Important Refrigeration and Air Conditioning Formulas PDF

Formulas
Examples
with Units

List of 12
Important Refrigeration and Air Conditioning Formulas

1) Air Refrigeration Cycles Formulas

1.1) Compression or Expansion Ratio Formula

Evaluate Formula

Formula

$$r_p = \frac{P_2}{P_1}$$

Example with Units

$$25 = \frac{10E6\,\text{Pa}}{4E5\,\text{Pa}}$$

1.2) COP of Bell-Coleman Cycle for given Compression Ratio and Adiabatic Index Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{1}{r_p^{\frac{\gamma - 1}{\gamma}} - 1}$$

Example

$$0.6629 = \frac{1}{25^{\frac{1.4 - 1}{1.4}} - 1}$$

1.3) COP of Bell-Coleman Cycle for given Temperatures, Polytropic Index and Adiabatic Index Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{T_1 - T_4}{\left(\frac{n}{n - 1}\right) \cdot \left(\frac{\gamma - 1}{\gamma}\right) \cdot \left(\left(T_2 - T_3\right) - \left(T_1 - T_4\right)\right)}$$

Example with Units

$$0.6017 = \frac{300\,\text{K} - 290\,\text{K}}{\left(\frac{1.52}{1.52 - 1}\right) \cdot \left(\frac{1.4 - 1}{1.4}\right) \cdot \left(\left(356.5\,\text{K} - 326.6\,\text{K}\right) - \left(300\,\text{K} - 290\,\text{K}\right)\right)}$$

1.4) Energy Performance Ratio of Heat Pump Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{Q_{delivered}}{W_{per\ min}}$$

Example with Units

$$0.6 = \frac{5571.72\,\text{kJ/min}}{9286.2\,\text{kJ/min}}$$

1.5) Heat Absorbed during Constant Pressure Expansion Process Formula

Evaluate Formula

Formula

$$Q_{Absorbed} = C_p \cdot \left(T_1 - T_4 \right)$$

Example with Units

$$10.05\,\text{kJ/kg} = 1.005\,\text{kJ/kg*K} \cdot \left(300\,\text{K} - 290\,\text{K} \right)$$

1.6) Heat Rejected during Constant pressure Cooling Process Formula

Evaluate Formula

Formula

$$Q_R = C_p \cdot \left(T_2 - T_3 \right)$$

Example with Units

$$30.0495\,\text{kJ/kg} = 1.005\,\text{kJ/kg*K} \cdot \left(356.5\,\text{K} - 326.6\,\text{K} \right)$$

1.7) Relative Coefficient of Performance Formula

Evaluate Formula

Formula

$$COP_{relative} = \frac{COP_{actual}}{COP_{theoretical}}$$

Example

$$0.3333 = \frac{0.2}{0.6}$$

1.8) Theoretical Coefficient of Performance of Refrigerator Formula

Evaluate Formula

Formula

$$COP_{theoretical} = \frac{Q_{ref}}{w}$$

Example with Units

$$0.6 = \frac{600\,\text{kJ/kg}}{1000\,\text{kJ/kg}}$$

2) Air Refrigeration Systems Formulas

2.1) Initial Mass of Evaporant Required to be Carried for given Flight Time Formula

Evaluate Formula

Formula

$$M_{ini} = \frac{Q_r \cdot t}{h_{fg}}$$

Example with Units

$$53.5398\,\text{kg} = \frac{550\,\text{kJ/min} \cdot 220\,\text{min}}{2260\,\text{kJ/kg}}$$

2.2) Local Sonic or Acoustic Velocity at Ambient Air Conditions Formula

Evaluate Formula

Formula

$$a = \left(\gamma \cdot [R] \cdot \frac{T_i}{MW} \right)^{0.5}$$

Example with Units

$$340.0649\,\text{m/s} = \left(1.4 \cdot 8.3145 \cdot \frac{305\,\text{K}}{0.0307\,\text{kg}} \right)^{0.5}$$

