

Chapter 1. Definitions and Principles

Industrial chemical process – very complex

→ can be broken down into a series of steps



unit operation

(based on the same scientific principles)

Ex) 1. **Manufacturing of salt** (no chemical reaction appears)

transportation of solids and liquids

transfer of heat, evaporation, crystallization

drying, screening

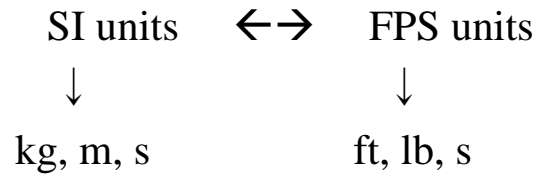
2. **Cracking of petroleum** (chemical reaction involves)

transportation of fluids and solids

distillation, mechanical separations

cracking reaction

Unit Systems



Standards

- (kg) Platinum cylinder (France 표준국)
- (s) ^{133}Cs 의 진동수 9,192,631,770 회
- (K) T_3 of pure water (물의 삼중점) 273.16 K
- (m) length of light path during 1/299,792,458 s
- (mol) ^{12}C 의 12 g에 해당하는 atom 수

*** SI Units**

$$\begin{array}{cccc}
 \text{N}, & \text{J}, & \text{K}, & \text{Pa} \\
 \downarrow & \downarrow & & \downarrow \\
 \text{kg} \cdot \text{m}/\text{s}^2 & \text{N} \cdot \text{m} & & \text{N}/\text{m}^2
 \end{array}$$

$$T(^{\circ}\text{C}) = T(\text{K}) - 273.15$$

$$g(\text{중력가속도}) = 9.8 \text{ m/s}^2$$

$$1 \text{ bar} = 1 \times 10^5 \text{ Pa} = 10^5 \text{ N/m}^2$$

$$1 \text{ atm} = 1.013 \text{ bar}$$

*** CGS Units**

g, cm, s

$$1 \text{ dyn} = 1 \text{ g} \cdot \text{cm}/\text{s}^2$$

$$1 \text{ erg} = 1 \text{ dyn} \cdot \text{cm} = 1 \times 10^{-7} \text{ J}$$

$$1 \text{ cal} = 4.184 \text{ J} \text{ (물 } 1 \text{ g을 } 1^{\circ}\text{C 올리는데 필요한 열량)}$$

$$\begin{aligned}
 R(\text{기체상수}) &= 8.314 \text{ J/mol} \cdot \text{K} && (\text{정의: } \lim_{p \rightarrow 0} \frac{pV}{nT} = R) \\
 &= 1.987 \text{ cal/mol} \cdot \text{K} \\
 &= 0.082 \text{ l} \cdot \text{atm/mol} \cdot \text{K}
 \end{aligned}$$

* FPS Units

$$1 \text{ lb} = 0.4536 \text{ kg}$$

$$1 \text{ ft} = 0.3048 \text{ m}$$

$$1 \text{ }^\circ\text{R} = 1/1.8 \text{ K}$$

$$T(^\circ\text{F}) = 32 + 1.8T(^\circ\text{C}) \quad T(^\circ\text{R}) = 459.67 + T(^\circ\text{F})$$

$$\text{물의 어는 점: } 0 \text{ }^\circ\text{C} = 273.15 \text{ K} = 491.67 \text{ }^\circ\text{R} = 32 \text{ }^\circ\text{F}$$

$$1 \text{ lb}_f (\text{pound force}) = 32.174 \text{ lb}\cdot\text{ft}/\text{s}^2$$

$$\leftarrow 1 \text{ lb}_f = 1 \text{ lb}_m \times \frac{9.80665 \text{ m}/\text{s}^2}{0.3048 \text{ m}/\text{ft}}$$

$$\text{cf.) } 1 \text{ kg}_f = 1 \text{ kg} \cdot (9.8 \text{ m}/\text{s}^2) = 9.8 \text{ N}$$

$$1 \text{ hp} (\text{horse power}) = 550 \text{ ft}\cdot\text{lb}_f/\text{s}$$

$$1 \text{ BTU} (\text{British thermal unit}) = 778.17 \text{ ft}\cdot\text{lb}_f \\ = 252 \text{ cal}$$

(물 1 lb를 1 °F 올리는데 필요한 열량)

$$\rightarrow 1 \text{ BTU}/\text{lb}\cdot^\circ\text{F} \equiv 1 \text{ cal}/\text{g}\cdot^\circ\text{C}$$

* Conversion factor

→ Appendix 1 (p. 1085 – 1087) 참고

Related Problems

(Example 1.1) Calculating factors for converting

(a) $N \rightarrow \text{lb}_f$

(b) $\text{BTU} \rightarrow \text{cal}$

(c) $\text{atm} \rightarrow \text{lb}_f/\text{in}^2 \text{ (psi)}$

(d) $\text{hp} \rightarrow \text{kW}$

(Probs.) 1.1, 1.2, 1.10, 1.11 and 1.16