Important Formulas in Gas Radiation, Radiation Exchange with Specular Surfaces & more Special Cases

List of 21 Important Formulas in Gas Radiation, Radiation Exchange with Specular Surfaces & more Special Cases

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1) Diffuse Radiation Exchange from Surface 1 to Surface 2

fx $q_{1\text{-}>2} = (J_{1D} \cdot A_1 \cdot F_{12}) \cdot (1 - \rho_{2s})$

Open Calculator

ex $1395.35\text{W} = (43\text{W/m}^2 \cdot 100\text{m}^2 \cdot 0.59) \cdot (1 - 0.45)$

2) Diffuse Radiation Exchange from Surface 2 to Surface 1

fx $q_{2\text{-}>1} = J_{2D} \cdot A_2 \cdot F_{21} \cdot (1 - \rho_{1s})$

Open Calculator

ex $423.94\text{W} = 44\text{W/m}^2 \cdot 50\text{m}^2 \cdot 0.41 \cdot (1 - 0.53)$

3) Diffuse Radiosity

fx $J_D = ((\varepsilon \cdot E_b) + (\rho_D \cdot G))$

Open Calculator

ex $665.4\text{W/m}^2 = ((0.95 \cdot 700\text{W/m}^2) + (0.5 \cdot 0.80\text{W/m}^2))$

4) Direct Diffuse Radiation from Surface 2 to Surface 1

fx $q_{2\text{-}>1} = A_2 \cdot F_{21} \cdot J_2$

Open Calculator

ex $1004.5\text{W} = 50\text{m}^2 \cdot 0.41 \cdot 49\text{W/m}^2$

5) Emissive Power of Blackbody through Medium

Open Calculator

fx $E_{bm} = [\text{Stefan-BoltZ}] \cdot \left(T_m^4\right)$

ex $459.2997\text{W/m}^2 = [\text{Stefan-BoltZ}] \cdot \left((300\text{K})^4\right)$

6) Emissive Power of Blackbody through Medium given Emissivity of Medium

Open Calculator

fx $E_{bm} = \frac{J_m}{\varepsilon_m}$

ex $265.9574\text{W/m}^2 = \frac{250\text{W/m}^2}{0.94}$

7) Emissivity of Medium given Emissive Power of Blackbody through Medium

Open Calculator

fx $\varepsilon_m = \frac{J_m}{E_{bm}}$

ex $0.943396 = \frac{250\text{W/m}^2}{265\text{W/m}^2}$

8) Energy Emitted by Medium

Open Calculator

fx $J_m = \varepsilon_m \cdot E_{bm}$

ex $249.1\text{W/m}^2 = 0.94 \cdot 265\text{W/m}^2$

9) Energy Leaving Surface 1 that is Transmitted through Medium

Open Calculator

fx $$E_{Leaving} = J_1 \cdot A_1 \cdot F_{12} \cdot \tau_m$$

ex $$2339.35J = 61W/m^2 \cdot 100m^2 \cdot 0.59 \cdot 0.65$$

10) Initial Radiation Intensity

Open Calculator

fx $$I_{\lambda o} = \frac{I_{\lambda x}}{\exp\left(-\left(\alpha_\lambda \cdot x\right)\right)}$$

ex $$919.4156W/sr = \frac{638W/sr}{\exp(-(0.42 \cdot 0.87m))}$$

11) Monochromatic Absorption Coefficient if Gas is Non-Reflecting

Open Calculator

fx $$\alpha_\lambda = 1 - \tau_\lambda$$

ex $$0.4 = 1 - 0.6$$

12) Monochromatic Transmissivity

Open Calculator

fx $$\tau_\lambda = \exp\left(-\left(\alpha_\lambda \cdot x\right)\right)$$

ex $$0.693919 = \exp(-(0.42 \cdot 0.87m))$$

13) Monochromatic Transmissivity if Gas is Non Reflecting

Open Calculator

fx $$\tau_\lambda = 1 - \alpha_\lambda$$

ex $$0.58 = 1 - 0.42$$

14) Net Heat Exchange in Transmission Process

fx $q_{1\text{-}2\ transmistted} = A_1 \cdot F_{12} \cdot \tau_m \cdot (J_1 - J_2)$

Open Calculator

ex $460.2W = 100m^2 \cdot 0.59 \cdot 0.65 \cdot (61W/m^2 - 49W/m^2)$

15) Net Heat Lost by Surface

fx $q = A \cdot ((\varepsilon \cdot E_b) - (\alpha \cdot G))$

Open Calculator

ex $33423.75W = 50.3m^2 \cdot ((0.95 \cdot 700W/m^2) - (0.64 \cdot 0.80W/m^2))$

16) Net Heat Lost by Surface given Diffuse Radiosity

fx $q = \left(\frac{\varepsilon \cdot A}{\rho_D}\right) \cdot ((E_b \cdot (\varepsilon + \rho_D)) - J_D)$

