Azra Ozyurt Week 8

26 Kasım 2019 Salı 16:27

TASK 1

The frame I use for understanding the differences:

+wood frame
+Double glazing, 12.7mm airspace
+fixed

U=1.92 W/m^2

Change 1: Add one pane

+wood frame
+triple glazing, 13 mm airspace
+fixed, insulated

U= 1.84 W/m^2

Change 2: Change gas

+wood frame
+double glazing, 13 mm argon space
+fixed, insulated

U= 1.67 W/m^2

Change 3: loer the emmissiviy of coating

+wood frame
+double glazing, 13 mm air space, no coating
+fixed, insulated

U= 2.76W/m^2

15:12

TASK 2 - PART 1

-Heat absorbing, double layers, wooden frame

-East side surface area: 14.4 m^2 , $fixed\ window$
-West side surface area: 14.4 m^2, $fixed\ window$
-North side surface area: 3.6 m^2, $fixed\ window$
-South side surface area: $3.6\ m^2$, $operable\ window$

-winter U: 0.438 W/m^2
-summer U: 0.435 W/m^2

Calculate the heating and cooling loads.

EAST HEATING

$$U_{window_{east}} = 2.84 \frac{W}{M^2 K}$$

$$HF_{window_{east}} = U_{window_{east}} \times \Delta T_{heating} = 2.84 * 24.8 = 70.4 \frac{W}{m2}$$

$$Q_{window_{east}} = HF_{window_{east}} \times A_{window_{east}} = 70.4 * 14.4 = \mathbf{1014.2\ W}$$

EAST COOLING

$$\mathrm{CF}_{fen} = U(\Delta t - 0.46\,\mathrm{DR}) + \mathrm{PXI} \times \mathrm{SHGC} \times \mathrm{IAC} \times \mathrm{FF}_s$$

$$PXI_{window_{east}} = E_D + E_d = 559 + 188 = 747$$

SHGC = 0.54
NO internal shading so IAC = 1

From the table for easten window of a detached hourse FFs = 0.31

$$CF_{windwo_{east\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 747 * 0.54 * 1 * 0.31 = 125.1$$

$$\boldsymbol{CF_{windwo_{east\,heatTrasnferPart}}} = U_{window_{east}}(\Delta T_{cooling} - 0.46\,DR) = 2.84\,(7.9 - 0.46 * 11.9) = 6.9 \frac{W}{m2}$$

$$CF_{windwo_{east}} = CF_{windwo_{east\downarrow heatTrasnferPart}} + CF_{windwo_{east\downarrow IrradiationPart}} = 6.9 + 125.1 = 132 \frac{W}{m^2}$$

$$\boldsymbol{Q_{windwo_{east}} = CF_{windwo_{east}} \times A_{window_{east}} = 132 * 14.4 = 1900.8\ W}$$

WEST HEATING

$$U_{window_{WEST}} = 2.84 \frac{W}{M^2 K}$$

$$HF_{window_{WEST}} = U_{window_{WEST}} \times \Delta T_{heating} = 2.84 * 24.8 = 70.4 \frac{W}{m2}$$

$$Q_{window_{WEST}} = HF_{window_{WEST}} \times A_{window_{WEST}} = 70.4 * 14.4 = \mathbf{1014.2\ W}$$

WEST COOLING

$$\mathrm{CF}_{fen} = U(\Delta t - 0.46\,\mathrm{DR}) + \mathrm{PXI} \times \mathrm{SHGC} \times \mathrm{IAC} \times \mathrm{FF}_s$$

$$PXI_{window_{WEST}} = E_D + E_d = 559 + 188 = 747$$

SHGC = 0.54
NO internal shading so IAC = 1

From the table for WESTERN window of a detached hourse FFs = 0.56

$$CF_{windwo_{WEST\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 747 * 0.54 * 1 * 0.56 = 225.9$$

$$CF_{windwo_{WEST}\downarrow heatTrasnferPart} = U_{window_{WEST}}(\Delta T_{cooling} - 0.46\,DR) = 2.84\,(7.9 - 0.46 * 11.9) = 6.9\frac{W}{m2}$$

$$CF_{windwo_{WEST}} = CF_{windwo_{WEST}\downarrow heatTrasnferPart} + CF_{windwo_{WEST}\downarrow IrradiationPart} = 6.9 + 225.9 = 232.8\frac{W}{m^2}$$

$$\boldsymbol{Q_{windwo_{WEST}} = CF_{windwo_{WEST}} \times A_{window_{WEST}} = 132 * 14.4 = 3352.32\,W}$$

