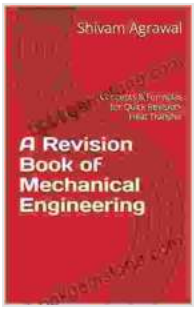
Concepts and Formulas for Quick Revision of Heat Transfer

Formula for Heat Conduction:

Q = kA(T1 - T2) / L

where:



A Revision Book of Mechanical Engineering: Concepts & Formulas for Quick Revision-Heat Transfer by Marie Cirano

★★★★★ 5 out of 5

Language	: English
File size	: 2782 KB
Text-to-Speech	: Enabled
Enhanced typesetting	: Enabled
Word Wise	: Enabled
Print length	: 41 pages
Screen Reader	: Supported

- Q is the heat transfer rate (W)
- k is the thermal conductivity (W/mK)
- A is the area of contact (m2)
- T1 and T2 are the temperatures of the objects in contact (K)
- L is the distance between the objects (m)

Formula for Heat Convection:

$Q = hA(Ts - Tf)$

where:

- Q is the heat transfer rate (W)
- h is the convection heat transfer coefficient (W/m2K)
- A is the surface area of the object exposed to the fluid (m2)
- Ts is the temperature of the object's surface (K)
- Tf is the temperature of the fluid (K)

Formula for Heat Radiation:

$Q = \varepsilon\sigma A(T4 - Ts4)$

where:

- Q is the heat transfer rate (W)
- ε is the emissivity of the surface (dimensionless)
- σ is the Stefan-Boltzmann constant (5.67 x 10-8 W/m2K4)
- A is the surface area of the object (m2)
- T is the absolute temperature of the object (K)
- Ts is the absolute temperature of the surroundings (K)

Formula for Specific Heat Capacity:

$cp = Q / (m\Delta T)$

where:

- cp is the specific heat capacity (J/kgK)
- Q is the heat absorbed or released (J)
- m is the mass of the material (kg)
- ΔT is the change in temperature (K)

Formula for Thermal Resistance:

R = L / kA

where:

- R is the thermal resistance (m2K/W)
- L is the thickness of the material (m)
- k is the thermal conductivity (W/mK)
- A is the surface area (m2)

Formula for Critical Heat Flux:

qcr = hfgρgσ(ρl - ρg)3/2 / μlL

where:

- qcr is the critical heat flux (W/m2)
- hfg is the latent heat of vaporization (J/kg)
- ρ is the density (kg/m3)

- g is the acceleration due to gravity (m/s2)
- σ is the surface tension (N/m)
- μl is the liquid viscosity (Pa-s)
- L is the characteristic length (m)

Examples of Empirical Correlations:

- **Nusselt Number for Laminar Flow in a Tube:** Nu = 4.36
- **Colburn Factor for Turbulent Flow in a Tube:** jH = 0.023Re0.8Prn
- **Chilton-Colburn Analogy for Gas Flow:** St = jHPr2/3

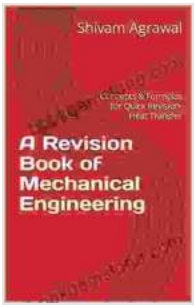
where:

- Nu is the Nusselt number
- Re is the Reynolds number
- Pr is the Prandtl number
- jH is the Colburn factor
- St is the Stanton number

Types of Heat Exchangers:

- **Shell-and-Tube Heat Exchanger:** Consists of a series of tubes enclosed in a cylindrical shell.
- **Double-Pipe Heat Exchanger:** Consists of two concentric pipes, with the fluid entering and leaving through the inner and outer pipes.

- **Plate-and-Frame Heat Exchanger:** Uses parallel plates separated by gaskets to create flow channels.



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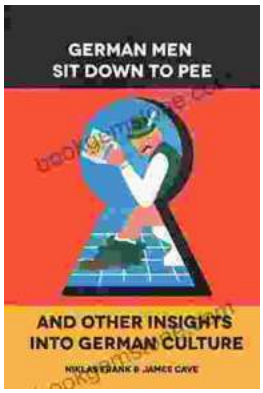

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