WEEK 8 ASSIGNMENT

TGEORGE

1) TASK 1

Using the diagrams given in the presentation calculate how much (%) is the effect of applying different modifications (changing the gas, adding an extra pane, using a low emissivity coating) on the U value with respect to a benchmark case of double layer with air and no coating?
(keep the gap thickness to be 13 mm)

$$U_{window} = \frac{U_{center}A_{center} + U_{edge}A_{edge} + U_{frame}A_{frame}}{A_{window}}$$

If we are dealing with a double pane window we can disregard the thermal resistance of glass layers

$$\frac{1}{U_{doublepane}} = \frac{1}{h_i} + \frac{1}{h_{space}} + \frac{1}{h_0}$$

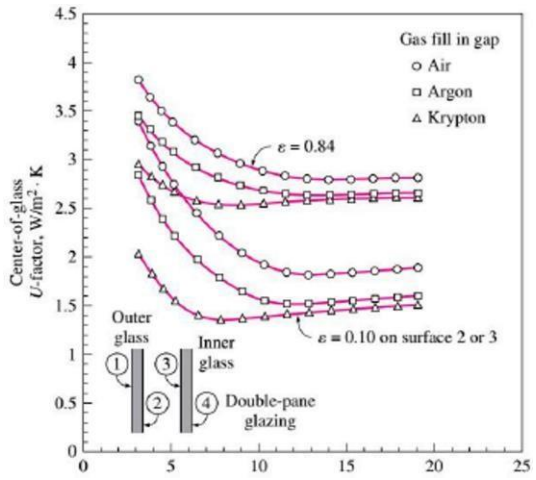
$$h_{space} = h_{rad} + h_{conv}$$

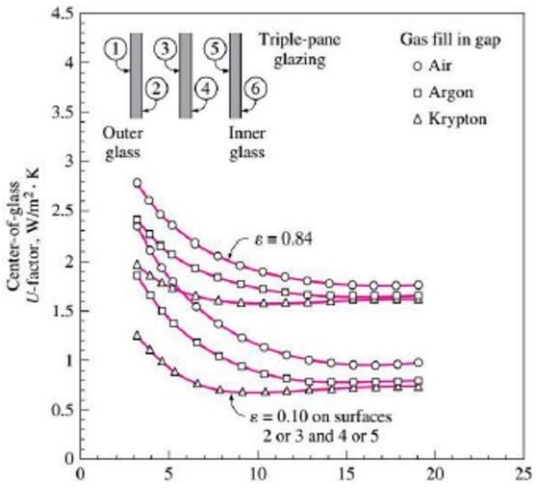
Hspace changes by changing the gas that fills the gap. If we take the gap thickness to be 13mm from the graph we know that by changing the gas that fills the gap from air to argon the Uvalue of the center of the glass decreases from 2.8 $\frac{W}{m^2K}$ to 2.65 $\frac{W}{m^2K'}$ which means the U-value decreases about 5.36%

By changing the gas that fills the gap from air to krypton, the Uvalue of the center of the glass decreases from 2.8 $\frac{W}{m^2K}$ to 2.6 $\frac{W}{m^2K}$ which means U-value decreases about 7.14%

Uvalue also increase by adding an extra pane. If we use the diagram from the slides we know that when the gap thickness is 13mm and the gas that fills the gap is air then by adding an extra pane the U-value of the center of the glass decreases from 2.8 $\frac{W}{m^2K}$ to 1.8 $\frac{W}{m^2K}$ which is almost a 35.71% decrease.

Another method would be to coat the glass surfaces with a material that has a low emissivity.





Using the diagrams from the slides and taking the gap thickness as 13mm and the gas filling the gap is air, we can tell that by coating the glass surface with a film that has the emissivity of 0.1, the Uvalue of the center of the glass decreases from 2.8 $\frac{W}{m^2K}$ to 1.8 $\frac{W}{m^2K}$ which means there is a 35.71% decrease in the Uvalue

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 ?

