WEEK 8

Monday, December 16, 2019 2:31 AM

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- 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)

	BENCHMARK	1	2	3
GAP	13mm	13mm	13mm	13mm
e	0,84	0,84	0,1	0,84
N° PANE	2	2	2	3
GAS	AIR	KRYPTON	AIR	AIR
UFACTOR	2,8 W/m2 K	2,6 W/m2 K	1,8 W/m2 K	1,8 W/m2 K
%	100%	93%	64%	64%

- Consider the house that we analysed in the alst two examples, calculate the heating and cooling load of the other windows which are fixed

  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

TSUMMER: 24°

TWINTER: 20°

HEATING DB 99%: - 4,8

COOLING DB/MCWB 1%: 31,9

$DT_{cooling}$ =31.9−24=7.9℃

$DT_{heating}$ =20−(−4.8)=24.8℃ DR=11.9℃

Wood Frames

Window1(east, wood frame, fixed)

$A_{window1}$ = 14.4㎡

Heating:

$U_{window1}$ =2.84W/㎡·K

$HF_{window1} = U_{window1} \cdot DT_{cooling} = 2.84 \cdot 24.8 = 70.44 W / ㎡$

$Q_{window1} = HF_{window1} \cdot A_{window} = 70.44 \cdot 14.44 = 1014.2W$

Cooling:

Heat transfer:

$CF_{window1} = U_{window1} (DT_{cooling} - 0.46DR) = 2.84(7.9 - 0.46 \acute{} 11.9) = 6.9W / ㎡$

Irradiation：

ED= 559,

Ed = 188,

FF_{seast}

= 0.31

$PXI_{window1} = ED + Ed = 559+188=747$

$CF_{window1} = PXI \acute{} SHGC \acute{} IAC \acute{} FF_{seast} = 747 \acute{} 0.54 \acute{} 1 \acute{} 0.31 = 125.1$

$CF_{fenestration1} = U_{window1} (DT_{cooling} - 0.46DR) + PXI \acute{} SHGC \acute{} IAC \acute{} FF_{seast}$

$= 6.9 + 125.1 = 132W / ㎡$

$Q\&_{window1} = CFfenestration1 \acute{} A_{window1} = 132 \acute{} 14.4 = 1900.8W$

Window2(west, wood frame, fixed)

$A_{window2} = 14.4㎡$

Heating:

$U_{window\ 2} = 2.84W/㎡{\cdot}K$

$HF_{window\ 2} = U_{window\ 2} \acute{} DT_{cooling} = 2.84 \acute{} 24.8 = 70.44\ W/㎡Q$

$Q_{window\ 2} = HF_{window\ 2} \acute{} Awindow2 = 70.44 \acute{} 14.4 = 1014.2W$

Cooling:

Heat transfer:

$CF_{window\ 2} = U_{window\ 2} (DT_{cooling} - 0.46DR) = 2.84(7.9 - 0.46 \acute{} 11.9) = 6.9\ W/㎡$

Irradiation:

ED=559, Ed=188,

$FF_{swest} = 0.56$,

PXIwindow1 = ED + Ed =559+188=747

$CF_{window\ 2} = PXI \acute{} SHGC \acute{} IAC \acute{} FF_{swest} = 747 \acute{} 0.56 \acute{} 1 \acute{} 0.56 = 225.9$

$CF_{fenestration\ 2} = U_{window\ 2} (DT_{cooling} - 0.46DR) + PXI \acute{} SHGC \acute{} IAC \acute{} FF_{swest}$

$= 6.9 + 225.9 = 232.8W / ㎡$

$Q\&_{window2} = CF_{fenestration\ 2} \acute{} A_{window2} = 232.8 \acute{} 14.4 = 3352.32W$

Window3(south, wood frame, fixed)

$A_{window3} = 3.6㎡$

Heating:

$U_{window3} = 2.84\ W/㎡{\cdot}K$

$HF_{window3} = U_{window3} \acute{} DT_{cooling} = 2.84 \acute{} 24.8 = 70.44\ W/㎡Q_{window3} = HF_{window3} \acute{} A_{window3} = 70.44 \acute{} 3.6 = 253.6W$

Cooling:

Heat transfer:

$CF_{window3} = U_{window3} (DT_{cooling} - 0.46DR) = 2.84(7.9 - 0.46 \acute{} 11.9) = 6.9W / ㎡$

