CH365 Chemical Engineering Thermodynamics

Lesson 2
Fundamentals 2

Professor Andrew Biaglow

Work

When a force acts over a distance, work is force times displacement:

force is F and displacement is dl

Eq. 1.2 $$dW = F\,dl$$

positive (+) if F and dl are in the same direction
negative (-) if F and dl are in the opposite direction

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Take Notes!

Energy and Work Overview

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Take Notes!

Heat

"Flows" from region of higher T to region of lower T

Take Notes Here!

Temperature difference is the "driving force" for the flow of energy as heat

Take Notes Here!

The driving force analogy comes from physics:

- voltage difference drives current flow in an electrical circuit
- gravitational potential drives free fall of an object
- pressure difference drives fluid flow in a horizontal pipe
- concentration difference drives molecular diffusion

Heat is transferred between the system and its surroundings.

Take Notes Here!

1 calorie raises the temperature of 1 gram of water 1 deg C

1 Btu raises the temperature of 1 lb_m of water 1 deg F

Take Notes Here!

Energy - Derivations

Use Newton's 2nd Law - Get down into the weeds

Kinetic Energy

$$F = ma$$

$$dW = F\,dl$$

$$dW = m\,a\,dl$$

$$a \equiv \frac{du}{dt}$$

u = velocity

$$dW = m\frac{du}{dt}dl = m\frac{dl}{dt}du$$

$$u \equiv \frac{dl}{dt}$$

$$dW = m\,u\,du$$

$$W = m\int_{u_1}^{u_2} u\,du$$

Lord Kelvin, 1856

$$W = m\left(\frac{u_2^2}{2} - \frac{u_1^2}{2}\right) = \Delta\left(\frac{mu^2}{2}\right)$$ Eq. 1.4

$$E_K \equiv \frac{1}{2}mu^2$$ Eq. 1.5

Potential Energy

$$F = ma = mg$$

$$W = F\left(z_2 - z_1\right) = mg\left(z_2 - z_1\right) = \Delta\left(mzg\right)$$ Eq. 1.6

$$E_P \equiv mgz$$ Eq. 1.7

Questions?