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Refrigeration and Air Conditioning Formulas

Calculators! Examples! Conversions!

List of 25 Refrigeration and Air Conditioning Formulas

Refrigeration and Air Conditioning

Air Refrigeration Cycles

1) Energy Performance Ratio of Heat Pump

Open Calculator

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

ex $$4.807692 = \frac{1250\text{kJ/min}}{260\text{kJ/min}}$$

2) Relative Coefficient of Performance

Open Calculator

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

ex $$0.833333 = \frac{5}{6}$$

3) Theoretical Coefficient of Performance of Refrigerator

Open Calculator

fx $$COP_{theoretical} = \frac{Q}{w}$$

ex $$1.5 = \frac{600kJ/kg}{400kJ/kg}$$

Bell-Coleman Cycle or Reversed Brayton or Joule Cycle

4) Compression or Expansion Ratio

Open Calculator

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

ex $$2.5 = \frac{10Bar}{4Bar}$$

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

Open Calculator

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

ex $$4.565925 = \frac{1}{(2)^{\frac{1.4-1}{1.4}} - 1}$$

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

fx Open Calculator

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

ex
$$0.538462 = \frac{300K - 290K}{\left(\frac{1.30}{1.30-1}\right) \cdot \left(\frac{1.4-1}{1.4}\right) \cdot ((350K - 325K) - (300K - 290K))}$$

7) Heat Absorbed during Constant Pressure Expansion Process

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

Open Calculator

ex
$$10.05kJ/kg = 1.005kJ/kg{*}K \cdot (300K - 290K)$$

8) Heat Rejected during Constant pressure Cooling Process

fx
$$Q_R = C_p \cdot (T_2 - T_3)$$

Open Calculator

ex
$$25.125kJ/kg = 1.005kJ/kg{*}K \cdot (350K - 325K)$$

Air Refrigeration Systems

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

Open Calculator

$$M = \frac{Q_r \cdot t}{h_{fg}}$$

$$0.442478\text{kg} = \frac{50\text{kJ/min} \cdot 20\text{min}}{2260\text{kJ/kg}}$$

10) Local Sonic or Acoustic Velocity at Ambient Air Conditions

Open Calculator

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

$$172.0047\text{m/s} = \left(1.4 \cdot [R] \cdot \frac{305\text{K}}{0.120\text{kg}}\right)^{0.5}$$

11) Ram Efficiency

Open Calculator

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

$$0.866667 = \frac{150000\text{Pa} - 85000\text{Pa}}{160000\text{Pa} - 85000\text{Pa}}$$

Simple Air Cooling System

12) Specific Heat Capacity at Constant Pressure using Adiabatic Index

Open Calculator

$$C_p = \frac{\gamma \cdot [R]}{\gamma - 1}$$

$$0.029101 \text{kJ/kg*K} = \frac{1.4 \cdot [R]}{1.4 - 1}$$

13) Temperature Ratio at Start and End of Ramming Process

Open Calculator

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

$$1.202801 = 1 + \frac{(60 \text{m/s})^2 \cdot (1.4 - 1)}{2 \cdot 1.4 \cdot [R] \cdot 305 \text{K}}$$

Basics of Refrigeration and Air Conditioning

14) Entropy Change for Isochoric Process given Pressures

Open Calculator

$$\Delta S_{CV} = m_{gas} \cdot C_{v\ molar} \cdot \ln\left(\frac{P_f}{P_i}\right)$$

$$130.2996 \text{J/kg*K} = 2 \text{kg} \cdot 103 \text{J/K*mol} \cdot \ln\left(\frac{160000 \text{Pa}}{85000 \text{Pa}}\right)$$

15) Entropy Change for Isochoric Process given Temperature

Open Calculator

fx $$\Delta S_{CV} = m_{gas} \cdot C_{v\ molar} \cdot \ln\left(\frac{T_f}{T_i}\right)$$

ex $$25.38592 \text{J/kg*K} = 2\text{kg} \cdot 103 \text{J/K*mol} \cdot \ln\left(\frac{345\text{K}}{305\text{K}}\right)$$

