Mean Beam Length of a Furnace or Gas Space

Mean beam length of a gas volume for radiation to its whole boundary (3.6 V/A, Hottel) and the optically thin limit (4 V/A), for gas emissivity look-ups.

Method: Hottel: mean beam length L_e ≈ 3.6 V/A for radiation to the whole enclosure; optically thin limit 4 V/A (Hottel and Sarofim, Radiative Transfer, McGraw-Hill, 1967; Incropera, Fundamentals of Heat and Mass Transfer)

Input parameters

Unit system: SI

Parameter	Value	Unit
Gas volume	450.00	m^3
Bounding surface area	420.00	m^2

Calculated results

Parameter	Value	Unit
Mean beam length 3.6 V/A	3.8571	m
Optically thin limit 4 V/A	4.2857	m

Notes for this case

• Multiply the beam length by the partial pressures of CO_2 and H_2O, in the units of your chart or correlation (atm·m, atm·ft or bar·m), to read the gas emissivity.

Formula and method

$$L_e = 3.6\frac{V}{A}, \quad L_0 = 4\frac{V}{A}$$

Variables

V	Gas volume	m^3
A	Bounding surface area	m^2
L_e	Mean beam length 3.6 V/A	m
L_0	Optically thin limit 4 V/A	m

Method and standards

Hottel's whole-enclosure mean beam length, 3.6 V/A, an average over the usual optical depths, and the optically thin limit 4 V/A.

Assumptions and limits

- Whole-enclosure average. For particular shapes and for radiation to one part of the boundary (tube banks, long cylinders, radiation to the base of a cylinder), the tabulated mean beam lengths in Hottel and Sarofim or Incropera differ from 3.6 V/A: use them there.
- V and A must describe a real enclosure: V/A cannot exceed that of a sphere, √(A/36π).

References

• Hottel: mean beam length L_e ≈ 3.6 V/A for radiation to the whole enclosure; optically thin limit 4 V/A (Hottel and Sarofim, Radiative Transfer, McGraw-Hill, 1967; Incropera, Fundamentals of Heat and Mass Transfer)

Report details

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Release checks	2 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/boilers-power-plant/furnace-heating-surfaces/mean-beam-length

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.