EXCHANGE OF RADIANT HEAT BETWEEN TWO WALLS SEPARATED BY REFLECTIVE INSULATING MATERIAL

As a general rule the radiant flow Q_{1-2} (W) between two infinite parallel planes (factors 1 and 2) separated by a medium which neither absorbs nor emits radiation may be described as follows:

$$Q_{1-2} = \frac{\sigma T_1^4 - \sigma T_2^4}{\dfrac{1-\varepsilon_1}{A_1 \varepsilon_1} + \dfrac{1}{A_1 F_{1-2}} + \dfrac{1-\varepsilon_2}{A_2 \varepsilon_2}} \qquad (1)$$

where T denotes the temperature (K), ε the emissivity, F_{1-2} the facing factor between the two planes, A the area (m^2) and σ Stefan-Boltzmann's constant (5.67 10^{-8} $W.m^{-2}.K^{-4}$).

If both planes have the same area ($A_1 = A_2 = A$) and face each other completely ($F_{1-2} = 1$), then expression (1) is written in terms of flow density ($W.m^{-2}$)

$$Q''_{1-2} = \frac{\varepsilon_1 \varepsilon_2 (\sigma T_1^4 - \sigma T_2^4)}{1 - (1 - \varepsilon_1)(1 - \varepsilon_2)} \qquad (2)$$

Moreover, the conductive flow density in a wall of thickness "e" and thermal conductivity "k" is given by:

$$Q''_{cond} = \frac{T_1 - T_2}{R_{cond}} \qquad (3)$$

where R_{cond} is the thermal resistance (by conduction) and T_1 and T_2 are the temperatures of the two sides of the wall respectively.

$$R_{cond} = \frac{e}{k} \qquad (4)$$

Expression (2) may also be written in the same form as expression (3), defining a radiation resistance R_{1-2} such that:

$$Q''_{1-2} = \frac{T_1 - T_2}{R_{1-2}} \qquad (5)$$

The theory outlined above was applied to two emitting walls between which was placed an insulating panel. The table overleaf shows, in addition to the data considered, the results obtained (in bold).

Test carried out on 30 micron pure aluminium. Made in Belgium.

The general data are:

- emissivity of both walls: 0.9
- thermal conductivity of insulation: 0.041 $W.m^{-1}.K^{-1}$

and the abbreviations used in the table are:

- $R_{1\text{-}is}$: radiant thermal resistance between wall 1 and the insulation;
- $T_{is\text{-}1}$: temperature of insulation facing wall 1;
- R_{is} : thermal resistance of insulation;
- $T_{is\text{-}2}$: temperature of insulation facing wall 2;
- $R_{is\text{-}2}$: radiant thermal resistance between the insulation and wall 2;
- R_{eq} : equivalent thermal resistance (radiation and conduction) between the two walls;
- $R_{eq.0}$: radiant thermal resistance between the two walls without insulation;
- $Flux_{2\text{-}1}$: thermal flow density between wall 1 and wall 2;
- $Flux_{2\text{-}1,0}$: thermal flow density between wall 1 and wall 2 without the insulation.

	ALUTHERMO 7 mm
Thickness (mm)	7
T wall no. 1 (°C)	0
T wall no. 2 (°C)	+20
Insulation emissivity	0.16
$R_{1\text{-}is}$ (m^2.K/W)	1.304
$T_{is\text{-}1}$ (K)	283.03
R_{is} (m^2.K/W)	0.171
$T_{is\text{-}2}$ (K)	284.32
$R_{is\text{-}2}$ (m^2.K/W)	1.165
R_{eq} (m^2.K/W)	**2.639**
$R_{eq.0}$ (m^2.K/W)	0.237
$Flux_{2\text{-}1}$ (W/m^2)	7.578
Flux $_{2\text{-}1,0}$ (W/m^2)	84.4

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