Seyedsina Seyedi

Assignment 8

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 thickenss to be 13 mm)

Gap thickness = 13mm

1.Changing the gas from air → ARGON we have this result:

U-value of the centre of the glass is declined from 2.8 to 2.65 $\frac{w}{m^2k}$ → u value is decline around 5.36%

2.Changing the gas from air → krypton we have this result:

U-value of the centre of the glass is declined from 2.8 to 2.6 $\frac{w}{m^2k}$ → u value is decline around 7.14%

3. by adding an extra pane:

Gap thickness = 13mm

By adding extra pane the U value is declined around 35.7% that is changed from 2.8$\frac{w}{m^2k}$ to 1.8$\frac{w}{m^2k}$

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: 44,92 N

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° LATITUDE

No internal shading – AIC = 1

DR = 11,9

Aluminum Frame Section

Window1

A_{W1east}= 14,4 m^2

EAST
FIXED
Aluminum FRAME

Heating:

$U_{w1east=}$ 3.61 W/m^2 K

$HF_{w1east=} U_{W1east} * \Delta T_{cooling}$ = 3.61 *24.8 = 89.52 W/m^2

Q_{w1east}= $HF_{W1east} * A_{W1east}$ = 89.52 * 14.4 = 1289.1 W

Cooling:

Part for Heat transfer

$CF_{W1east} = U_{W1east} *(\Delta T_{cooling} – 0.46 * DR)$ = 3.61* (7,9 − 0,46 · 11,9) = 8.7 W/m^2

Part for Irradiation part

E_D = 559

E_d= 188

East window of a detached house - FFS = 0.31

SHGC= 0.56

$PXI_{W1east} = E_D + E_d$ = 559 + 188 = 747

CF_{W1east} = PXI*SHGC*IAC*FF_s= 747*0.56*1*0.31=129.6

$CF_{fenestration1east} = U_{w1east}*(\Delta T_{cooling} - 0.46 * DR) + PXI * SHGC * IAC * FF_s = 8.7 + 129.6 = 138.3$ W/m^2

$\dot{Q}_{w1east} = CF_{fenestration1east} * A_{W1east} = 138.3*14.4 = 1991.5$ W

WINDOW2

$A_{W2west} = 14{,}4$ m^2

WEST
FIXED
Aluminum FRAME

Heating:

$U_{W2west} = 3.61$ W/m^2 K

$HF_{W2west} = U_{W2west} * \Delta T_{cooling} = 3.61 * 24.8 = 70.44$

$Q_{W2west} = HF_{W2west} * A_{W2west} = 89.52 * 14.4 = 1289.1$ W

Cooling:

Part for Heat transfer

$CF_{W2west} = U_{W2west} *(\Delta T_{cooling} - 0.46 * DR) = 3.61\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 8.7$ W/m^2

$E_D = 559$

$E_d = 188$

West window of a detached house - FFS = 0.56

SHGC= 0.56

$PXI_{W2west} = E_D + E_d = 559 + 188 = 747$

$CF_{W2west} = PXI*SHGC*IAC*FF_s = 747*0.56*1*0.56 = 234.26$

$CF_{fenestration2west}= U_{w2west}*(\Delta T_{cooling} – 0.46 * DR) +PXI *SHGC *IAC * FF_s = 8.7+234.26=242.96\ W/m^2$

$\dot{Q}_{W2west} = CF_{fenestration2west} * A_{W2west} = 242.96 * 14.4 = 3498.6\ W$

WINDOW3

$A_{W3south}= 3.6\ m^2$

SOUTH
FIXED
ALUMINIUM FRAME

Heating:

$U_{W3south=} 3.61\ W/m^2 K$

$HF_{W3south=} U_{W3south} * \Delta T_{cooling} = 3.61 *24.8 = 89.52\ W/ m^2$

$Q_{W3south}= HF_{W3south} * A_{W3south} = 89.52 * 3.6 = 322.2\ W$

Cooling:

Heat transfer part

$CF_{W3south} = U_{W3south} *(\Delta T_{cooling} – 0.46 * DR) = 3.61\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 8.7\ W/m^2$

