Week 8

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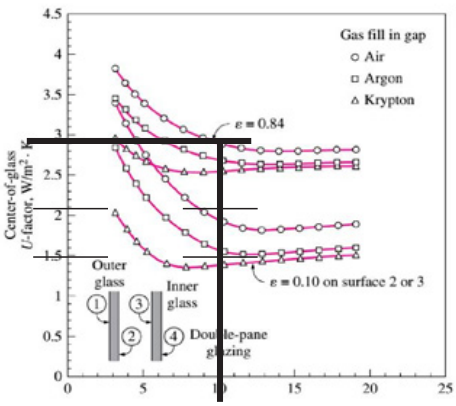
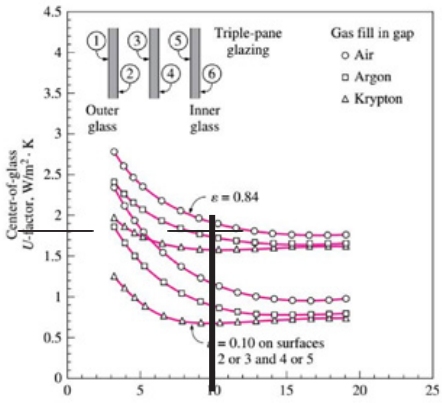
Task 1

To get the U-value of a window:

$$U_{window} = (U_{center}A_{center} + U_{edge}A_{edge} + U_{frame}A_{frame}) / A_{window}$$





With double pane glazing: (when e = 0.10):

U factor (krypton) when using Krypton = 1.4 w/m2k

U factor (Argon) = 1.5 w/m2k

when e = 0.84

U factor of Krypton and Argon = 2.1 w/m2k

Ufactor of the air is 2.3 w/m2k

With triple pane glazing: (when e = 0.10):

U factor (Krypton) = 0.7 w/m2k

U factor (Argon) = 0.8 w/m2k

when e = 0.84

U factor of Krypton and Argon = 1.6 w/m2k

Ufactor of the air is 1.8 w/m2k

Task 2

Consider the house that we analysed in the last two examples, calculate the heating and cooling load of the other windows which are fixed 14.4 m2 on the west, fixed 3.6 m2 on the south and an operable 3.6 m2 on the south (the same window and frame type). How much does the total value change if I change the frame of the window from wooden one to aluminium ?

Piacenza:

LAT: 44.92N LONG: 9.73 E Elev.: 138

T_{summer}: 24° T_{winter}: 20° HEATING DB 99%: -4.8

COOLING DB/MCWB 1%: 31.9

$\Delta T_{cooling} = 31.9 - 24 = 7.9°C$

$\Delta T_{heating} = 20 - (-4.8) = 24.8°C$

East side of the building:

45° Lattitude

No internal shading - AIC = 1

DR = 11.9

$q_{westwindow} = A \times CF_{westwindow}$

$A = 14.4 m^2$

$CF_{westwind.} = U_{westw.}(\Delta T_{cooling} - 0.46\,DR)$

$U_{westwindow} = 2.84 \frac{W}{m^2K}$

$CF_{westwindow} = 2.84 \frac{W}{m^2K} \times (7.9K - 0.46 \times 11.9K) = 6.89 \frac{W}{m^2K}$

$PXI_{westwind} = E_D + Ed = 599 + 188 = 747$

$SHGC = 0.54$

Without internal shading: $IAC = 1$

$FF_S = 0.56$

$CF_{westwindow} = PXI \times SHGC \times IAC \times FF_S$

$q_{westwindow} = A \times CF_{westwindow} = A \times (CF_{heat\,transfer} + CF_{iradiation})$

$\approx 14.4 m^2 \times (6.89 + 747 \times 0.54 \times 1 \times 0.56) \frac{W}{m^2} \approx 3352W$

Heating load of Fixed window on west:

$q_{westwindow} = A \times HF_{westwindow} = A \times U_{westwindow} \Delta T_{heating}$

$= 14.4 m^2 \times 2.84 \frac{W}{m^2K} \times 24.8K \approx 1014.22W$

Aluminum frames: $U_{w.w} = 3.61 \frac{W}{m^2K}$, $SHGC = 0.56$

$CF'_{ww\,for\,heat\,transfer} = U'_{ww} \times (\Delta T_{cooling} - 0.46DR)$

$= 3.61 \frac{W}{m^2K} \times (7.9K - 0.46 \times 11.9K) \approx 8.76 \frac{W}{m^2}$

