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Important Formulas in Radiation Heat Transfer

Calculators!

Examples!

Conversions!

List of 33 Important Formulas in Radiation Heat Transfer

Important Formulas in Radiation Heat Transfer

1) Absorptivity given Reflectivity and Transmissivity

Open Calculator

fx $\alpha = 1 - \rho - \tau$

ex $0.65 = 1 - 0.10 - 0.25$

2) Area of Surface 1 given Area 2 and Radiation Shape Factor for Both Surfaces

Open Calculator

fx $A_1 = A_2 \cdot \left(\frac{F_{21}}{F_{12}} \right)$

ex $34.74576\text{m}^2 = 50\text{m}^2 \cdot \left(\frac{0.41}{0.59} \right)$

3) Area of Surface 2 given Area 1 and Radiation Shape Factor for Both Surfaces

Open Calculator

fx $A_2 = A_1 \cdot \left(\frac{F_{12}}{F_{21}} \right)$

ex $49.99171\text{m}^2 = 34.74\text{m}^2 \cdot \left(\frac{0.59}{0.41} \right)$

4) Emissive Power of Blackbody

Open Calculator

fx $$E_b = [\text{Stefan-BoltZ}] \cdot \left(T^4\right)$$

ex $$324.2963\text{W/m²} = [\text{Stefan-BoltZ}] \cdot \left((275\text{K})^4\right)$$

5) Emissive Power of Non Blackbody given Emissivity

Open Calculator

fx $$E = \varepsilon \cdot E_b$$

ex $$308.0755\text{W/m²} = 0.95 \cdot 324.29\text{W/m²}$$

6) Emissivity of Body

Open Calculator

fx $$\varepsilon = \frac{E}{E_b}$$

ex $$0.949983 = \frac{308.07\text{W/m²}}{324.29\text{W/m²}}$$

7) Energy of each Quanta

Open Calculator

fx $$E_q = [hP] \cdot \nu$$

ex $$5\text{E\^{}-19J} = [hP] \cdot 7.5\text{E\^{}14Hz}$$

8) Frequency given Speed of Light and Wavelength

Open Calculator

fx $$\nu = \frac{[c]}{\lambda}$$

ex $$7.5\text{E\^{}14Hz} = \frac{[c]}{400\text{nm}}$$

9) Heat Transfer between Concentric Spheres

Open Calculator

fx $$q = \frac{A_1 \cdot [\text{Stefan-BoltZ}] \cdot \left(\left(T_1^4\right) - \left(T_2^4\right)\right)}{\left(\frac{1}{\varepsilon_1}\right) + \left(\left(\left(\frac{1}{\varepsilon_2}\right) - 1\right) \cdot \left(\left(\frac{r_1}{r_2}\right)^2\right)\right)}$$

ex $$731.5713\text{W} = \frac{34.74\text{m}^2 \cdot [\text{Stefan-BoltZ}] \cdot \left(\left((202\text{K})^4\right) - \left((151\text{K})^4\right)\right)}{\left(\frac{1}{0.4}\right) + \left(\left(\left(\frac{1}{0.3}\right) - 1\right) \cdot \left(\left(\frac{10\text{m}}{20\text{m}}\right)^2\right)\right)}$$

10) Heat Transfer between Small Convex Object in Large Enclosure

Open Calculator

fx $$q = A_1 \cdot \varepsilon_1 \cdot [\text{Stefan-BoltZ}] \cdot \left(\left(T_1^4\right) - \left(T_2^4\right)\right)$$

ex

$$902.2712\text{W} = 34.74\text{m}^2 \cdot 0.4 \cdot [\text{Stefan-BoltZ}] \cdot \left(\left((202\text{K})^4\right) - \left((151\text{K})^4\right)\right)$$

11) Heat Transfer between Two Infinite Parallel Planes given Temp and Emissivity of Both Surfaces