NORTH HEATING

$$U_{window_{NORTH}} = 2.84\frac{W}{M^2K}$$

$$HF_{window_{NORTH}} = U_{window_{NORTH}} \times \Delta T_{heating} = 2.84 * 24.8 = 70.4\frac{W}{m2}$$

$$Q_{window_{NORTH}} = HF_{window_{NORTH}} \times A_{window_{NORTH}} = 70.4 * 3.6 = \boldsymbol{253.44\,W}$$

NORTH COOLING

$$\mathrm{CF}_{fen} = U(\Delta t - 0.46\,\mathrm{DR}) + \mathrm{PXI} \times \mathrm{SHGC} \times \mathrm{IAC} \times \mathrm{FF}_s$$

$$PXI_{window_{NORTH}} = E_D + E_d = 85 + 76 = 161$$

SHGC = 0.54
NO internal shading so IAC = 1

From the table for NORTHERN window of a detached hourse FFs = 0.44

$$CF_{windwo_{NORTH}\downarrow IrradiationPart} = PXI \times SHGC \times IAC \times FF_S = 161 * 0.54 * 1 * 0.44 = 38.25$$

$$\boldsymbol{CF_{windwNORTH_{heatTrasnferPart}}} = U_{window_{NORTH}}(\Delta T_{cooling} - 0.46\,DR) = 2.84\,(7.9 - 0.46 * 11.9) = 6.9\frac{W}{m2}$$

$$CF_{windwo_{NORTH}} = CF_{windwo_{NORTH}\downarrow heatTrasnferPart} + CF_{windwo_{NORTH}\downarrow IrradiationPart} = 6.9 + 38.25 = 45{,}15\frac{W}{m^2}$$

$$\boldsymbol{Q_{windwo_{NORTH}} = CF_{windwo_{NORTH}} \times A_{window_{NORTH}} = 45,15 * 3.6 = 162.54\,W}$$

SOUTH HEATING

$$U_{window_{SOUTH}} = 2.87\frac{W}{M^2K}$$

$$HF_{window_{SOUTH}} = U_{window_{SOUTH}} \times \Delta T_{heating} = 2.87 * 24.8 = 71.2\frac{W}{m2}$$

$$Q_{window_{SOUTH}} = HF_{window_{SOUTH}} \times A_{window_{SOUTH}} = 71.2 * 3.6 = \boldsymbol{256.32\,W}$$

SOUTH COOLING

$$\mathrm{CF}_{fen} = U(\Delta t - 0.46\,\mathrm{DR}) + \mathrm{PXI} \times \mathrm{SHGC} \times \mathrm{IAC} \times \mathrm{FF}_s$$

$PXI_{window_{SOUTH}} = E_D + E_d = 348 + 209 = 557$

SHGC = 0.46
NO internal shading so IAC = 1

From the table for SOUTHERN window of a detached hourse FFs = 0.47

$CF_{windwo_{SOUTH\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 557 * 0.46 * 1 * 0.47 = 120.5$

$\boldsymbol{CF_{windwSOUTH_{heatTrasnferPart}}} = U_{window_{SOUTH}}(\Delta T_{cooling} - 0.46\,DR) = 2.84\,(7.9 - 0.46 * 11.9) = 6.9\frac{W}{m2}$

$CF_{windwo_{SOUTH}} = CF_{windwo_{SOUTH\downarrow heatTrasnferPart}} + CF_{windwo_{SOUTH\downarrow IrradiationPart}} = 6.9 + 120.5 = 127.4\frac{W}{m^2}$

$\boldsymbol{Q_{windwo_{SOUTH}} = CF_{windwo_{SOUTH}} \times A_{window_{SOUTH}} = 127.4 * 3.6 = 458.64\ W}$

