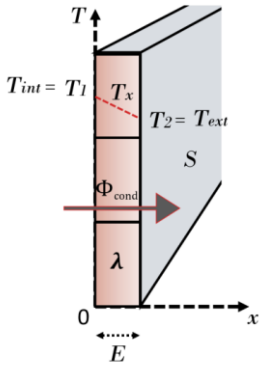
TD: Heat tranfer

Part 1: heat transfer mode "conduction"

Explanation of the heat transfer mode "conduction"



Fourier's law

Φcond = λ S dT/dx

Φcond = λ S (dT)/L

Φcond: Heat flux by conduction in W;

λ: Thermal conductivity of the material in W/m°C; (see table bellow showing the λ of some materials)

S: Surface area of the element in m2;

L: Thickness of the material in m;

T1-T2: Surface temperature difference in (°C) or (K).

Matériau	k (W/m.K)	Matériau	k (W/m.K)
Argent	419	Plâtre	0,48
Cuivre	386	Amiante	0,16
Aluminium	204	Bois (feuillu-résineux)	0,12-0,23
Acier doux	45	Liège	0,044-0,049
Acier inox	15	Laine de roche	0,038-0,041
Glace	1,88	Laine de verre	0,035-0,051
Béton	1,4	Polystyrène expansé	0,036-0,047
Brique terre cuite	1,1	Polystyrène (mousse)	0,030-0,045
Verre	1,05	Polystyrène extrudé	0,027
Eau	0,60	Air	0,026

Exircise n°1:

Assuming we have two walls, the first is a concrete wall characterized by a thermal conductivity of 1.4 W/mK. The second wall is made of hollow bricks with a thermal conductivity of 0.8 W/mK. Both walls have a thickness of 0.3 m, with a surface area of 15 m2. The outside temperature is 30°C, and the inside temperature is 25°C. Calculate the heat transfer by conduction through these walls.

Part 2: Thermal resistance R

Explanation of the thermal resistance and its related parameters

$R = (dt)/ \Phi cond$

$\Phi cond = \lambda S dt /L$

Therefore:

$dt = L \Phi cond / \lambda S$

Therefore:

$R = (E \Phi cond / \lambda S) / \Phi cond$

Therefore:

$R = E / \lambda S$ m2°C/W

Where:

- R: Thermal resistance by conduction
- Φcond: Heat flux by conduction in W;
- λ: Thermal conductivity of the material in W/m°C;
- S: Surface area of the element in m2;
- L: Thickness of the material in m;
- Dt: Surface temperature difference in (°C) or (K)

Exircise n°2:

Calculate the thermal resistance of the previous walls. Compare and provide an interpretation of the results of the heat transfer and the thermal resistance of both walls. Conclude which one is superior in terms of thermal performance.