

國立臺北大學自然資源與環境管理研究所

101 學年度第一學期『環境工程科學概論』

課程講義(四)：物質與能量平衡、環境計量

- INTRODUCTION – UNIFYING THEORIES
 - Conservation of Matter => Chemical Reactions
 - Conservation of Energy => Laws of Thermodynamics
 - Conservation of Matter and Energy => The Theory of Relativity
- MATERIAL BALANCE
 - Control Volume, Control Mass, and System
 - Steady State vs. Transit or Dynamic => Rate of Change
 - (Accumulation Rate) = (Input Rate) – (Output Rate) ± (Transformation Rate)
 - Steady-State Conservative Systems
 - Batch Systems with Non-conservative Pollutants
 - Steady-State Systems with Non-conservative Pollutants
- ENERGY BALANCE
 - First Law of Thermodynamics
 - ⇒ Thermal Unit of Energy
 - ⇒ Specific Heat Capacity
 - ⇒ Latent Heat, Overheated Steam, Subcritical and Supercritical
 - ⇒ Pressurized Water Reactors (vs. Boiling Water Reactors)
 - Second Law of Thermodynamics
 - ⇒ Energy: Heat, Kinetic Energy, Potential, Electricity, etc.
 - ⇒ Work, Unusable Energy, Entropy and Disorder/Randomness
 - ⇒ Thermal Efficiency: Carnot Engine
 - ⇒ Thermal Power Plants: Coal, Oil and Natural Gas; Steam Generator and Internal combustion; Combined Cycle and IGCC
 - Conductive and Convective Heat Transfer
 - Radiant Heat Transfer
 - ⇒ Solar Energy: Heat vs. Photovoltaic
 - ⇒ Electromagnetic Spectrum
 - ⇒ Wavelength vs. Frequency
 - Heat Engine vs. Heat Pump
- UNIT OF MEASUREMENT
 - Basic Units: Length, Mass, Time, and Temperature
 - International System of Units (SI) vs. Imperial System (U.S. customary units)
 - 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), μ-mho/cm
- Units for Soil Contaminants: mg/kg, meq/100g (CEC)
- Common Prefixes: p, n, μ, m, c, d, k, M, G, T
- Conversion Factors => Emission Factors
- Dimensionless Analysis: Manning Equation

TABLE 1.1 Some Basic Units and Conversion Factors¹

Quantity	SI Units	SI Symbol	Conversion Factor =	USCS Units
Length	Meter	m	3.2808	ft
Mass	Kilogram	kg	2.2046	lb
Temperature	Celsius	°C	1.8 (°C) + 32	°F
Area	Square meter	m ²	10.7639	ft ²
Volume	Cubic meter	m ³	35.3147	ft ³
Energy	Kilojoule	kJ	0.9478	Btu
Power	Watt	W	3.4121	Btu/hr
Velocity	Meter/sec	m/s	2.2369	mi/hr
Flow rate	Meter ³ /sec	m ³ /s	35.3147	ft ³ /s
Density	Kilogram/meter ³	kg/m ³	0.06243	lb/ft ³

10 ⁻¹⁵	femto	f
10 ⁻¹²	pico	p
10 ⁻⁹	nano	n
10 ⁻⁶	micro	μ
10 ⁻³	milli	m
10 ⁻²	centi	c
10 ⁻¹	deci	d
10	deka	da
10 ²	hecto	h
10 ³	kilo	k
10 ⁶	mega	M
10 ⁹	giga	G
10 ¹²	tera	T
10 ¹⁵	peta	P
10 ¹⁸	exa	E
10 ²¹	zetta	Z
10 ²⁴	yotta	Y

SI prefixes							
Prefix	Symbol	1000 ^m	10 ⁿ	Decimal	Short scale	Long scale	Since
yotta	Y	1000 ⁸	10²⁴	1000000000000000000000000	Septillion	Quadrillion	1991
zetta	Z	1000 ⁷	10²¹	100000000000000000000000	Sextillion	Trilliard	1991
exa	E	1000 ⁶	10¹⁸	10000000000000000000000	Quintillion	Trillion	1975
peta	P	1000 ⁵	10¹⁵	1000000000000000000000	Quadrillion	Billiard	1975
tera	T	1000 ⁴	10¹²	100000000000000000000	Trillion	Billion	1960
giga	G	1000 ³	10⁹	10000000000000000000	Billion	Milliard	1960
mega	M	1000 ²	10⁶	1000000		Million	1960
kilo	k	1000 ¹	10³	1000		Thousand	1795
hecto	h	1000 ^{2/3}	10²	100		Hundred	1795
deca	da	1000 ^{1/3}	10¹	10		Ten	1795
		1000 ⁰	10⁰	1		One	–
deci	d	1000 ^{-1/3}	10⁻¹	0.1		Tenth	1795
centi	c	1000 ^{-2/3}	10⁻²	0.01		Hundredth	1795
milli	m	1000 ⁻¹	10⁻³	0.001		Thousandth	1795
micro	μ	1000 ⁻²	10⁻⁶	0.000001		Millionth	1960
nano	n	1000 ⁻³	10⁻⁹	0.000000001	Billionth	Milliardth	1960
pico	p	1000 ⁻⁴	10⁻¹²	0.000000000001	Trillionth	Billionth	1960
femto	f	1000 ⁻⁵	10⁻¹⁵	0.000000000000001	Quadrillionth	Billiardth	1964
atto	a	1000 ⁻⁶	10⁻¹⁸	0.000000000000000001	Quintillionth	Trillionth	1964
zepto	z	1000 ⁻⁷	10⁻²¹	0.00000000000000000001	Sextillionth	Trilliardth	1991
yocto	y	1000 ⁻⁸	10⁻²⁴	0.0000000000000000000001	Septillionth	Quadrillionth	1991