TOTAL Q WINDOW COOLING
= 458.64+162.54+3352.32+1900.8 = 5874.3 W

TOTAL Q WINDOW HEATING
=256.32+253.44+1014.2+1014.2 = 2538.36 W

TASK 2 - PART 2

-Heat absorbing, double layers, **ALIMINUM** frame (U and SHGC VALUES CHANGES)

-East side surface area: 14.4 m^2 , *fixed window*
-West side surface area: 14.4 m^2, *fixed window*
-North side surface area: 3.6 m^2, *fixed window*
-South side surface area: *3.6* m^2, *operable window*

-winter U: 0.438 W/m^2
-summer U: 0.435 W/m^2

Calculate the heating and cooling loads.

EAST HEATING

$U_{window_{east}} = 3.61\frac{W}{M^2K}$

$HF_{window_{east}} = U_{window_{east}} \times \Delta T_{heating} = 3.61 * 24.8 = 89.5\ \frac{W}{m2}$

$Q_{window_{east}} = HF_{window_{east}} \times A_{window_{east}} = 89.5 * 14.4 =$ ***1288.8 W***

EAST COOLING

$$\mathrm{CF}_{fen} = U(\Delta t - 0.46\,\mathrm{DR}) + \mathrm{PXI} \times \mathrm{SHGC} \times \mathrm{IAC} \times \mathrm{FF}_s$$

$PXI_{window_{east}} = E_D + E_d = 559 + 188 = 747$

SHGC = 0.56
NO internal shading so IAC = 1

From the table for easten window of a detached hourse FFs = 0.56

$CF_{windwo_{east\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 747 * 0.54 * 1 * 0.31 = 125.1$

$CF_{windwo_{east heatTrasnferPart}} = U_{window_{east}}(\Delta T_{cooling} - 0.46\,DR) = 3.61\,(7.9 - 0.46 * 11.9) = 8.7\frac{W}{m2}$

$CF_{windwo_{east}} = CF_{windwo_{east\downarrow heatTrasnferPart}} + CF_{windwo_{east\downarrow IrradiationPart}} = 8.7 + 125.1 = 133{,}8\frac{W}{m^2}$

$\boldsymbol{Q_{windwo_{east}} = CF_{window} \times A_{window_{east}} = 132 * 14.4 = 1926.72\,W}$

WEST HEATING

$U_{window_{WEST}} = 3.61\frac{W}{M^2K}$

$HF_{window_{WEST}} = U_{window_{WEST}} \times \Delta T_{heating} = 3.61 * 24.8 = 89.5\frac{W}{m2}$

$Q_{window_{WEST}} = HF_{window_{WEST}} \times A_{window_{WEST}} = 89.5 * 14.4 = \boldsymbol{1288.8\,W}$

WEST COOLING

$$\mathrm{CF}_{fen} = U(\Delta t - 0.46\,\mathrm{DR}) + \mathrm{PXI} \times \mathrm{SHGC} \times \mathrm{IAC} \times \mathrm{FF}_s$$

$PXI_{window_{WEST}} = E_D + E_d = 559 + 188 = 747$

SHGC = 0.56
NO internal shading so IAC = 1

From the table for WESTERN window of a detached hourse FFs = 0.56

$CF_{windwo_{WEST\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 747 * 0.56 * 1 * 0.56 = 234.3$

$CF_{windwo_{WEST\downarrow heatTrasnferPart}} = U_{window_{WEST}}(\Delta T_{cooling} - 0.46\,DR) = 3.61\,(7.9 - 0.46 * 11.9) = 8.7\frac{W}{m2}$

$CF_{windwo_{WEST}} = CF_{windwo_{WEST\downarrow heatTrasnferPart}} + CF_{windwo_{WEST\downarrow IrradiationPart}} = 8.7 + 234.3 = 243\frac{W}{m^2}$

$\boldsymbol{Q_{windwo_{WEST}} = CF_{windwo_{WEST}} \times A_{window_{WEST}} = 243 * 14.4 = 3499.2\,W}$

