Air-Conditioning & Refrigeration

BSc

Lecture 11

Course weekly Outline &

Ch.1 (Introduction to Air conditioning & Refrigeration)

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Chapter Five: Heating load calculations:

5.1: Calculation procedure:

Heating load through structural components and windows:

$$Q_s = U\,A\,(T_i - T_o)$$

$$V_{inf} = \frac{Volume \times N}{3600}$$

N = Air changes per Hour

type of rooms	ACH
No doors & windows	0.5
one side with doors & wind	1.
two sides " " "	1.5
Three " " " "	2.
Corridors	2

Heating load through floor:

$$Q_s = U\,A\,(T_i - T_{earth})$$

Heating load by infiltration:

$$Q_s = 1.22\ V_{infiltration}\,(T_i - T_o)$$

$$Q_L = 2940\ V_{infiltration}\,(W_i - W_o)$$

Where : U is the overall heat transfer coefficient

A is the area of the wall ,roof or floor

T_o is the outside temperature of the space

T_i is the inside temperature of the space

T_{earth} is the floor temperature of the space

ρ is the air density

V is the volume flow rate of the infiltration air

W_o is the moisture content of the outside air

W_i is the moisture content of the inside air

5.2: Ventilation :

The ventilation load can be estimated by knowing the amount of the fresh air required by the given space .This can be found in tables according to the function of building . If the amount of ventilated air is known then the ventilation load may be estimated by :

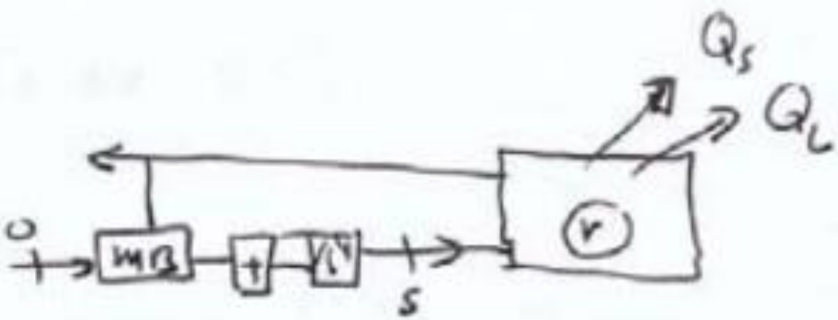
$Q_{vent} = 1.2 * V_{vent} (h_i - h_o)$

This load represent the total load for ventilation ie(sensible + latent)

5.3: Quantities of air required for heating (cms)

$V_s = Q_s / (1.22 (T_s - T_r))$

5.4 : Applications :



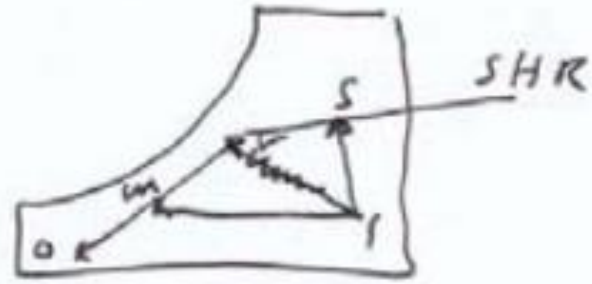


Table 1: Thermal properties of wall building materials

Material	k* (W/m K)	ρ* (kg/m^3)	Cp* (J/kg K)	α (x 10^{-7}) (m^2/s)	Thermal mass C (kJ/K m^2) (= ρ Cp) (x 10^{6})	Thermal inertia $(k\ \rho\ Cp)^{1/2}$ (J m^{-2} K^{-1} $S^{-1/2}$)
Cement plastering	0.721	1762	840	4.87	1.480	1033.02
Brick wall	0.811	1820	880	5.06	1.601	1139.69
EPS insulation	0.035	24	1340	10.8	0.032	33.55
Cellular concrete	0.188	704	1050	2.54	0.739	372.78
Dense concrete	1.740	2410	880	8.20	2.120	1920.98