Cooling load $q'_{ww} = A \times CF'_{ww}$

$= A \times (CF'_{cw} + CF'_{ww})$

$\approx 14.4 m^2 \times (8.76 + 747 \times 0.54 \times 1 \times 0.56) \frac{W}{m^2} = 3499.48W$

Heating load $q'_{ww} = A \times HF'_{ww} = A \times U'_{ww} \Delta T_{heating}$

$= 14.4 m^2 \times 3.61 \frac{W}{m^2K} \times 24.8K = 1289.2W$

$q_{westwindow} = A \times CF_{southwindow}$

$A = 3.6 m^2$

$CF_{southwindow} = U_{sw} (\Delta T_{Cooling} - 0.46 DR)$

$U_{sw} = 2.84 \frac{W}{m^2K}$

$CF_{sw} = 2.84 \frac{W}{m^2K} \times (7.9K - 0.46 \times 11.9K) = 6.89 \frac{W}{m^2K}$

$P \times I_{sw} = E_D + E_d = 348 + 209 = 577$

$SHGC = 0.54$

Without internal shading, $IAC = 1$

$FF_S = 0.47$

$CF_{sw} = P \times I \times SHGC \times IAC \times FF_S$

$q_{sw} = A \times CF_{sw} = A \times U_{sw} \Delta T_{heating}$

$= 3.6 m^2 \times 2.84 \frac{W}{m^2K} \times 24.8K = 253.56W$

Aluminum frames: $U_{sw} = 3.61 \frac{W}{m^2K}$, $SHGC = 0.56$

$CF'_{sw\ for\ heat\ transfer} = U'_{sw} \times (\Delta T_{Cooling} - 0.46 DR)$

$= 3.61 \frac{W}{m^2K} \times (7.9K - 0.46 \times 11.9K) = 8.76 \frac{W}{m^2}$

Cooling load $q'_{sw} = A \times CF'_{sw}$

$A \times (CF'_{sw\ for\ heat\ transfer} + CF'_{sw\ irradiation})$

$= 3.6 m^2 \times (8.76 + 557 \times 0.56 \times 1 \times 0.47) \frac{W}{m^2} = 559.3W$

Heating load $q'_{sw} = A \times HF'_{sw} = A \times U'_{sw} \Delta T_{heating}$

$= 3.6 m^2 \times 3.61 \frac{W}{m^2K} \times 24.8K = 322.3W$

Operable window on south:

Cooling load $q_{sw} = A \times CF_{sw}$, $A = 3.6m^2$

$CF_{sw} = U_{sw} (\Delta T_{cooling} - 0.46DR)$

$U_{ww} = 2.87 \frac{W}{m^2K}$

$PXI_{ww} = E_D + E_d = 348 + 209 = 557$

$SHGC = 0.46$

Without internal shading, $IAC = 1$

$FF_s = 0.47$

$CF_{sw} = PXI \times SHGC \times IAC \times FF_s$

$q_{sw} = A \times CF_{sw} = A \times (CF_{heat\ transfer} + CF_{irradiation})$

$= 3.6m^2 \times (6.89 + 557 \times 0.46 \times 1 \times 0.47) \frac{W}{m^2} = 458.58W$

Heating load $q_{sw} = A \times HF_{sw} = A \times U_{sw} \Delta T_{heating}$

$= 3.6m^2 \times 2.87 \frac{W}{m^2K} \times 24.8K = 256.23W$

Aluminium frames: $U_{west\ window} = 4062 \frac{W}{m^2K}$, $SHGC = 0.55$

CF'_{ww} for heat transfer $= U'_{ww} \times (\Delta T_{cooling} - 0.46DR)$

$= 4.62 \frac{W}{m^2K} \times (7.9K - 0.46 \times 11.9K) = 11.21 \frac{W}{m^2}$

Cooling load $q'_{sw} = A \times CF'_{sw}$

$= A \times (CF'_{sw}$ for heat transfer $+ CF'_{sw}$ irradiation$)$

$= 3.6m^2 (11.21 + 557 \times 0.55 \times 1 \times 0.47) \frac{W}{m^2} = 558.7W$

Heating load $q'_{west\ window} = A \times HF'_{sw} = A \times U'_{sw} \Delta T_{heating}$

$= 3.6m^2 \times 4.62 \frac{W}{m^2K} \times 24.8K = 412.47W$