2.3) Ram Efficiency Formula

Evaluate Formula

Formula

$$\eta = \frac{p_2' - P_i}{P_f - P_i}$$

Example with Units

$$0.8667 = \frac{150000\,\text{Pa} - 85000\,\text{Pa}}{160000\,\text{Pa} - 85000\,\text{Pa}}$$

2.4) Temperature Ratio at Start and End of Ramming Process Formula

Evaluate Formula

Formula

$$T_{ratio} = 1 + \frac{v_{process}^{2} \cdot (\gamma - 1)}{2 \cdot \gamma \cdot [R] \cdot T_i}$$

Example with Units

$$1.2028 = 1 + \frac{60\,\text{m/s}^{2} \cdot (1.4 - 1)}{2 \cdot 1.4 \cdot 8.3145 \cdot 305\,\text{K}}$$

Variables used in list of Refrigeration and Air Conditioning Formulas above

- **a** Sonic Velocity *(Meter per Second)*
- **C_p** Specific Heat Capacity at Constant Pressure *(Kilojoule per Kilogram per K)*
- **COP_{actual}** Actual Coefficient of Performance
- **$COP_{relative}$** Relative Coefficient of Performance
- **$COP_{theoretical}$** Theoretical Coefficient of Performance
- **h_{fg}** Latent Heat of Vaporization *(Kilojoule per Kilogram)*
- **M_{ini}** Initial Mass *(Kilogram)*
- **MW** Molecular Weight *(Kilogram)*
- **n** Polytropic Index
- **P_1** Pressure at Start of Isentropic Compression *(Pascal)*
- **p_2'** Stagnation Pressure of System *(Pascal)*
- **P_2** Pressure at End of Isentropic Compression *(Pascal)*
- **P_f** Final Pressure of System *(Pascal)*
- **P_i** Initial Pressure of System *(Pascal)*
- **$Q_{Absorbed}$** Heat Absorbed *(Kilojoule per Kilogram)*
- **$Q_{delivered}$** Heat Delivered to Hot Body *(Kilojoule per Minute)*
- **Q_r** Rate of Heat Removal *(Kilojoule per Minute)*
- **Q_R** Heat Rejected *(Kilojoule per Kilogram)*
- **Q_{ref}** Heat Extracted from Refrigerator *(Kilojoule per Kilogram)*
- **r_p** Compression or Expansion Ratio
- **t** Time in Minutes *(Minute)*
- **T_1** Temperature at Start of Isentropic Compression *(Kelvin)*
- **T_2** Ideal Temp at End of Isentropic Compression *(Kelvin)*

Constants, Functions, Measurements used in list of Refrigeration and Air Conditioning Formulas above

- constant(s): **[R]**, 8.31446261815324
  Universal gas constant
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Time** in Minute (min)
  Time Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Pressure** in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Power** in Kilojoule per Minute (kJ/min)
  Power Unit Conversion
- Measurement: **Specific Heat Capacity** in Kilojoule per Kilogram per K (kJ/kg*K)
  Specific Heat Capacity Unit Conversion
- Measurement: **Latent Heat** in Kilojoule per Kilogram (kJ/kg)
  Latent Heat Unit Conversion
- Measurement: **Rate of Heat Transfer** in Kilojoule per Minute (kJ/min)
  Rate of Heat Transfer Unit Conversion
- Measurement: **Specific Energy** in Kilojoule per Kilogram (kJ/kg)
  Specific Energy Unit Conversion

- T_3 Ideal Temp at End of Isobaric Cooling *(Kelvin)*
- T_4 Temperature at End of Isentropic Expansion *(Kelvin)*
- T_i Initial Temperature *(Kelvin)*
- T_{ratio} Temperature Ratio
- $v_{process}$ Velocity *(Meter per Second)*
- **w** Work Done *(Kilojoule per Kilogram)*
- $W_{per\ min}$ Work Done per min *(Kilojoule per Minute)*
- **γ** Heat Capacity Ratio
- **η** Ram Efficiency

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