16) Entropy Change for Isothermal Process given Volumes

Open Calculator

fx $$\Delta S = m_{gas} \cdot [R] \cdot \ln\left(\frac{V_f}{V_i}\right)$$

ex $$2.77793 \text{J/kg*K} = 2\text{kg} \cdot [R] \cdot \ln\left(\frac{13\text{m}^3}{11\text{m}^3}\right)$$

17) Entropy Change in Isobaric Process given Temperature

Open Calculator

fx $$\Delta S_{CP} = m_{gas} \cdot C_{p\ molar} \cdot \ln\left(\frac{T_f}{T_i}\right)$$

ex $$30.06876 \text{J/kg*K} = 2\text{kg} \cdot 122 \text{J/K*mol} \cdot \ln\left(\frac{345\text{K}}{305\text{K}}\right)$$

18) Entropy Change in Isobaric Processin Terms of Volume

Open Calculator

fx $$\Delta S_{CP} = m_{gas} \cdot C_{p\ molar} \cdot \ln\left(\frac{V_f}{V_i}\right)$$

ex $$40.7612 \text{J/kg*K} = 2\text{kg} \cdot 122 \text{J/K*mol} \cdot \ln\left(\frac{13\text{m}^3}{11\text{m}^3}\right)$$

19) Equipment Total Cooling Load

Open Calculator

fx $$Q_T = Q_{\text{per hour}} \cdot L_F$$

ex $$10\text{Btu/h} = 8\text{Btu/h} \cdot 1.25$$

20) Heat Transfer at Constant Pressure

Open Calculator

fx $$Q_{\text{per unit}} = m_{\text{gas}} \cdot C_{\text{p molar}} \cdot (T_f - T_i)$$

ex $$9.76\text{kJ/kg} = 2\text{kg} \cdot 122\text{J/K*mol} \cdot (345\text{K} - 305\text{K})$$

21) Isobaric Work for given Mass and Temperatures

Open Calculator

fx $$W_b = N \cdot [R] \cdot (T_f - T_i)$$

ex $$16628.93\text{J} = 50\text{mol} \cdot [R] \cdot (345\text{K} - 305\text{K})$$

22) Isobaric Work for given Pressure and Volumes

Open Calculator

fx $$W_b = P_{\text{abs}} \cdot (V_f - V_i)$$

ex $$200000\text{J} = 100000\text{Pa} \cdot (13\text{m}^3 - 11\text{m}^3)$$

23) Mass Flow Rate in Steady Flow

Open Calculator

fx $$m = A \cdot \frac{u_{\text{Fluid}}}{v}$$

ex $$19.63636\text{kg/s} = 24\text{m}^2 \cdot \frac{9\text{m/s}}{11\text{m}^3/\text{kg}}$$

24) Specific Heat Capacity at Constant Pressure

Open Calculator

fx $$C_{p\ molar} = [R] + C_{v\ molar}$$

ex $$111.3145\text{J/K*mol} = [R] + 103\text{J/K*mol}$$

25) Work Done in Adiabatic Process given Adiabatic Index

Open Calculator

fx $$W = \frac{m_{gas} \cdot [R] \cdot (T_i - T_f)}{\gamma - 1}$$

ex $$\text{-}1662.892524\text{J} = \frac{2\text{kg} \cdot [R] \cdot (305\text{K} - 345\text{K})}{1.4 - 1}$$

Variables Used

- **a** Sonic Velocity *(Meter per Second)*
- **A** Cross Sectional Area *(Square Meter)*
- $C_{p\ molar}$ Molar Specific Heat Capacity at Constant Pressure *(Joule Per Kelvin Per Mole)*
- C_p Specific Heat Capacity at Constant Pressure *(Kilojoule per Kilogram per K)*
- $C_{v\ molar}$ Molar Specific Heat Capacity at Constant Volume *(Joule Per Kelvin Per Mole)*
- 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)*
- L_F Latent Factor
- **m** Mass Flow Rate *(Kilogram per Second)*
- **M** Mass *(Kilogram)*
- m_{gas} Mass of Gas *(Kilogram)*
- **MW** Molecular Weight *(Kilogram)*
- **n** Polytropic Index
- **N** Amount of Gaseous Substance in Moles *(Mole)*
- P_1 Pressure at Start of Isentropic Compression *(Bar)*
- p_2' Stagnation Pressure of System *(Pascal)*
- P_2 Pressure at End of Isentropic Compression *(Bar)*