Open Calculator

fx $$q = \frac{A \cdot [\text{Stefan-BoltZ}] \cdot \left(\left(T_1^4 \right) - \left(T_2^4 \right) \right)}{\left(\frac{1}{\varepsilon_1} \right) + \left(\frac{1}{\varepsilon_2} \right) - 1}$$

ex $$675.7228\text{W} = \frac{50.3\text{m}^2 \cdot [\text{Stefan-BoltZ}] \cdot \left(\left((202\text{K})^4 \right) - \left((151\text{K})^4 \right) \right)}{\left(\frac{1}{0.4} \right) + \left(\frac{1}{0.3} \right) - 1}$$

12) Heat Transfer between Two Long Concentric Cylinder given Temp, Emissivity and Area of Both Surfaces

Open Calculator

fx $$q = \frac{\left([\text{Stefan-BoltZ}] \cdot A_1 \cdot \left(\left(T_1^4 \right) - \left(T_2^4 \right) \right) \right)}{\left(\frac{1}{\varepsilon_1} \right) + \left(\left(\frac{A_1}{A_2} \right) \cdot \left(\left(\frac{1}{\varepsilon_2} \right) - 1 \right) \right)}$$

ex $$547.3353\text{W} = \frac{\left([\text{Stefan-BoltZ}] \cdot 34.74\text{m}^2 \cdot \left(\left((202\text{K})^4 \right) - \left((151\text{K})^4 \right) \right) \right)}{\left(\frac{1}{0.4} \right) + \left(\left(\frac{34.74\text{m}^2}{50\text{m}^2} \right) \cdot \left(\left(\frac{1}{0.3} \right) - 1 \right) \right)}$$

13) Mass of Particle Given Frequency and Speed of Light

Open Calculator

fx $$m = [\text{hP}] \cdot \frac{\nu}{[c]^2}$$

ex $$5.5\text{E\^{}-36kg} = [\text{hP}] \cdot \frac{7.5\text{E\^{}14Hz}}{[c]^2}$$

14) Maximum Wavelength at given Temperature

Open Calculator

fx $$\lambda_{Max} = \frac{2897.6}{T_R}$$

ex $$499586.2\mu m = \frac{2897.6}{5800K}$$

15) Net Energy Leaving given Radiosity and Irradiation

Open Calculator

fx $$q = A \cdot (J - G)$$

ex $$15452.16W = 50.3m^2 \cdot (308W/m^2 - 0.80W/m^2)$$

16) Net Heat Exchange between Two Surfaces given Radiosity for Both Surface

Open Calculator

fx $$q_{1\text{-}2} = \frac{J_1 - J_2}{\frac{1}{A_1 \cdot F_{12}}}$$

ex $$245.9592W = \frac{61W/m^2 - 49W/m^2}{\frac{1}{34.74m^2 \cdot 0.59}}$$

17) Net Heat Exchange given Area 1 and Shape Factor 12

Open Calculator

fx $$Q_{1\text{-}2} = A_1 \cdot F_{12} \cdot (E_{b1} - E_{b2})$$

ex $$3176.973W = 34.74m^2 \cdot 0.59 \cdot (680W/m^2 - 525W/m^2)$$

18) Net Heat Exchange given Area 2 and Shape Factor 21

Open Calculator

fx $$Q_{1\text{-}2} = A_2 \cdot F_{21} \cdot (E_{b1} - E_{b2})$$

ex $$3177.5\text{W} = 50\text{m}^2 \cdot 0.41 \cdot (680\text{W/m}^2 - 525\text{W/m}^2)$$

19) Net Heat Transfer from Surface given Emissivity, Radiosity and Emissive Power

Open Calculator

fx $$q = \left(\frac{(\varepsilon \cdot A) \cdot (E_b - J)}{1 - \varepsilon}\right)$$

ex $$15568.35\text{W} = \left(\frac{(0.95 \cdot 50.3\text{m}^2) \cdot (324.29\text{W/m}^2 - 308\text{W/m}^2)}{1 - 0.95}\right)$$

20) Radiation Heat Transfer between Plane 1 and Shield given Temperature and Emissivity of Both Surfaces