Part for Irradiation part

$E_D = 348$

$E_d= 209$

South window of a detached house - FFS = 0.47

SHGC= 0.56

$PXI_{W3south} = E_D + E_d = 348 + 209 = 557$

$CF_{W3south} = PXI*SHGC*IAC*FF_s= 557*0.56*1*0.47=146.6$

$CF_{fenestration3south} = U_{w3south} *(\Delta T_{cooling} - 0.46 * DR) + PXI *SHGC *IAC * FF_s = 8.7 + 146.6 = 155.3\ W/m^2$

$\dot{Q}_{w3south} = CF_{fenestration3south} * A_{W3south} = 155.3*3.6 = 559.08\ W$

WINDOW 4

$A_{W4south} = 3.6\ m^2$

SOUTH
OPERABLE
ALUMINIUM FRAME

Heating:

$U_{W4south} = 4.62\ W/m^2\ K$

$HF_{W4south} = U_{W4south} * \Delta T_{cooling} = 4.62 *24.8 = 114.57\ W/m^2$

$Q_{W4south} = HF_{W4south} * A_{W4south} = 114.57 * 3.6 = 412.4\ W$

Cooling:

Heat transfer part

$CF_{W4south} = U_{W4south} *(\Delta T_{cooling} - 0.46 * DR) = 4.62\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 11.2\ W/m^2$

Part for Irradiation part

$E_D = 348$

$E_d = 209$

South window of a detached house - FFS = 0.47

SHGC= 0.55

$PXI_{W4south} = E_D + E_d = 348 + 209 = 557$

$CF_{W4south} = PXI*SHGC*IAC*FF_s = 557*0.55*1*0.47 = 143.95$

$CF_{fenestration4south} = U_{w3south} *(\Delta T_{cooling} - 0.46 * DR) + PXI *SHGC *IAC * FF_s = 11.2 +143.98=155.18\ W/m^2$

$\dot{Q}_{w4south} = CF_{fenestration4south} * A_{W4south} = 155.18*3.6 = 558.65\ W$

$\dot{Q}_{\text{Total windows Cooling Aluminum frame}} = 1991.5 + 3498.6 + 559.08 + 558.65 = 6607.8\ W$

$\dot{Q}_{\text{Total windows Heating Aluminum frame}} = 1289.1 + 1289.1 + 322.2 + 412.4 = 3312.8\ W$

Wood Frame Section

WINDOW1

$A_{W1east} = 14{,}4\ m^2$

EAST
FIXED
WOOD FRAME

Heating:

$U_{w1east=} 2{,}84\ W/m^2\ K$

$HF_{w1east=} U_{W1east} * \Delta T_{cooling} = 2.84 *24.8 = 70.44$

$Q_{w1east} = HF_{W1east} * A_{W1east} = 70.44 * 14.4 = 1014.2\ W$

Cooling:

Part for Heat transfer

$CF_{W1east} = U_{W1east} *(\Delta T_{cooling} - 0.46 * DR) = 2{,}84\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 6{,}9\ W/m^2$

Part for Irradiation part

$E_D = 559$

$E_d = 188$

East window of a detached house - FFS = 0.31

SHGC= 0.54

$PXI_{W1east} = E_D + E_d = 559 + 188 = 747$

$CF_{W1east} = PXI*SHGC*IAC*FF_s = 747*0.54*1*0.31=125.1$

$CF_{fenestration1east} = U_{w1east}*(\Delta T_{cooling} - 0.46 * DR) + PXI *SHGC *IAC * FF_s = 6.9 + 125.1 = 132$ W/m^2

$\dot{Q}_{w1east} = CF_{fenestration1east} * A_{W1east} = 132*14.4 = 1900.8$ W

WINDOW 2

$A_{W2west} = 14{,}4$ m^2

WEST
FIXED
WOOD FRAME

Heating:

$U_{W2west} = 2{,}84$ W/m^2 K

$HF_{W2west} = U_{W2west} * \Delta T_{cooling} = 2.84 *24.8 = 70.44$

$Q_{W2west} = HF_{W2west} * A_{W2west} = 70.44 * 14.4 = 1014.2$ W

Cooling:

Part for Heat transfer

$CF_{W2west} = U_{W2west} *(\Delta T_{cooling} - 0.46 * DR) = 2{,}84\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 6{,}9$ W/m^2