Irradiation:

ED=348, Ed=209,

FF_{ssouth} =0.47

$PXI_{window3}$ =ED+Ed=348+209=557

$CF_{window3}$ = PXI ´ SHGC ´ IAC ´ FF_{ssouth} = 557 ´ 0.54 ´1´ 0.47 = 141.4

$CF_{fenestration\ 3}$ = Uwindow3 ($DT_{cooling}$ - 0.46DR) + PXI ´ SHGC ´ IAC ´ FF_{ssouth}

= 6.9 + 141.4 = 148.3W / ㎡

$Q_{window3}$ = $CF_{fenestration\ 3}$ ´ $A_{window3}$ = 148.3 ´ 3.6 = 533.88W

Window4(south, wood frame, openable)

$A_{window4}$ = 3.6㎡

Heating:

$U_{window\ 4}$ =2.87 W/㎡·K

$HF_{window\ 4}$ = $U_{window\ 4}$ ´ $DT_{cooling}$ =2.87 ´ 24.8=71.17 W/㎡Q $Q_{window\ 4}$ = $HF_{window\ 4}$ ´ $A_{window\ 4}$ = 71.17 ´ 3.6 = 256.2W

Cooling:

Heat transfer:

$CF_{window\ 4}$ = $U_{window\ 4}$ ($DT_{cooling}$ - 0.46DR) = 2.87(7.9 - 0.46 ´11.9) = 6.96W / ㎡

Irradiation:

ED=348, Ed=209, SRom=0.46,

FFssouth =0.47

PXIwindow4 =ED+Ed=348+209=557

$CF_{window\ 4}$ = PXI ´ SHGC ´ IAC ´ FF_{ssouth} = 557 ´ 0.46 ´1´ 0.47 = 120.4

$CF_{fenestration\ 4}$ = $U_{window\ 4}$ ($DT_{cooling}$ - 0.46DR) + PXI ´ SHGC ´ IAC ´ FF_{ssouth}

= 6.9 + 120.4 = 127.3W / ㎡

Q&window 4 = $CF_{fenestration\ 4}$ ´ Awindow 4 = 127.3 ´ 3.6 = 458.28W Q&totalcoolingwood =1900.8+3352.32+533.88+458.28=6245.3w

Q&totalheatingwood =1014.2+1014.2+253.6+256.2=2538.2w

Aluminum Frames

Window1(south, aluminum frame, fixed)

$A_{window1}$ = 14.4㎡

Heating:

$U_{window1}$ =3.61 w/㎡·K

$HF_{window1}$ = $U_{window1}$ ´ $DT_{cooling}$ = 3.61´ 24.8 = 89.52W / ㎡

$Q_{window1}$ = $HF_{window1}$ ´ $A_{window1}$ = 89.52 ´14.4 = 1289.1W

Cooling:

Heat transfer:

$CF_{window1}$ = $U_{window1}$ ($DT_{cooling}$ - 0.46DR) = 3.61(7.9 - 0.46 ´11.9) = 8.7W / ㎡

Irradiation：

ED= 559,

Ed = 188, SRom=0.56

FF_{seast} = 0.31

$PXI_{window1}$ = ED + Ed =559+188=747

$CF_{window1}$ = PXI ´ SHGC ´ IAC ´ FF_{seast} = 747 ´ 0.56 ´1´ 0.31 = 129.6

$CF_{fenestration1}$ = $U_{window1}$ ($DT_{cooling}$ - 0.46DR) + PXI ´ SHGC ´ IAC ´ FF_{seast}

= 8.7 + 129.6 = 138.3W / ㎡

$Q_{\&window1}$ = $CF_{fenestration1}$ ´ $A_{window1}$ = 138.3 ´14.4 = 1991.5W

Window2(west, aluminum frame, fixed)

$A_{window\ 2}$ = 14.4㎡

Heating:

$U_{window\ 2}$ =3.61 w/㎡·K

$HF_{window\ 2}$ = $U_{window\ 2}$ ´ $DT_{cooling}$ = 3.61´ 24.8 = 89.52W / ㎡Q

$Q_{window\ 2}$ = $HF_{window\ 2}$ ´ $A_{window\ 2}$ = 89.52 ´14.4 = 1289.1W

Cooling:

Heat transfer:

CFwindow 2 = Uwindow 2 ($DT_{cooling}$ - 0.46DR) = 3.61(7.9 - 0.46 ´11.9) = 8.7W / ㎡

Irradiation:

ED=559, Ed=188,

FF_{swest} =0.56

$PXI_{window2}$ =ED+Ed=559+188=747

$CF_{window2}$ = PXI ´ SHGC ´ IAC ´ FFswest = 747 ´ 0.56 ´1´ 0.56 = 234.26

$CF_{fenestration\ 2}$ = $U_{window\ 2}$ ($DT_{cooling}$ - 0.46DR) + PXI ´ SHGC ´ IAC ´ FF_{swest}

= 8.7 + 234.26 = 242.96W / ㎡

$Q_{\&window\ 2}$ = $CF_{fenestration\ 2}$ ´ $A_{window\ 2}$ = 242.96 ´14.4 = 2398.6W

Window3(south, aluminum frame, fixed)

$A_{window3}$ = 3.6㎡

Heating:

$U_{window3}$ =3.61 W/㎡·K

$HF_{window3}$ = $U_{window3}$ ´ $DT_{cooling}$ = 3.61´ 24.8 = 89.52W / ㎡Q

$Q_{window3}$ = $HF_{window3}$ ´ $A_{window3}$ = 89.52 ´ 3.6 = 322.2W

Cooling:

Heat transfer:

$CF_{window3}$ = $U_{window3}$ ($DT_{cooling}$ - 0.46DR) = 3.61(7.9 - 0.46 ´11.9) = 8.7W / ㎡

Irradiation:

ED=348, Ed=209,

FF_{ssouth} =0.47

$PXI_{window3}$ =ED+Ed=348+209=557

$CF_{window3}$ = PXI ´ SHGC ´ IAC ´ FF_{ssouth} = 557 ´ 0.56 ´1´ 0.47 = 146.6

$CF_{fenestration\ 3}$ = $U_{window3}$ ($DT_{cooling}$ - 0.46DR) + PXI ´ SHGC ´ IAC ´ FF_{ssouth}

= 8.7 + 146.6 = 155.3W / ㎡

$Q_{\&window3}$ = $CF_{fenestration\ 3}$ ´ $A_{window3}$ = 155.3 ´ 3.6 = 559.08W

Window4(south, aluminum frame, openable)

Awindow4 = 3.6㎡

Heating:

$U_{window\ 4}$ =4.62 W/㎡·K R

$HF_{window4}$ = $U_{window4}$ ´ $DT_{cooling}$ = 4.62 ´ 24.8 = 114.57W / ㎡Q

$Q_{window\ 4}$ = $HF_{window\ 4}$ ´ $A_{window\ 4}$ = 114.57 ´ 3.6 = 412.4W

Cooling:

Heat transfer:

$CF_{window\ 4}$ = $U_{window\ 4}$ ($DT_{cooling}$ - 0.46DR) = 4.62(7.9 - 0.46 ´11.9) = 11.2W / ㎡

Irradiation:

ED=348, Ed=209, SRom=0.55,

FF_{ssouth} =0.47

$PXI_{window4}$ =ED+Ed=348+209=557

$CF_{window\ 4}$ = PXI ´ SHGC ´ IAC ´ FF_{ssouth} = 557 ´ 0.55 ´1´ 0.47 = 143.98

$CF_{fenestration\ 4}$ = Uwindow4 ($DT_{cooling}$ - 0.46DR) + PXI ´ SHGC ´ IAC ´ FF_{ssouth}

= 11.2 + 143.98 = 155.18W / ㎡

$Q_{\&window4}$ = $CF_{fenestration\ 4}$ ´ $A_{window4}$ = 155.18 ´ 3.6 = 558.65W $Q_{\&totalcoolingaluminum}$ =1991.5+3498.6+559.08+558.65=6607.8w $Q_{\&totalheatingaluminum}$ =1289.1+1289.1+322.2+412.4=3312.8w

Conclusion:

$Q_{\&totalcoolingwood}$

/ $Q_{\&totalcoolingaluminum}$ =6245.3/6607.8=94.5%

$Q_{\&totalheatingwood}$ / $Q_{\&totalheatingaluminum}$ =2538.2/3312.8=76.6%

From the result we can conclude that window with wooden frame has better resistance than aluminum frame. 94.5% for cooling and 76.6% for heating.