CHEMICAL PROCESS CALCULATIONS

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Introduction

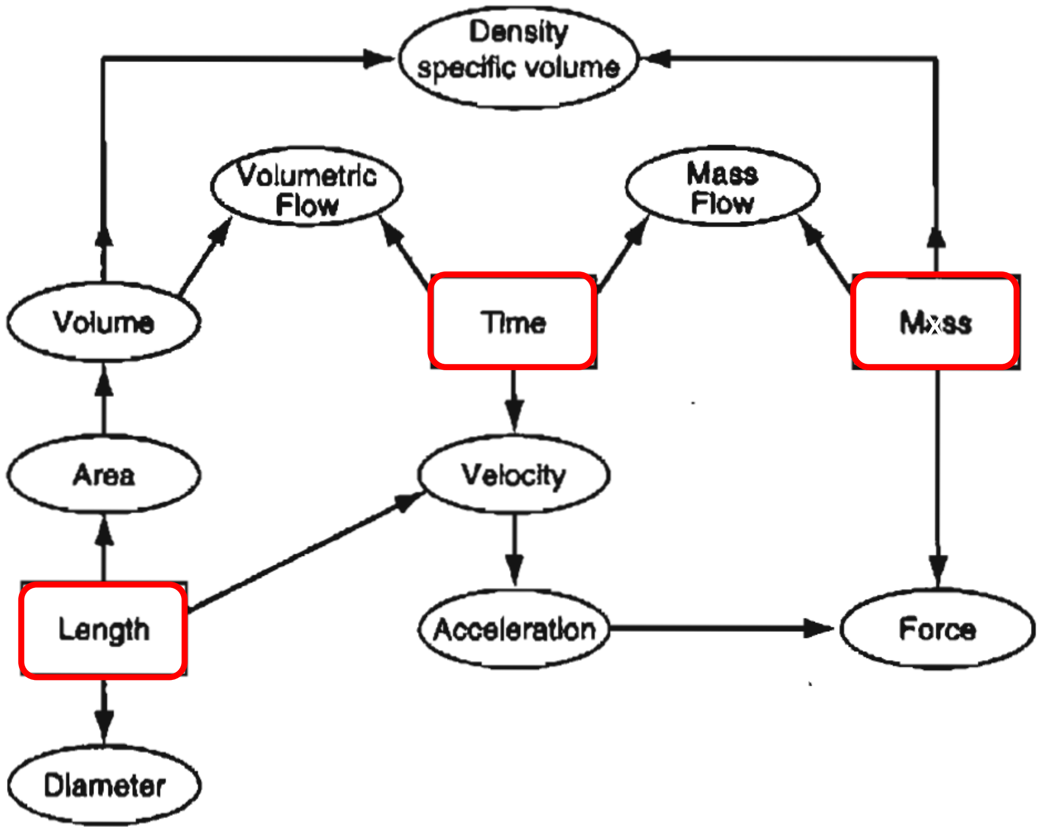
- systems involve **processes** designed to transform raw materials into desired products

- Dimensions, Units, and their conversion
- Processes and Process Variables
- **Material Balances**
- Energy Balances (Prof. Rabibrata Mukherjee)

Units and Dimensions

- **Dimension** is a property that can be measured, such as
  - length, time, mass, or temperature, or calculated by multiplying or dividing other dimensions.
- **Units** are means of expressing the dimensions, such as
  - **cm** for length, **s** for time, **g** for mass, °C for temperature
  - Base units
  - Multiple units
  - Derived units

Units and Dimensions



Base Units

Quantity	Unit	Symbol
Length	meter (SI)	m
	centimeter (CGS)	cm
Mass	kilogram (SI)	kg
	gram (CGS)	g
Moles	gram-mole	mol or g-mole
Time	second	s
Temperature	kelvin	K
Electric current	ampere	A
Light intensity	candela	cd

Multiple Unit Preferences

tera (T) $= 10^{12}$	centi (c) $= 10^{-2}$
giga (G) $= 10^{9}$	milli (m) $= 10^{-3}$
mega (M) $= 10^{6}$	micro (μ) $= 10^{-6}$
kilo (k) $= 10^{3}$	nano (n) $= 10^{-9}$

Derived Units

Quantity	Unit	Symbol	Equivalent in Terms of Base Units
Volume	liter	L	$0.001\ m^3$
			$1000\ cm^3$
Force	newton (SI)	N	$1\ kg \cdot m/s^2$
	dyne (CGS)		$1\ g \cdot cm/s^2$
Pressure	pascal (SI)	Pa	$1\ N/m^2$
Energy, work	joule (SI)	J	$1\ N \cdot m = 1\ kg \cdot m^2/s^2$
	erg (CGS)		$1\ dyne \cdot cm = 1\ g \cdot cm^2/s^2$
	gram-calorie	cal	$4.184\ J = 4.184\ kg \cdot m^2/s^2$
Power	watt	W	$1\ J/s = 1\ kg \cdot m^2/s^3$

Significant Figures and Precision

- The **significant figures** of a number are the digits from the first nonzero digit on the left to either

(a) the last digit (zero or nonzero) on the right if there is a decimal point OR

(b) the last nonzero digit of the number if there is no decimal point

2300 or 2.3×10^3 has two significant figures.
2300. or 2.300×10^3 has four significant figures.
2300.0 or 2.3000×10^3 has five significant figures.
23,040 or 2.304×10^4 has four significant figures.
0.035 or 3.5×10^{-2} has two significant figures.
0.03500 or 3.500×10^{-2} has four significant figures.

Significant Figures and Precision

- When two or more quantities are combined by multiplication and/or division, the number of significant figures in the result should equal the lowest number of significant figures of any of the multiplicands or divisors.

$$\underset{(3)}{(3.57)}\underset{(4)}{(4.286)} = \underset{(7)}{15.30102} \Longrightarrow \underset{(3)}{15.3}$$

$$\underset{(2)}{(5.2 \times 10^{-4})}\underset{(4)}{(0.1635 \times 10^{7})}/\underset{(3)}{(2.67)} = \underset{(9)}{318.426966} \Longrightarrow \underset{(2)}{3.2 \times 10^{2}} = \underset{(2)}{320}$$

Texts

- **BASIC PRINCIPLES AND CALCULATIONS IN CHEMICAL ENGINEERING**
  - David M. Himmelblau and James B. Riggs
  - Prentice Hall

- **ELEMENTARY PRINCIPLES OF CHEMICAL PROCESSES**
  - Richard M. Felder and Ronald W. Rousseau
  - John Wiley & Sons, Inc.

Marks

- Mid-Sem.: 30
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