- P_{abs} Absolute Pressure *(Pascal)*
- P_f Final Pressure of System *(Pascal)*
- P_i Initial Pressure of System *(Pascal)*
- Q Heat Extracted from Refrigerator *(Kilojoule per Kilogram)*
- $Q_{Absorbed}$ Heat Absorbed *(Kilojoule per Kilogram)*
- $Q_{delivered}$ Heat Delivered to Hot Body *(Kilojoule per Minute)*
- $Q_{per\ hour}$ Sensible Cooling Load *(Btu (th) per Hour)*
- $Q_{per\ unit}$ Heat Transfer *(Kilojoule per Kilogram)*
- Q_r Rate of Heat Removal *(Kilojoule per Minute)*
- Q_R Heat Rejected *(Kilojoule per Kilogram)*
- Q_T Total Cooling Load *(Btu (th) per Hour)*
- 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)*
- T_3 Ideal Temp at end of Isobaric Cooling *(Kelvin)*
- T_4 Temperature at End of Isentropic Expansion *(Kelvin)*
- T_f Final Temperature *(Kelvin)*
- T_i Initial Temperature *(Kelvin)*
- T_{ratio} Temperature Ratio
- u_{Fluid} Fluid Velocity *(Meter per Second)*
- v Specific Volume *(Cubic Meter per Kilogram)*
- V_f Final Volume of System *(Cubic Meter)*

- **V_i** Initial Volume of System *(Cubic Meter)*
- **$v_{process}$** Velocity *(Meter per Second)*
- **w** Work Done *(Kilojoule per Kilogram)*
- **W** Work *(Joule)*
- **W_b** Isobaric Work *(Joule)*
- **$W_{per\ min}$** Work Done per min *(Kilojoule per Minute)*
- **γ** Heat Capacity Ratio
- **ΔS** Change in Entropy *(Joule per Kilogram K)*
- **ΔS_{CP}** Entropy Change Constant Pressure *(Joule per Kilogram K)*
- **ΔS_{CV}** Entropy Change Constant Volume *(Joule per Kilogram K)*
- **η** Ram Efficiency

Constants, Functions, Measurements used

- Constant: **[R]**, 8.31446261815324 Joule / Kelvin * Mole
  Universal gas constant
- Function: **ln**, ln(Number)
  Natural logarithm function (base e)
- 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: **Amount of Substance** in Mole (mol)
  Amount of Substance Unit Conversion
- Measurement: **Volume** in Cubic Meter (m^3)
  Volume Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Pressure** in Bar (Bar), Pascal (Pa)
  Pressure Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Power** in Kilojoule per Minute (kJ/min), Btu (th) per Hour (Btu/h)
  Power Unit Conversion

- Measurement: **Heat of Combustion (per Mass)** in Kilojoule per Kilogram (kJ/kg)
  Heat of Combustion (per Mass) 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 Volume** in Cubic Meter per Kilogram (m^3/kg)
  Specific Volume Unit Conversion
- Measurement: **Specific Entropy** in Joule per Kilogram K (J/kg*K)
  Specific Entropy 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
- Measurement: **Molar Specific Heat Capacity at Constant Pressure** in Joule Per Kelvin Per Mole (J/K*mol)
  Molar Specific Heat Capacity at Constant Pressure Unit Conversion
- Measurement: **Molar Specific Heat Capacity at Constant Volume** in Joule Per Kelvin Per Mole (J/K*mol)
  Molar Specific Heat Capacity at Constant Volume Unit Conversion

Check other formula lists

- **Refrigeration and Air Conditioning Formulas**

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