Week Eight Assignment

Wednesday, November 27, 2019 12:25 AM

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)

Answer:

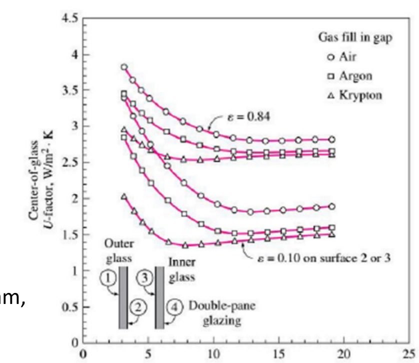
The U - value of a window:

$$Uwindow = \frac{UcenterAcenter + UedgeAedge + UframAfram}{Awindow}$$

If it is a double - pane window, disregard the thermal resistances of glass layers:

$$\frac{1}{Udouble - pane\ (ceter\ region)} = \frac{1}{hi} + \frac{1}{hspace} + \frac{1}{h0}, hspace$$

$$= hrad, space + hconv, space$$



The **h**space changes by changing the gas that fills the gap.
From the diagram in the right side, we can see that: When the gap thickness is 13 mm,

By changing the gas that fills the gap from air to argon, the U-value of the center of the glass decreases from 2.8 $\frac{w}{m2k}$ to 2.65$\frac{w}{m2k}$

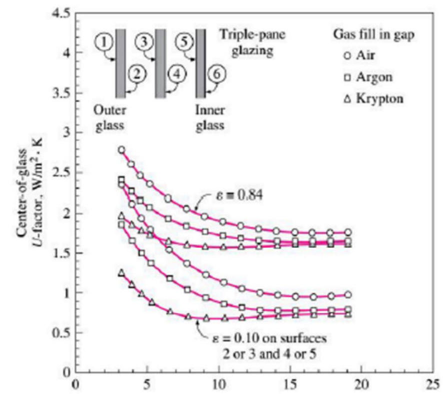
, which means the U-value decreases about 6.43%

By changing the gas that fills the gap from air to krypton, the U-value of the center of the glass decrease from 2.8$\frac{w}{m2k}$ to 2.6$\frac{w}{m2k}$

, which means the U-value decreases about 7.14%.

The **h**space changes by adding an extra pane.
From the diagram in the right side, we can see that:
When the gap thickenss is 13 mm, and the gas that fills the gap is air,
By adding an extra pane,

the U-value of the center of the glass decreases from $2.8\frac{w}{m2k}$ to $1.8\frac{w}{m2k}$
, which means the U-value decreases about 55.6%.



Another way to change the Ucenter, is to coat the glass surfaces
with a film that has a low emissivity.

From the diagram in the right we can see that:
When the gap thickenss is 13 mm, and the gas fills the gap is air,

By coating the glass surfaces with a film that has the emissivity of 0.1 to change the Ucenter, , the U-value of the center
of the glass
decreases from $2.8\frac{w}{m2k}$ to $1.8\frac{w}{m2k}$
, which means the U-value decreases about 55.6%.

Task 2:

Consider the house that we analyzed 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?

Answer:

PIACENZA, Italy WMO#: **160840**

Lat: **44.92N** Long: **9.73E** Elev: **138** StdP: **99.68** Time Zone: **1.00 (EUW)** Period: **89-10** WBAN: **99999**

Annual Heating and Humidification Design Conditions

Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB		
			99.6%			99%			0.4%		1%				
	99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	
1	-6.2	-4.8	-11.6	1.4	3.1	-8.8	1.8	1.8	8.8	5.6	7.7	6.2	2.1	250	(1)

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB		
		0.4%		1%		2%		0.4%		1%		2%				
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD	
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)	
8	11.9	33.1	22.7	31.9	22.4	30.3	21.8	24.6	30.2	23.7	29.2	22.9	28.3	2.4	90	(2)

Cooling design temperature **Tcooling = 24 °C**,
,and heating design temperature **Theating = 20 °C**, therefore,

ΔTcooling = 31.9 °C - 24 °C = 7.9 °C = 7.9K

ΔTheating = 20°C - (-4.8°C) = 24.8 °C = 24.8K

From the table above, **DR = 11.9 °C = 11.9K**

The cooling load of the fixed window on the west is:

q windowwest = A x **CF** windowwest

A = 14.4m2,

CF windowwest(Heat Trasnfer Part) = **U** windowwest (ΔTcooling - 0.46 DR)
,The window has a fixed heat absorbing double layer glass with a wooden frame,
And so, **U** windowwest = 2.84$\frac{w}{m2k}$

CF windowwest(Heat Trasnfer Part)= 2.84$\frac{w}{m2k}$x (7.9 K - 0.46x11.9 K) = 6.89$\frac{w}{m2k}$

PXI windowwest = ED + Ed = 559 +188 = 747
SHGC = 0.54

No internal shading, so **IAC** = 1 FFs = 0.56
CF windowwest(Irradiation Part) = PXI x SHGC x IAC x FFs

qwindowwest = A x **CF** windowwest = A x (**CF** windowwest(Heat Trasnfer Part) + **CF** windowwest(Irradiation Part))
=14.4 m2 x (6.89 +747x 0.54 x 1 x 0.56) $\frac{W}{m2}$= 3352.07 W

The heating load of the fixed window on the west is:

q windowwest = A x **HF** windowwest = A x **U** windowwest.ΔTheating
= 14.4 m2 x 2.84$\frac{w}{m2k}$x 24.8K = 1014.22 W