Open Calculator

fx $$q = A \cdot [\text{Stefan-BoltZ}] \cdot \frac{\left(T_{P1}^4\right) - \left(T_3^4\right)}{\left(\frac{1}{\varepsilon_1}\right) + \left(\frac{1}{\varepsilon_3}\right) - 1}$$

ex $$699.4575\text{W} = 50.3\text{m}^2 \cdot [\text{Stefan-BoltZ}] \cdot \frac{\left((452\text{K})^4\right) - \left((450\text{K})^4\right)}{\left(\frac{1}{0.4}\right) + \left(\frac{1}{0.67}\right) - 1}$$

21) Radiation Heat Transfer between Plane 2 and Radiation Shield given Temperature and Emissivity

Open Calculator

fx $$q = A \cdot [\text{Stefan-BoltZ}] \cdot \frac{\left(T_3^4\right) - \left(T_{P2}^4\right)}{\left(\frac{1}{\varepsilon_3}\right) + \left(\frac{1}{\varepsilon_2}\right) - 1}$$

ex $$1336.2\text{W} = 50.3\text{m}^2 \cdot [\text{Stefan-BoltZ}] \cdot \frac{\left((450\text{K})^4\right) - \left((445\text{K})^4\right)}{\left(\frac{1}{0.67}\right) + \left(\frac{1}{0.3}\right) - 1}$$

22) Radiation Temperature given Maximum Wavelength

Open Calculator

fx $$T_R = \frac{2897.6}{\lambda_{Max}}$$

ex $$5800\text{K} = \frac{2897.6}{499586.2\mu\text{m}}$$

23) Radiosity given Emissive Power and Irradiation

Open Calculator

fx $$J = (\varepsilon \cdot E_b) + (\rho \cdot G)$$

ex $$308.1555\text{W/m}^2 = (0.95 \cdot 324.29\text{W/m}^2) + (0.10 \cdot 0.80\text{W/m}^2)$$

24) Reflected Radiation given Absorptivity and Transmissivity

Open Calculator

fx $$\rho = 1 - \alpha - \tau$$

ex $$0.1 = 1 - 0.65 - 0.25$$

25) Reflectivity given Absorptivity for Blackbody

fx $\rho = 1 - \alpha$

Open Calculator

ex $0.35 = 1 - 0.65$

26) Reflectivity given Emissivity for Blackbody

fx $\rho = 1 - \varepsilon$

Open Calculator

ex $0.05 = 1 - 0.95$

27) Resistance in Radiation Heat Transfer when No Shield is Present and Equal Emissivities

fx $R = \left(\frac{2}{\varepsilon}\right) - 1$

Open Calculator

ex $1.105263 = \left(\frac{2}{0.95}\right) - 1$

28) Shape Factor 12 given Area of Both Surface and Shape Factor 21

fx $F_{12} = \left(\frac{A_2}{A_1}\right) \cdot F_{21}$

Open Calculator

ex $0.590098 = \left(\frac{50\text{m}^2}{34.74\text{m}^2}\right) \cdot 0.41$

29) Shape Factor 21 given Area of Both Surface and Shape Factor 12

Open Calculator

fx $$F_{21} = F_{12} \cdot \left(\frac{A_1}{A_2} \right)$$

ex $$0.409932 = 0.59 \cdot \left(\frac{34.74\text{m}^2}{50\text{m}^2} \right)$$

30) Temperature of Radiation Shield Placed between Two Parallel Infinite Planes with Equal Emissivities

Open Calculator

fx $$T_3 = \left(0.5 \cdot \left(\left(T_{P1}^4\right) + \left(T_{P2}^4\right)\right)\right)^{\frac{1}{4}}$$

ex $$448.541\text{K} = \left(0.5 \cdot \left(\left((452\text{K})^4\right) + \left((445\text{K})^4\right)\right)\right)^{\frac{1}{4}}$$

31) Total Resistance in Radiation Heat Transfer given Emissivity and Number of Shields

