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Energy Conversion Equations

by

Engineering Software

Energy Conversion Equations

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Engineering Formulas

Here are some of the basic engineering formulas/equations related to energy conversion systems:

Continuity Equation

$$m = \rho v A$$

Momentum Equation

$$F = (vm + pA)_{out - in}$$

Energy Equation

$$Q - W = ((h + v^2/2 + gh)m)_{out - in}$$

State Equation for Ideal Gas

$$pv = RT/MW$$

Perfect Gas

$$c_p = constant$$

$$\varkappa = C_p/C_v$$

Energy Conversion Equations

Isentropic Compression

$$T_2/T_1 = (p_2/p_1)^{(\varkappa-1)/\varkappa}$$

$$T_2/T_1 = (V_1/V_2)^{(\varkappa-1)}$$

$$p_2/p_1 = (V_1/V_2)^{\varkappa}$$

Combustion -- Flame Temperature

$$h_{reactants} = h_{products}$$

Isentropic Expansion

$$T_1/T_2 = (p_1/p_2)^{(\varkappa-1)/\varkappa}$$

$$T_1/T_2 = (V_2/V_1)^{(\varkappa-1)}$$

$$p_1/p_2 = (V_2/V_1)^{\varkappa}$$

Sonic Velocity

$$v_S = (\varkappa RT/MW)^{1/2}$$

Mach Number

$$\mathbf{M} = v/v_S$$

Energy Conversion Equations

Isentropic Flow

$$T_t/T = (1 + M^2(\varkappa - 1)/2)$$

$$p_t/p = (1 + M^2(\varkappa - 1)/2)^{\varkappa/(\varkappa-1)}$$

$$h_t = (h + v^2/2)$$

$$T_t = (T + v^2/(2C_p))$$

Thrust

Thrust = $vm + (p - p_a)A$

Cycle Efficiency

Cycle Efficiency = Net Work/Heat

Carnot Cycle Efficiency

Carnot Cycle Efficiency = $1 - T_{\text{heat rejection}}/T_{\text{heat addition}}$

Brayton Cycle Efficiency

Brayton Cycle Efficiency = $1 - 1/(p_2/p_1)^{(\varkappa-1)/\varkappa}$

Otto Cycle Efficiency

Compression Ratio = V_1/V_2

Otto Cycle Efficiency = 1 **-** 1/**Compression Ratio**$^{(\varkappa-1)}$

Diesel Cycle Efficiency

Compression Ratio (CR) = V_1/V_2

Cut-Off Ratio (COR) = V_3/V_2

Diesel Cycle Efficiency = 1 **- (COR$^{\varkappa}$ - 1)/(ϰ*CR$^{(\varkappa-1)}$*(COR - 1))**

Energy Conversion Equations

Fuel Cell

Fuel Cell Efficiency = - (G_{out} - G_{in})/HHV

Heat Rate

Heat Rate = (1/Cycle Efficiency)*3,412