When the frame were to be aluminium,
U windowwest = 3.61$\frac{w}{m2k}$, HSGC = 0.56

CF' windowwest (heat transfer part) = **U'**windowwest (ΔTcooling - 0.46 DR)

=3.61$\frac{w}{m2k}$ x (7.9 K - 0.46 x 11.9 K) =8.76 $\frac{W}{m2}$

Cooling load **q'**windowwest = A x **CF'** window
= A x (**CF'**windowwest(Heat Transfer Part) + **CF'** windowwest(Irradiation Part))
= 14.4 m2 x (8.76 +747x 0.56 x 1 x 0.56) $\frac{W}{m2}$ =3499.48 W

Heating load **q'**windowwest = A x **HF'**windowwest = A x **U'**windowwest. ΔTheating

= 14.4 m2 x 3.61$\frac{w}{m2k}$x 24.8 K = 1289.20 W

The cooling load of the fixed window on the south is:

q windowsouth = A x **CF** windowsouth
A = 3.6 m2,

CF windowsouth(Heat Trasnfer Part) = **U**windowsouth (ΔTcooling - 0.46 DR)

The window has a fixed heat absorbing double layer glass with a wooden frame,
So, **U** windowwast=2.842.84$\frac{w}{m2k}$
, **CF** windowsouth(Heat Transfer Part)= 2.842.84$\frac{w}{m2k}$ x (7.9 K - 0.46 x 11.9 K) = 6.89$\frac{W}{m2}$

PXI windowsouth = ED + Ed = 348 +209 = 557
SHGC = 0.55

No internal shading, so IAC =1

FFs = 0.47

CF windowsouth(Irradiation Part) = PXI x SHGC x IAC x FFs
qwindowsouth = A x **CF** windowsouth = A x (**CF** windowsouth(Heat Transfer Part) + **CF** windowsouth(Irradiation Part))
=3.6 m2 x (6.89 +557 x 0.54 x 1 x 0.47) $\frac{W}{m2}$ = 553.72 W

The heating load of the fixed window on the south is:

q windowsouth = A x **HF** windowsouth = A x **U** windowsouth ΔTheating
= 3.6 m2 x 2.84 $\frac{w}{m2k}$x 24.8K = 253.56 W

When the frame were to be aluminium,
U windowsouth = 3.61$\frac{w}{m2k}$, , HSGC = 0.56

CF' windowsouth(Heat Trasnfer Part) = **U'**(winidow south)(ΔTcooling - 0.46 DR)

=3.61$\frac{w}{m2k}$ X (7.9 K - 0.46 X 11.9 K) = 8.76$\frac{W}{m2}$

Cooling load **q'** windowsouth = A X **CF'**windowsouth

= A X (**CF'**windowsouth(Heat Trasnfer Part) + **CF'**windowsouth(Irradiation Part))
= 3.6 m2 X (8.76 +557 X 0.56 X 1 X 0.47) $\frac{W}{m2}$ = 559.30 W

Heating load **q'** windowsouth = A X **HF'**windowsouth
= A X **U'** windowsouth ΔTheating
= 3.6 m2 X 3.61$\frac{w}{m2k}$X 24.8 K = 322.30 W

The cooling load of the operable window on the south is:

q windowsouth = A X **CF** windowsouth
A = 3.6 m2,

CF windowsouth(Heat Trasnfer Part) = **U** windowsouth (ΔTcooling - 0.46 DR)
,The window has an operable heat absorbing double layer glass with a wooden frame,
So, **U** windowwast = 2.87$\frac{w}{m2k}$

, **CF** windowsouth(Heat Trasnfer Part) = 2.87$\frac{w}{m2k}$ X (7.9 K - 0.46 X 11.9 K) = 6.96$\frac{W}{m2}$

PXI windowsouth = ED + Ed = 348 +209 = 557
SHGC = 0.46

No internal shading, so **IAC** = 1

FFs = 0.47

CF windowsouth(Irradiation Part) = PXI X SHGC X IAC X FFs
q windowsouth = A X **CF** windowsouth = A X (**CF** windowsouth(Heat Trasnfer Part) + **CF** windowsouth(Irradiation Part))
=3.6 m2 X (6.96 +557 X 0.54 X 1 X 0.47) $\frac{W}{m2}$ = 553.98 W

The heating load of the fixed window on the south is:

q windowsouth = A X **HF** windowsouth = A X **U** windowsouth ΔTheating

$= 3.6\ m2\ X\ 2.87 \frac{w}{m2k} X\ 24.8K = 256.23\ W$

When the frame were to be aluminium, **U** windowsouth = $4.62 \frac{w}{m2k}$, HSGC = 0.55

CF' windowsouth(Heat Trasnfer Part) = U' windowsouth (ΔTcooling - 0.46 DR)

$=4.62 \frac{w}{m2k} X\ (7.9\ K - 0.46\ X\ 11.9\ K) = 11.21 \frac{W}{m2}$

Cooling load q' windowsouth = A X **CF'**windowsouth
= A X (CF'windowsouth(Heat Trasnfer Part) + CF'windowsouth(Irradiation Part))
$= 3.6\ m2\ X\ (11.21 + 557\ X\ 0.55\ X\ 1\ X\ 0.47) \frac{W}{m2} = 558.70\ W$

Heating load q' windowsouth = A X **HF'** windowsouth = A X **U'** windowsouth ΔTheating

$= 3.6\ m2\ X\ 4.62 \frac{w}{m2k} X\ 24.8\ K = 412.47\ W$