Open Calculator

fx $$R = (n + 1) \cdot \left(\left(\frac{2}{\varepsilon} \right) - 1 \right)$$

ex $$3.315789 = (2 + 1) \cdot \left(\left(\frac{2}{0.95} \right) - 1 \right)$$

32) Transmissivity Given Reflectivity and Absorptivity

Open Calculator

fx $$\tau = 1 - \alpha - \rho$$

ex $$0.25 = 1 - 0.65 - 0.10$$

33) Wavelength Given Speed of Light and Frequency

Open Calculator

fx $$\lambda = \frac{[c]}{\nu}$$

ex $$399.7233\text{nm} = \frac{[c]}{7.5\text{E\^{}14Hz}}$$

Variables Used

- **A** Area *(Square Meter)*
- **A_1** Surface Area of Body 1 *(Square Meter)*
- **A_2** Surface Area of Body 2 *(Square Meter)*
- **E** Emissive Power of Non Blackbody *(Watt per Square Meter)*
- **E_b** Emissive Power of Blackbody *(Watt per Square Meter)*
- **E_{b1}** Emissive Power of 1st Blackbody *(Watt per Square Meter)*
- **E_{b2}** Emissive Power of 2nd Blackbody *(Watt per Square Meter)*
- **E_q** Energy of Each Quanta *(Joule)*
- **F_{12}** Radiation Shape Factor 12
- **F_{21}** Radiation Shape Factor 21
- **G** Irradiation *(Watt per Square Meter)*
- **J** Radiosity *(Watt per Square Meter)*
- **J_1** Radiosity of 1st Body *(Watt per Square Meter)*
- **J_2** Radiosity of 2nd Body *(Watt per Square Meter)*
- **m** Mass of Particle *(Kilogram)*
- **n** Number of Shields
- **q** Heat Transfer *(Watt)*
- **$q_{1\text{-}2}$** Radiation Heat Transfer *(Watt)*
- **$Q_{1\text{-}2}$** Net Heat Transfer *(Watt)*
- **R** Resistance
- **r_1** Radius of Smaller Sphere *(Meter)*
- **r_2** Radius of Larger Sphere *(Meter)*

- **T** Temperature of Blackbody *(Kelvin)*
- **T_1** Temperature of Surface 1 *(Kelvin)*
- **T_2** Temperature of Surface 2 *(Kelvin)*
- **T_3** Temperature of Radiation Shield *(Kelvin)*
- **T_{P1}** Temperature of Plane 1 *(Kelvin)*
- **T_{P2}** Temperature of Plane 2 *(Kelvin)*
- **T_R** Radiation Temperature *(Kelvin)*
- **α** Absorptivity
- **ε** Emissivity
- **ε_1** Emissivity of Body 1
- **ε_2** Emissivity of Body 2
- **ε_3** Emissivity of Radiation Shield
- **λ** Wavelength *(Nanometer)*
- **λ_{Max}** Maximum Wavelength *(Micrometer)*
- **ν** Frequency *(Hertz)*
- **ρ** Reflectivity
- **τ** Transmissivity

Constants, Functions, Measurements used

- Constant: **[c]**, 299792458.0 Meter/Second
  Light speed in vacuum
- Constant: **[hP]**, 6.626070040E-34 Kilogram Meter² / Second
  Planck constant
- Constant: **[Stefan-BoltZ]**, 5.670367E-8 Kilogram Second^-3 Kelvin^-4
  Stefan-Boltzmann Constant
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Weight** in Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Frequency** in Hertz (Hz)
  Frequency Unit Conversion
- Measurement: **Wavelength** in Nanometer (nm), Micrometer (μm)
  Wavelength Unit Conversion
- Measurement: **Heat Flux Density** in Watt per Square Meter (W/m²)
  Heat Flux Density Unit Conversion

Check other formula lists

- **Gas Radiation Formulas**
- **Important Formulas in Gas Radiation, Radiation Exchange with Specular Surfaces & more Special Cases**
- **Important Formulas in Radiation Heat Transfer**
- **Radiation Exchange with Specular Surfaces Formulas**
- **Radiation Formulas**
- **Radiation Heat Transfer Formulas**
- **Radiation System consisting of Transmitting and Absorbing Medium between Two Planes. Formulas**