STUDENT SUCCESS CENTER
THE UNIVERSITY OF ALABAMA IN HUNTSVILLE

# Thermodynamics Review

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| Energy Balance – Closed Systems | $E_2 - E_1 = Q - W$ |
| Energy Rate Balance – Closed | $\frac{dE}{dt} = \dot{Q} - \dot{W}$ |
| Energy Rate Balance – Steady State | $0 = \dot{Q}_{CV} - \dot{W}_{CV} + \sum_i \dot{m}_i\left(h_i + \frac{V_i^2}{2} + gz_i\right) - \sum_e \dot{m}_e\left(h_e + \frac{V_e^2}{2} + gz_e\right.$ |
| Energy Balance – Power Cycle | $W_{cycle} = Q_{in} - Q_{out}$ |
| Thermal Efficiency – Power Cycle | $\eta = \frac{W_{cycle}}{Q_{in}}$ |
| Energy Balance – Refrigeration/Heat Pump Cycle | $W_{cycle} = Q_{out} - Q_{in}$ |
| Coefficient of Performance – Refrigeration | $\beta = \frac{Q_{in}}{W_{cycle}}$ |
| Coefficient of Performance – Heat Pump | $\gamma = \frac{Q_{out}}{W_{cycle}}$ |
| Closed System Entropy Balance | $S_2 - S_1 = \int_1^2 \left(\frac{\delta Q}{T}\right)_b + \sigma$ |
| Steady State Control Volume Entropy Rate Balance | $0 = \sum_j \frac{\dot{Q}_j}{T_j} + \sum_i \dot{m}_i s_i - \sum_e \dot{m}_e s_e + \dot{\sigma}_{CV}$ |
| Ideal Gas Relations – Constant Specific Heat ratio, k, s1=s2 | $\frac{T_2}{T_1} = \left(\frac{p_2}{p_1}\right)^{\frac{k-1}{k}}$ $\frac{T_2}{T_1} = \left(\frac{v_1}{v_2}\right)^{k-1}$ $\frac{p_2}{p_1} = \left(\frac{v_1}{v_2}\right)^{k}$ |
| Ideal Gas Relation for Entropy – Constant Specific Heat | $s(T_2, p_2) - s(T_1, p_1) = c_p \ln ln\left(\frac{T_2}{T_1}\right) - Rln\left(\frac{p_2}{p_1}\right)$ |
| Isentropic Efficiency Compressor & Pump | $\eta_c = \frac{\left(-\frac{\dot{W}_{CV}}{\dot{m}}\right)_s}{-\frac{\dot{W}_{CV}}{\dot{m}}} = \frac{h_{2s} - h_1}{h_2 - h_1}$ |
| Isentropic Efficiency Turbine | $\eta_t = \frac{-\frac{\dot{W}_{CV}}{\dot{m}}}{\left(-\frac{\dot{W}_{CV}}{\dot{m}}\right)_s} = \frac{h_1 - h_2}{h_1 - h_{2s}}$ |
| Saturation Table – Property Relationship (use for v, u, h, & s) | $u_1 = u_f + x_1(u_g - u_f)$ |
| Tds Relations | $Tds = du - pdv$ $Tds = dh - vdp$ |

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