

Important Efficiency Metrics Formulas PDF



Formulas Examples with Units

List of 12 Important Efficiency Metrics Formulas

1) Change in Kinetic Energy of Jet Engine Formula

Formula

$$\Delta KE = \frac{\left((m_a + m_f) \cdot V_e^2 \right) - (m_a \cdot V^2)}{2}$$

Evaluate Formula 

Example with Units

$$87.0389 \text{ kJ} = \frac{\left((3.5 \text{ kg/s} + 0.0315 \text{ kg/s}) \cdot 248 \text{ m/s}^2 \right) - (3.5 \text{ kg/s} \cdot 111 \text{ m/s}^2)}{2}$$

2) Effective speed ratio Formula

Formula

$$\alpha = \frac{V}{V_e}$$

Example with Units

$$0.4476 = \frac{111 \text{ m/s}}{248 \text{ m/s}}$$

Evaluate Formula 

3) Isentropic Efficiency of Expansion Machine Formula

Formula

$$\eta_T = \frac{W_{\text{actual}}}{W_{s,\text{out}}}$$

Example with Units

$$0.8595 = \frac{104 \text{ kJ}}{121 \text{ kJ}}$$

Evaluate Formula 

4) Net work output in simple gas turbine cycle Formula

Formula

$$W_{\text{Net}} = C_p \cdot \left((T_3 - T_4) - (T_2 - T_1) \right)$$

Evaluate Formula 

Example with Units

$$57.408 \text{ kJ} = 1.248 \text{ kJ/kg} \cdot \text{K} \cdot \left((555 \text{ K} - 439 \text{ K}) - (370 \text{ K} - 300 \text{ K}) \right)$$

5) Overall Efficiency given Specific Fuel Consumption Formula

Formula

$$\eta_o = \frac{V}{\text{TSFC} \cdot Q}$$

Example with Units

$$0.6123 = \frac{111 \text{ m/s}}{0.015 \text{ kg/h/N} \cdot 43510 \text{ kJ/kg}}$$

Evaluate Formula 



6) Overall Efficiency of Propulsive System Formula

Formula

$$\eta_{0,prop} = \eta_{th} \cdot \eta_{transmission} \cdot \eta_{propulsive}$$

Example

$$0.0385 = 0.064 \cdot 0.97 \cdot 0.62$$

Evaluate Formula 

7) Propulsive efficiency Formula

Formula

$$\eta_{propulsive} = \frac{T_p}{P}$$

Example with Units

$$0.6206 = \frac{54_{kW}}{87.01_{kW}}$$

Evaluate Formula 

8) Propulsive efficiency given aircraft velocity Formula

Formula

$$\eta_{propulsive} = \frac{2 \cdot V}{V_e + V}$$

Example with Units

$$0.6184 = \frac{2 \cdot 111_{m/s}}{248_{m/s} + 111_{m/s}}$$

Evaluate Formula 

9) Propulsive Efficiency given Effective Speed Ratio Formula

Formula

$$\eta_{propulsive} = \frac{2 \cdot \alpha}{1 + \alpha}$$

Example

$$0.6183 = \frac{2 \cdot 0.4475}{1 + 0.4475}$$

Evaluate Formula 

10) Propulsive power Formula

Formula

$$P = \frac{1}{2} \cdot \left((m_a + m_f) \cdot V_e^2 - (m_a \cdot V^2) \right)$$

Example with Units

$$87.0389_{kW} = \frac{1}{2} \cdot \left((3.5_{kg/s} + 0.0315_{kg/s}) \cdot 248_{m/s}^2 - (3.5_{kg/s} \cdot 111_{m/s}^2) \right)$$

Evaluate Formula 

11) Thermal Efficiency of Jet Engines given Effective Speed Ratio Formula

Formula

$$\eta_{th} = \frac{V_e^2 \cdot (1 - \alpha^2)}{2 \cdot f \cdot Q}$$

Example with Units

$$0.0628 = \frac{248_{m/s}^2 \cdot (1 - 0.4475^2)}{2 \cdot 0.009 \cdot 43510_{kJ/kg}}$$

Evaluate Formula 

12) Transmission Efficiency given Output and Input of Transmission Formula

Formula

$$\eta_{transmission} = \frac{P_{out}}{P_{in}}$$

Example with Units

$$0.9636 = \frac{106_{kW}}{110_{kW}}$$

Evaluate Formula 



Variables used in list of Efficiency Metrics Formulas above

- **C_p** Specific Heat Capacity at Constant Pressure (Kilojoule per Kilogram per K)
- **f** Fuel Air Ratio
- **m_a** Mass Flow Rate (Kilogram per Second)
- **m_f** Fuel Flow Rate (Kilogram per Second)
- **P** Propulsive Power (Kilowatt)
- **P_{in}** Transmission Input Power (Kilowatt)
- **P_{out}** Transmission Output Power (Kilowatt)
- **Q** Fuel Calorific Value (Kilojoule per Kilogram)
- **T_1** Temperature at Inlet of Compressor (Kelvin)
- **T_2** Temperature at Exit of Compressor (Kelvin)
- **T_3** Temperature at Inlet of Turbine (Kelvin)
- **T_4** Temperature at Exit of Turbine (Kelvin)
- **T_p** Thrust Power (Kilowatt)
- **TSFC** Thrust-Specific Fuel Consumption (Kilogram per Hour per Newton)
- **V** Flight Speed (Meter per Second)
- **V_e** Exit Velocity (Meter per Second)
- **W_{actual}** Actual Work (Kilojoule)
- **W_{Net}** Net Work Output (Kilojoule)
- **$W_{s,out}$** Isentropic Work Output (Kilojoule)
- **α** Effective Speed Ratio
- **ΔKE** Change in Kinetic Energy (Kilojoule)
- **η_o** Overall Efficiency
- **$\eta_{O,prop}$** Propulsive System Overall Efficiency
- **$\eta_{propulsive}$** Propulsive Efficiency
- **η_T** Turbine Efficiency
- **η_{th}** Thermal Efficiency
- **$\eta_{transmission}$** Efficiency of Transmission

Constants, Functions, Measurements used in list of Efficiency Metrics Formulas above

- **Measurement: Temperature** in Kelvin (K)
Temperature Unit Conversion 
- **Measurement: Speed** in Meter per Second (m/s)
Speed Unit Conversion 
- **Measurement: Energy** in Kilojoule (KJ)
Energy Unit Conversion 
- **Measurement: Power** in Kilowatt (kW)
Power Unit Conversion 
- **Measurement: Specific Heat Capacity** in Kilojoule per Kilogram per K (kJ/kg*K)
Specific Heat Capacity Unit Conversion 
- **Measurement: Mass Flow Rate** in Kilogram per Second (kg/s)
Mass Flow Rate Unit Conversion 
- **Measurement: Specific Energy** in Kilojoule per Kilogram (kJ/kg)
Specific Energy Unit Conversion 
- **Measurement: Thrust Specific Fuel Consumption** in Kilogram per Hour per Newton (kg/h/N)
Thrust Specific Fuel Consumption Unit Conversion 



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