NORTH HEATING

$U_{window_{NORTH}} = 3.61\frac{W}{M^2K}$

$HF_{window_{NORTH}} = U_{window_{NORTH}} \times \Delta T_{heating} = 3.61 * 24.8 = 89.5\frac{W}{m2}$

$Q_{window_{NORTH}} = HF_{window_{NORTH}} \times A_{window_{NORTH}} = 89.5 * 3.6 = 322{,}2\ \boldsymbol{W}$

NORTH COOLING

$$CF_{fen} = U(\Delta t - 0.46\,DR) + PXI \times SHGC \times IAC \times FF_s$$

$PXI_{window_{NORTH}} = E_D + E_d = 85 + 76 = 161$

SHGC = 0.56
NO internal shading so IAC = 1

From the table for NORHTHERN window of a detached hourse FFs = 0.44

$CF_{windwo_{NORTH\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 161 * 0.56 * 1 * 0.44 = 39.7$

$\boldsymbol{CF_{windwNORTH_{heatTrasnferPart}}} = U_{window_{NORTH}}(\Delta T_{cooling} - 0.46\,DR) = 3.61\,(7.9 - 0.46 * 11.9) = 8.7\frac{W}{m2}$

$CF_{windwo_{NORTH}} = CF_{windwo_{NORTH\downarrow heatTrasnferPart}} + CF_{windwo_{NORTH\downarrow IrradiationPart}} = 8{,}7 + 39.7 = 48.4\ \frac{W}{m^2}$

$\boldsymbol{Q_{windwo_{NORTH}} = CF_{windwo_{NORTH}} \times A_{window_{NORTH}} = 48.4 * 3.6 = 174.24\ W}$

SOUTH HEATING

$U_{window_{SOUTH}} = 4.62\frac{W}{M^2K}$

$HF_{window_{SOUTH}} = U_{window_{SOUTH}} \times \Delta T_{heating} = 2.87 * 24.8 = 71.2\frac{W}{m2}$

$Q_{window_{SOUTH}} = HF_{window_{SOUTH}} \times A_{window_{SOUTH}} = 71.2 * 3.6 = \boldsymbol{256.32\ W}$

SOUTH COOLING

$$CF_{fen} = U(\Delta t - 0.46\,DR) + PXI \times SHGC \times IAC \times FF_s$$

$PXI_{window_{SOUTH}} = E_D + E_d = 348 + 209 = 557$

SHGC = 0.55
NO internal shading so IAC = 1

From the table for SOUTHERN window of a detached hourse FFs = 0.47

$CF_{windwo_{SOUTH\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 557 * 0.55 * 1 * 0.47 = 144$

$\boldsymbol{CF_{windwSOUTH_{heatTrasnferPart}}} = U_{window_{SOUTH}}(\Delta T_{cooling} - 0.46\,DR) = 4{,}62\,(7.9 - 0.46 * 11.9) = 11\frac{W}{m2}$

$CF_{windwo_{SOUTH}} = CF_{windwo_{SOUTH\downarrow heatTrasnferPart}} + CF_{windwo_{SOUTH\downarrow IrradiationPart}} = 11 + 144 = 155\frac{W}{m^2}$

$\boldsymbol{Q_{windwo_{SOUTH}} = CF_{windwo_{SOUTH}} \times A_{window_{SOUTH}} = 155 * 3.6 = 558\ W}$

WOODEN FRAME

TOTAL Q WINDOW COOLING
= 458.64+162.54+3352.32+1900.8 = 5874.3 W

TOTAL Q WINDOW HEATING
=256.32+253.44+1014.2+1014.2 = 2538.36 W

ALIMINUM FRAME

TOTAL Q WINDOW COOLING
= 1926.72+3499.2+174.24+558=6158.16W

TOTAL Q WINDOW HEATING
=1288.8+1288.8+322.2+256.32=3156.12W

THE OUTCOME FOR THE TASK 2:

The Aliminum frame values creates way higer heat load volumes. It requires way more energy to
Heat or cool then the wooden frame.

For cooling, if I change the frame from wooden to aliminum the Q value increases by 238.86 W

For heating, if I change the frame from wooden to aliminum the Q value increases by 617.76 W