Open Calculator

ex

$$33411.27W = \left(\frac{0.95 \cdot 50.3m^2}{0.5}\right) \cdot ((700W/m^2 \cdot (0.95 + 0.5)) - 665.4W/m^2)$$

17) Radiation Intensity at given Distance using Beer's Law

fx $I_{\lambda x} = I_{\lambda o} \cdot \exp(-(\alpha_\lambda \cdot x))$

Open Calculator

ex $638.4055W/sr = 920W/sr \cdot \exp(-(0.42 \cdot 0.87m))$

18) Reflectivity given Specular and Diffuse Component

fx $\rho = \rho_s + \rho_D$

Open Calculator

ex $0.9 = 0.4 + 0.5$

19) Temperature of Medium given Emissive Power of Blackbody

Open Calculator

fx $$T_m = \left(\frac{E_{bm}}{[\text{Stefan-BoltZ}]}\right)^{\frac{1}{4}}$$

ex $$261.4621K = \left(\frac{265W/m^2}{[\text{Stefan-BoltZ}]}\right)^{\frac{1}{4}}$$

20) Transmissivity given Specular and Diffuse Component

Open Calculator

fx $$\tau = (\tau_s + \tau_D)$$

ex $$0.82 = (0.24 + 0.58)$$

21) Transmissivity of Transparent Medium given Radiosity and Shape Factor

Open Calculator

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

ex $$0.649718 = \frac{460W}{100m^2 \cdot 0.59 \cdot (61W/m^2 - 49W/m^2)}$$

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_b** Emissive Power of Blackbody *(Watt per Square Meter)*
- **E_{bm}** Emissive Power of Blackbody through Medium *(Watt per Square Meter)*
- **$E_{Leaving}$** Energy Leaving Surface *(Joule)*
- **F_{12}** Radiation Shape Factor 12
- **F_{21}** Radiation Shape Factor 21
- **G** Irradiation *(Watt per Square Meter)*
- **$I_{\lambda o}$** Initial Radiation Intensity *(Watt per Steradian)*
- **$I_{\lambda x}$** Radiation Intensity at Distance x *(Watt per Steradian)*
- **J_1** Radiosity of 1st Body *(Watt per Square Meter)*
- **J_{1D}** Diffuse Radiosity for Surface 1 *(Watt per Square Meter)*
- **J_2** Radiosity of 2nd Body *(Watt per Square Meter)*
- **J_{2D}** Diffuse Radiosity for Surface 2 *(Watt per Square Meter)*
- **J_D** Diffuse Radiosity *(Watt per Square Meter)*
- **J_m** Radiosity for Transparent Medium *(Watt per Square Meter)*
- **q** Heat Transfer *(Watt)*
- **$q_{1\text{->}2}$** Heat Transfer from Surface 1 to 2 *(Watt)*
- **$q_{1\text{-}2\ transmistted}$** Radiation Heat Transfer *(Watt)*
- **$q_{2\text{->}1}$** Heat Transfer from Surface 2 to 1 *(Watt)*
- **T_m** Temperature of Medium *(Kelvin)*

- **x** Distance *(Meter)*
- **α** Absorptivity
- **α_{λ}** Monochromatic Absorption Coefficient
- **ε** Emissivity
- **ε_{m}** Emissivity of Medium
- **ρ** Reflectivity
- **ρ_{1s}** Specular Component of Reflectivity of Surface 1
- **ρ_{2s}** Specular Component of Reflectivity of Surface 2
- **ρ_{D}** Diffuse Component of Reflectivity
- **ρ_{s}** Specular Component of Reflectivity
- **τ** Transmissivity
- **τ_{D}** Diffuse Component of Transmissivity
- **τ_{m}** Transmissivity of Transparent Medium
- **τ_{s}** Specular Component of Transmissivity
- **τ_{λ}** Monochromatic Transmissivity

Constants, Functions, Measurements used

- Constant: **e**, 2.71828182845904523536028747135266249
  Napier's constant
- Constant: **[Stefan-BoltZ]**, 5.670367E-8 Kilogram Second^-3 Kelvin^-4
  Stefan-Boltzmann Constant
- Function: **exp**, exp(Number)
  Exponential function
- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Temperature** in Kelvin (K)
  Temperature Unit Conversion
- Measurement: **Area** in Square Meter (m^2)
  Area Unit Conversion
- Measurement: **Energy** in Joule (J)
  Energy Unit Conversion
- Measurement: **Power** in Watt (W)
  Power Unit Conversion
- Measurement: **Heat Flux Density** in Watt per Square Meter (W/m^2)
  Heat Flux Density Unit Conversion
- Measurement: **Radiant Intensity** in Watt per Steradian (W/sr)
  Radiant Intensity 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

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