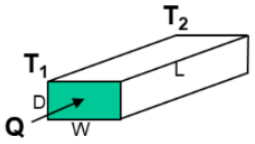
衛星熱控作業

Homework

A steel plate (width W=2cm, length L=10cm, thickness D=1cm, conductivity=43.3W/m°C) is used to conduct the heat from the hot end (T_1=100°C) to cold end (T_2=20°C).

(a) How many watts of the heat (Q) can be conducted through the steel plate?

(b) How to improve the heat transfer capability based on the same hot end (T_1=100°C) and cold end (T_2=20°C) temperatures?

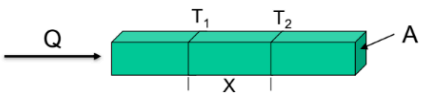


Heat Transfer Mechanism-Conduction

- Conduction in a solid is the transfer of heat from one point in the solid to another as a result of a temperature gradient.
- Conduction cannot occur in a vacuum. Molecules must be present for conduction to take place.

Conduction equation : $Q = -KA\,dT/dx$; or $Q = KA(T_1-T_2)/X$

Where, Q= rate of heat conduction along the X direction, W
K= thermal conductivity, W/m°C
A= cross-section area of the path, m^2
dT/dX= temperature gradient along the path, °C /m
T_1, T_2= surface temperature, °C
X= distance between T_1 & T_2



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In [3]:
```python
import numpy as np

# Given values
k = 43.3  # Thermal conductivity in W/m°C
W = 0.02  # Width in meters
L = 0.1   # Length in meters
D = 0.01  # Thickness in meters
T1 = 100  # Hot end temperature in °C
T2 = 20   # Cold end temperature in °C

# Cross-sectional area
A = D * W
```

```
# Temperature difference
delta_T = T1 - T2

# Heat conducted using Fourier's law
Q = (k * A * delta_T) / L

# Output results
Q
```

Out[3]: 6.927999999999999

(b) How to improve heat transfer capability:

There are several ways to improve the heat transfer capability while maintaining the same temperature difference:

1. **Increase thermal conductivity ((k)):**
   - Use a material with higher thermal conductivity.
2. **Increase the cross-sectional area ((A)):**
   - Increase either the width ((W)) or length ((L)) of the steel plate.
3. **Reduce thickness ((D)):**
   - Make the plate thinner.
4. **Use a better thermal interface material:**
   - Place a high-conductivity material between the steel plate and the heat sources.