

國立臺北大學自然資源與環境管理研究所
114 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 ($E=MC^2$)
⇒ $E = (2.2 \times 10^{13})(m)$: 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 Disorder/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), $\mu\text{g}/\text{m}^3$, iTEQ
⇒ Units for Water Pollutants: mg/L, ppm(m), $\mu\text{-mho}/\text{cm}$
⇒ Units for Soil Contaminants: mg/kg, meq/100g (CEC)