$E_D = 559$

$E_d = 188$

West window of a detached house - FFS = 0.31

SHGC= 0.54

$PXI_{W2west} = E_D + E_d = 559 + 188 = 747$

$CF_{W2west} = PXI*SHGC*IAC*FF_s=747*0.54*1*0.56=225.9$

$CF_{fenestration2west}= U_{w2west}*(\Delta T_{cooling} – 0.46 * DR) +PXI *SHGC *IAC * FF_s = 6.9+225.9=232.8$ W/m^2

$\dot{Q}_{W2west} = CF_{fenestration2west} * A_{W2west} = 232.8 * 14.4 = 3352.32$ W

WINDOW3

$A_{W3south}= 3.6\ m^2$

SOUTH
FIXED
WOOD FRAME

Heating:

$U_{W3south=}$ 2,84 $W/m^2 K$

$HF_{W3south=} U_{W3south} * \Delta T_{cooling} = 2.84 *24.8 = 70.44\ W/m^2$

$Q_{W3south}= HF_{W3south} * A_{W3south} = 70.44 * 3.6 = 253.6$ W

Cooling:

Heat transfer part

$CF_{W3south} = U_{W3south} *(\Delta T_{cooling} – 0.46 * DR) = 2,84\ (7,9 - 0,46 \cdot 11,9) = 6,9\ W/m^2$

Part for Irradiation part

$E_D = 348$

$E_d= 209$

South window of a detached house - FFS = 0.31

SHGC= 0.54

$PXI_{W3south} = E_D + E_d = 348 + 209 = 557$

$CF_{W3south} = PXI*SHGC*IAC*FF_s = 557*0.54*1*0.47=141.4$

$CF_{fenestration3south} = U_{w3south} *(\Delta T_{cooling} - 0.46 * DR) + PXI *SHGC *IAC * FF_s = 6.9 +141.4=148.3\ W/m^2$

$\dot{Q}_{w3south} = CF_{fenestration3south} * A_{W3south} = 148.3*3.6 = 533.88\ W$

WINDOW 4

$A_{W4south} = 3.6\ m^2$

SOUTH
OPERABLE
WOOD FRAME

Heating:

$U_{W4south} = 2,87\ W/m^2\ K$

$HF_{W4south} = U_{W4south} * \Delta T_{cooling} = 2.87 *24.8 = 71.17\ W/\ m^2$

$Q_{W4south} = HF_{W4south} * A_{W4south} = 71.17 * 3.6 = 256.2\ W$

Cooling:

Heat transfer part

$CF_{W4south} = U_{W4south} *(\Delta T_{cooling} - 0.46 * DR) = 2,87\ (7,9 - 0,46 \cdot 11,9) = 6,96\ W/m^2$

Part for Irradiation part

$E_D = 348$

$E_d = 209$

South window of a detached house - FFS = 0.47

SHGC= 0.46

$PXI_{W4south} = E_D + E_d = 348 + 209 = 557$

$CF_{W4south} = PXI*SHGC*IAC*FF_s = 557*0.46*1*0.47 = 120.4$

$CF_{fenestration4south} = U_{w3south} *(\Delta T_{cooling} - 0.46 * DR) + PXI *SHGC *IAC * FF_s = 6.9 + 120.4 = 127.3\ W/m^2$

$\dot{Q}_{w4south} = CF_{fenestration4south} * A_{W4south} = 127.3*3.6 = 458.28\ W$

$\dot{Q}_{\text{Total windows Cooling wood frame}} = 1900,.8 + 3352.32 + 533.88 + 458.28 = 6245.3\ W$

$\dot{Q}_{\text{Total windows Heating wood frame}} = 1014.2+1014.2+253.6+256.2 = 2538.2\ W$

Result:

$\dot{Q}_{\text{Total windows Cooling Aluminium frame}}$ **= 6607 W**

is bigger than

$\dot{Q}_{\text{Total windows Cooling wood frame}}$ **=6245.3 W**

$\dot{Q}_{\text{Total windows Heating Aluminium frame}}$= **3312.8 W**

is bigger than

$\dot{Q}_{\text{Total windows Heating wood frame}}$ **=2538.2 W**

the wood frame is better because of resistance of this material.