CASE 1 : FIXED WINDOW ON WEST :

Cooling load :

Frame : wood

$q_{windowW} = A * CF_{windowW}$; A= 14,4 m²

$Cf_{windowWheattransfer} = U_{windowW} (\Delta T_{cooling} - 0,46\ DR) = 2,84 * (7,9 - 0,46 * 11,9)$

$Cf_{windowWheattransfer}$ =6,89 w/m²

$PXI_{windowW} = E_D + E_d = 559 + 188 = 747$; SHGC =0,54 ; IAC = 1 ; Ff_s = 0,56

$Cf_{windowWirradiation} = PXI * SHGC * IAC * FF_s = 747 * 0,54 * 1 * 0,56$

$Cf_{windowWirradiation}$ =225,9

$q_{windowW} = A * CF_{windowW} = A * (CF_{windowWheattransfer} + CF_{windowWirradiation}) = 14,4 * (6,89 + 225,9)$

$q_{windowW}$ = 3352,17 W

Heating load :

Frame : aluminium

$q_{windowW} = A * HF_{windowW} = A * U_{windowW}\ \Delta T_{heating} = 14,4 * 2,84 * 24,8$

$q_{windowW}$ = 1014,22 W

$U_{windowW}$ = 3,61 ; HSGC=0,56

$CF'_{windowWheattransfer} = U'_{windowW} *((\Delta T_{cooling}$-0,46 DR) =3,61*(7,9-0,46*11,9)

$CF'_{windowWheattransfer}$ =

8,76 Cooling load :

$q'_{windowW} = A*CF'_{windowW} = A*(CF'_{windowWheattransfer} + CF'_{windowWirradiation})$

=14,4* (8,76+234,26)

q'windowW =3499,49 W

Heating load :

$q'_{windowW} = A*HF'_{windowW} = A*U'_{windowW}* \Delta T_{heating}$ = 14,4*3,61*24,8

q'windowW = 1289,2 W

CASE 2: FIXED WINDOW ON SOUTH:

Cooling load :

Frame : wood

$q_{windowS} = A*CF_{windowS}$; A= 3,6 m²

$Cf_{windowSheattransfer} = U_{windowS} (\Delta T_{cooling}$-0,46 DR) = 2,84*(7,9-0,46*11,9)

$Cf_{windowSheattransfer}$ =6,89 w/m²

$PXI_{windowS} = E_D+E_d$ = 348+209=557 ; SHGC =0,56 ; IAC = 1 ; Ff_S = 0,47

$Cf_{windowSirradiation}$ = PXI*SHGC*IAC*FF_S = 557*0,56*1*0,47

$Cf_{windowSirradiation}$ = 146,60

$q_{windowS} = A*CF_{windowS} = A*(CF_{windowSheattransfer} + CF_{windowSirradiation})$= 3,6 * (6,89+146,60)

qwindowW = 552,56 W

Heating load :

Frame : aluminium

$q_{windowS} = A*HF_{windowS} = A*U_{windowS} \Delta T_{heating}$ = 3,6*2,84*24,8

qwindowW = 253,56 W

$U_{windowS}$ = 3,61 ; HSGC=0,56

CF'windowSheattransfer = $U'_{windowS}$ *((ΔTcooling-0,46 DR) =3,61*(7,9-0,46*11,9)

CF'windowWheattransfer = 8,76 W/m²

Cooling load :

q'windowS = A*CF'windowS = A*(CF'windowSheattransfer + CF'windowSirradiation) =3,6* (8,76+146,60)

q'windowS=559,3 W

Heating load :

q'windowS = A*HF'windowS = A*U'windowS* ΔTheating = 3,6*3,61*24,8

q'windowW = 322,3 W

CASE 3: OPERABLE WINDOW ON SOUTH:

COOLING LOAD FOR THE OPERABLE:

qwindowS = A*CFwindowS ; A= 3,6 m²

CfwindowSheattransfer = UwindowS (ΔTcooling-0,46 DR) = 2,87*(7,9-0,46*11,9)

CfwindowSheattransfer =6,96 w/m²

PXIwindowS = ED+Ed = 348+209=557 ; SHGC =0,46 ; IAC = 1 ; Ffs = 0,47

CfwindowSirradiation = PXI*SHGC*IAC*FFs = 557*0,46*1*0,47

CfwindowSirradiation = 120,42

qwindowS = A*CFwindowS = A*(CFwindowSheattransfer + CFwindowSirradiation)= 3,6 * (6,96+141,36)

qwindowS = 533,97 W

HEATING LOAD **(fixed window):**

qwindowS = A*HFwindowS= A*UwindowS ΔTheating = 3,6*2,87*24,8

qwindowW = 256,23 W

with aluminium frame :

UwindowS = 3,61 ; HSGC=0,56

CF'windowSheattransfer = $U'_{windowS}$ *((ΔTcooling-0,46 DR) =4,62*(7,9-0,46*11,9)

CF'windowWheattransfer = 11,21 W/m²

Cooling load :

q'windowS = A*CF'windowS = A*(CF'windowSheattransfer + CF'windowSirradiation) =3,6* (11,21+143,98)

q'windowS=558,7 W

Heating load :

q'windowS = A*HF'windowS = A*U'windowS* ΔTheating = 3,6*4,62*24,8

q'windowS= 412,47 W