Table 6.A.18: Thermal conductivity of some common *construction* materials

		Density (kg/m^3)	Conductivity ($W/m \cdot K$)
Walls	Brickwork (outer leaf)	1700	0.77
	Brickwork (inner leaf)	1700	0.56
	Lightweight aggregate concrete block	1400	0.57
	Autoclaved aerated concrete block	600	0.18
	Concrete (medium density)	1800	1.13
		2000	1.33
		2200	1.59
	Concrete (high density)	2400	1.93
	Reinforced concrete (1% steel)	2300	2.3
	Reinforced concrete (2% steel)	2400	2.5
	Mortar (protected)	1750	0.88
	Mortar (exposed)	1750	0.94
	Gypsum	600	0.18
		900	0.30
		1200	0.43
	Sandstone	2600	2.3
	Limestone (soft)	1800	1.1
	Limestone (hard)	2200	1.7
	Timber framing in prefabricated wall panels	480	0.12
	Timber (softwood, plywood, chipboard)	500	0.13
	Timber (hardwood)	700	0.18
Surface finishes	Plasterboard	700	0.21
	Fibreboard	400	0.1
	Tiles (ceramic)	2300	1.3
	External sand-cement rendering	1300	1.0
	Plaster (dense)	1300	0.57
	Plaster (lightweight)	600	0.18
Roofs	Aerated concrete slab	500	0.16
	Asphalt	2100	0.70
	Felt/bitumen layers	1100	0.23
	Screed	1200	0.41
	Stone chippings	2000	2.0
	Tiles (clay)	2000	1.0
	Tiles (concrete)	2100	1.5
	Wood wool slab	500	0.10

Table 6.A.1: Indicative *U-values* (W/m^2K) for windows, rooflights, doors with wood or plastic frai

	Gap between panes			Adjust for roo [Note
	6 mm	12 mm	16 mm or more	
Double-glazing (air filled)	3.1	2.8	2.7	
Double-glazing (low-E, ε_n = 0.2, air filled) [Note 2]	2.7	2.3	2.1	
Double-glazing (low-E, ε_n = 0.15, air filled)	2.7	2.2	2.0	
Double-glazing (low-E, ε_n = 0.1, air filled)	2.6	2.1	1.9	
Double-glazing (low-E, ε_n = 0.05, air filled)	2.6	2.0	1.8	
Double-glazing (argon filled) [Note 3]	2.9	2.7	2.6	
Double-glazing (low-E, ε_n = 0.2, argon filled)	2.5	2.1	2.0	
Double-glazing (low-E, ε_n = 0.15, argon filled)	2.4	2.0	1.9	
Double-glazing (low-E, ε_n = 0.1, argon filled)	2.3	1.9	1.8	
Double-glazing (low-E, ε_n = 0.05, argon filled)	2.3	1.8	1.7	
Triple-glazing (air filled)	2.4	2.1	2.0	
Triple-glazing (low-E, ε_n = 0.2, air filled)	2.1	1.7	1.6	
Triple-glazing (low-E, ε_n = 0.15, air filled)	2.1	1.7	1.6	
Triple-glazing (low-E, ε_n = 0.1, air filled)	2.0	1.6	1.5	
Triple-glazing (low-E, ε_n = 0.05, air filled)	1.9	1.5	1.4	
Triple-glazing (argon filled)	2.2	2.0	1.9	
Triple-glazing (low-E, ε_n = 0.2, argon filled)	1.9	1.6	1.5	
Triple-glazing (low-E, ε_n = 0.15, argon filled)	1.8	1.5	1.4	
Triple-glazing (low-E, ε_n = 0.1, argon filled)	1.8	1.5	1.4	
Triple-glazing (low-E, ε_n = 0.05, argon filled)	1.7	1.4	1.3	
Solid wooden door [Note 4] 3.0				N/A

Notes:

1. The *U-values* in this table are based on the frame comprising 30% of the total window area.
2. The emissivities quoted are normal emissivities. (Corrected emissivity is used in the calculation of *glazing U-values*.) Uncoated glass is assumed to have a normal emissivity of 0.89.
3. The gas mixture is assumed to consist of 90% argon and 10% air.
4. For doors which are half-glazed the *U-value* of the door is the average of the appropriate window *U-value* and that of the non-glazed part of the door (e.g. 3.0 W/m^2K for a wooden door).
5. For roof lights refer to table 6A3