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

Formulas
Examples
with Units

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

1) Diffuse Radiation Exchange from Surface 1 to Surface 2 Formula

Evaluate Formula

Formula

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

Example with Units

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

2) Diffuse Radiation Exchange from Surface 2 to Surface 1 Formula

Evaluate Formula

Formula

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

Example with Units

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

3) Diffuse Radiosity Formula

Evaluate Formula

Formula

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

Example with Units

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

4) Direct Diffuse Radiation from Surface 2 to Surface 1 Formula

Evaluate Formula

Formula

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

Example with Units

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

5) Emissive Power of Blackbody through Medium Formula

Evaluate Formula

Formula

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

Example with Units

$$459.2997\,\text{W/m}^2 = 5.7\text{E-}8 \cdot \left(300\,\text{K}^4 \right)$$

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

Evaluate Formula

Formula

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

Example with Units

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

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

Evaluate Formula

Formula

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

Example with Units

$$0.9434 = \frac{250\,\text{W/m}^2}{265\,\text{W/m}^2}$$

8) Energy Emitted by Medium Formula

Evaluate Formula

Formula

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

Example with Units

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

9) Energy Leaving Surface 1 that is Transmitted through Medium Formula

Evaluate Formula

Formula

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

Example with Units

$$2339.35\,\text{J} = 61\,\text{W/m}^2 \cdot 100\,\text{m}^2 \cdot 0.59 \cdot 0.65$$

10) Initial Radiation Intensity Formula

Evaluate Formula

Formula

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

Example with Units

$$919.4156\,\text{W/sr} = \frac{638\,\text{W/sr}}{\exp\left(-\left(0.42 \cdot 0.87\,\text{m}\right)\right)}$$

11) Monochromatic Absorption Coefficient if Gas is Non-Reflecting Formula

Evaluate Formula

Formula

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

Example

$$0.4 = 1 - 0.6$$

12) Monochromatic Transmissivity Formula

Evaluate Formula

Formula

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

Example with Units

$$0.6939 = \exp\left(-\left(0.42 \cdot 0.87\,\text{m}\right)\right)$$

13) Monochromatic Transmissivity if Gas is Non Reflecting Formula

Evaluate Formula

Formula

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

Example

$$0.58 = 1 - 0.42$$

14) Net Heat Exchange in Transmission Process Formula

Evaluate Formula

Formula

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

Example with Units

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

15) Net Heat Lost by Surface Formula

Evaluate Formula

Formula

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

Example with Units

$$33423.7464\,W = 50.3\,m^2 \cdot \left(\left(0.95 \cdot 700\,W/m^2 \right) - \left(0.64 \cdot 0.80\,W/m^2 \right) \right)$$

16) Net Heat Lost by Surface given Diffuse Radiosity Formula

Evaluate Formula

Formula

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

Example with Units

$$33411.272\,W = \left(\frac{0.95 \cdot 50.3\,m^2}{0.5} \right) \cdot \left(\left(700\,W/m^2 \cdot \left(0.95 + 0.5 \right) \right) - 665.4\,W/m^2 \right)$$

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

Evaluate Formula

Formula

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

Example with Units

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

18) Reflectivity given Specular and Diffuse Component Formula

Evaluate Formula

Formula

$$\rho = \rho_s + \rho_D$$

Example

$$0.9 = 0.4 + 0.5$$

19) Temperature of Medium given Emissive Power of Blackbody Formula

Evaluate Formula

Formula

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

Example with Units

$$261.4621\,K = \left(\frac{265\,W/m^2}{5.7E\text{-}8} \right)^{\frac{1}{4}}$$

20) Transmissivity given Specular and Diffuse Component Formula

Evaluate Formula

Formula

$$\tau = \left(\tau_s + \tau_D \right)$$

Example

$$0.82 = \left(0.24 + 0.58 \right)$$

21) Transmissivity of Transparent Medium given Radiosity and Shape Factor Formula

Evaluate Formula

Formula

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

Example with Units

$$0.6497 = \frac{460\,\text{W}}{100\,\text{m}^2 \cdot 0.59 \cdot \left(61\,\text{W/m}^2 - 49\,\text{W/m}^2 \right)}$$

Variables used in list of Important Formulas in Gas Radiation, Radiation Exchange with Specular Surfaces & more Special Cases above

- **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)*
- $q_{1->2}$ Heat Transfer from Surface 1 to 2 *(Watt)*
- $q_{1\text{-}2\ transmistted}$ Radiation Heat Transfer *(Watt)*
- $q_{2->1}$ Heat Transfer from Surface 2 to 1 *(Watt)*
- T_m Temperature of Medium *(Kelvin)*
- **x** Distance *(Meter)*
- **α** Absorptivity
- α_λ Monochromatic Absorption Coefficient

Constants, Functions, Measurements used in list of Important Formulas in Gas Radiation, Radiation Exchange with Specular Surfaces & more Special Cases above

- constant(s): **[Stefan-BoltZ]**, 5.670367E-8 *Stefan-Boltzmann Constant*
- Functions: **exp**, exp(Number) *n an exponential function, the value of the function changes by a constant factor for every unit change in the independent variable.*
- Measurement: **Length** in Meter (m) *Length 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: **Heat Flux Density** in Watt per Square Meter (W/m²) *Heat Flux Density Unit Conversion*
- Measurement: **Radiant Intensity** in Watt per Steradian (W/sr) *Radiant Intensity Unit Conversion*

- 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

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