收入(存款)、支出(提款)、債權與債務
  - □ Steady-State Conservative Systems => Non-conservative Pollutants
  - □ Batch Systems with Non-Conservative Pollutants => Reaction Order
  - □ Net Zero Emission vs. Carbon Neutrality
- ENERGY BALANCE
  - □ First Law of Thermodynamics
    ⇒ Thermal Unit of Energy; Specific Heat Capacity
    ⇒ Latent Heat, Overheated Stream, Subcritical and Supercritical
    ⇒ Pressurized Water Reactors 壓水式反應爐 (vs. Boiling Water Reactors 沸水式)
  - □ Second Law of Thermodynamics
    ⇒ Energy: Heat, Kinetic Energy, Potential, Electricity, etc.
    ⇒ Work, Unusable Energy, Entropy and Disorderness/Randomness
    ⇒ Thermal Efficiency: Carnot Engine => Fuel Cell
    ⇒ Thermal Power Plants: Coal, Oil and Natural Gas; Combined Cycle (複循環)
  - □ Conductive and Convective Heat Transfer
  - □ Radiant Heat Transfer
    ⇒ Solar Energy: Heat vs. Photovoltaic
  - □ Heat Engine vs. Heat Pump (熱泵)
- UNIT OF MEASUREMENT
  - □ Basic Units: Length, Mass, Time, and Temperature
  - □ International System of Units (SI) vs. Imperial System (U.S. customary units)
  - □ SI Unit Prefixes and Greek Alphabet => Appendixes
  - □ Extended Units: Concentration, Dose, ppm(m), ppb(v), Energy, “Equivalent”
    ⇒Units for Air Pollutants: ppm(v), ppb(v), $\mu g/m^3$, iTEQ
    ⇒Units for Water Pollutants: mg/L, ppm(m), μ-mho/cm
    ⇒Units for Soil Contaminants: mg/kg, meq/100g (CEC)