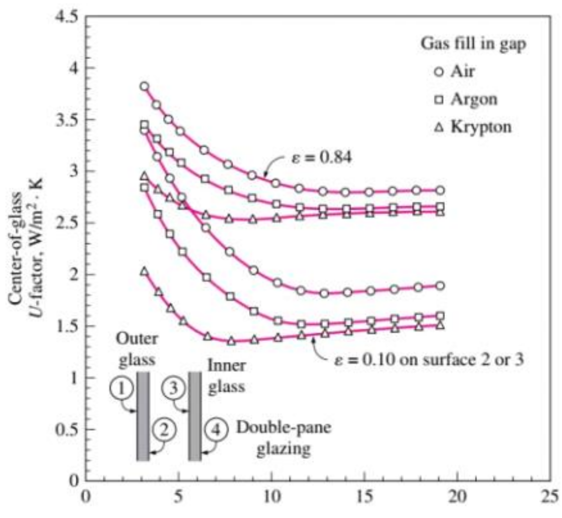
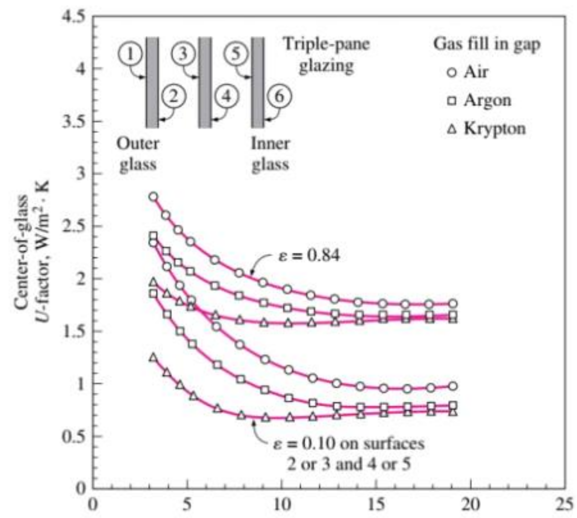
Week8 Zhou Yuhan

2019年11月27日 0:38

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)





To calculate the U-value of a window,

U window =$\frac{UcAc+UeAe+\mathrm{UfAf}}{Aw}$

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

$$\frac{1}{Udouble}=\frac{1}{hi}+\frac{1}{hs}+\frac{1}{h_0}\quad h_s=h_{rad}+h_{conv}$$

The gap thickness is 13mm,

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$\frac{W}{㎡k}$ to 2.65$\frac{W}{㎡k}$,

The U-value of the center of the glass decreases 5.36%

By changing the gas that fills the gap from air to krypton,

The U-value of the center of the glass decreases from 2.8$\frac{W}{㎡k}$ to 2.6$\frac{W}{㎡k}$,

The U-value of the center of the glass decreases 7.14%

When the gap thickness is 13mm, and the gas fills the gap is air,

By coating the glass surfaces with a film that has the emissivity of 0.1

The U-value of the center of the glass decreases from 2.8$\frac{W}{㎡k}$ to 1.8$\frac{W}{㎡k}$,

The U-value of the center of the glass decreases 35.71%

Task 2 Consider the house that we analysed in the alst 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, 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)

$\Delta T_{cooling} = 31.9 - 24 = 7.9\,°C$

$\Delta T_{heating} = 20 - (-4.8) = 24.8\,°C$

$DR = 11.9\,°C$

<u>The cooling load of the fixed window on the west:</u>

$Q_{window_{west}} = A * CF_{window_{west}}$

A=14.4㎡

$CF_{winow_{west}} = U_{window_{west}}\left(\Delta T_{cooling} - 0.46DR\right)$

$U_{window_{west}} = 2.85\frac{W}{㎡K}$

$CF_{window_{west}} = 2.85\frac{W}{㎡K} * (7.9K - 0.46 * 11.9K) = \frac{6.89W}{㎡}$

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

SHGC=0.54 IAC=1 $FF_s = 0.56$

$CF_{window_{west}} = PXI * SHGC * IAC * FF_s$

$q_{window_{west}} = A * CF_{window_{west}} = A * \left(CF_{window_{west}(heat)} + CF_{window_{(irradiation)}}\right)$

$\approx 14.4\,m^2 * 2.85\frac{W}{㎡K} * 24.8K = 1014.22W$

<u>The heating load of the fixed window on the west:</u>

$CF_{winow_{west}} = U_{window_{west}}\left(\Delta T_{cooling} - 0.46DR\right)$

$U_{window_{west}} = 3.61\frac{W}{㎡K}$

$CF_{window_{west}} = 3.61\frac{W}{㎡K} * (7.9K - 0.46 * 11.9K) = 8.76\frac{W}{㎡K}$

Cooling load $q_{window_{west}} = A * CF_{window_{west}} = 3500W$

Heating load $q_{window_{west}} = A * CF_{window_{west}} = A * \left(CF_{window_{west}(heat)} + CF_{window_{(irradiation)}}\right) = 1290W$

<u>The cooling load of the fixed window on the south:</u>

$q_{window_{south}} = A * CF_{window_{south}}$

A=3.6㎡

$U_{window_{south}} = 2.84\frac{W}{㎡K}$

$CF_{window_{west}} = 2.84\frac{W}{㎡K} * (7.9K - 0.46 * 11.9K) = 6.89\frac{W}{㎡K}$

$PXI_{window_{south}} = E_D + E_d = 248 + 209 = 557$

SHGC=0.54 IAC=1 $FF_s = 0.47$

$CF_{window_{west}} = PXI * SHGC * IAC * FF_s$

$q_{window_{west}} = A * CF_{window_{west}} = A * \left(CF_{window_{west}(heat)} + CF_{window_{(irradiation)}}\right)$

$\approx 3.6m^2 * (6.89 + 557 * 0.54 * 1 * 0.47)\frac{W}{m^2K} = 553.72W$

<u>The heating load of the fixed window on the south:</u>

$q_{window_{south}} = A * HF_{window_{south}} = A * U_{window_{south}} \Delta T_{heating}$

$=3.6m^2 * 2.84\frac{W}{m^2K} * 24.8K = 254W$

When Aluminium:

$U_{window_{west}} = 3.61\frac{W}{m^2K}$

$CF_{window_{west}} = 3.61\frac{W}{m^2K} * (7.9K - 0.46 * 11.9K) = 8.76\frac{W}{m^2K}$

Cooling load $q_{window_{west}} = A * CF_{window_{west}} = 559.30\ W$

Heating load $q_{window_{west}} = A * CF_{window_{west}} = A * \left(CF_{window_{west}(heat)} + CF_{window_{(irradiation)}}\right) = 322.30\ W$

<u>The cooling load of the operable window on the west:</u>

$Q_{window_{west}} = A * CF_{window_{west}}$

$A=3.6m^2$

$CF_{winow_{west}} = U_{window_{west}}\left(\Delta T_{cooling} - 0.46DR\right)$

$U_{window_{west}} = 2.87\frac{W}{m^2K}$

$CF_{window_{west}} = 2.85\frac{W}{m^2K} * (7.9K - 0.46 * 11.9K) = 6.96\frac{W}{m^2K}$

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

SHGC=0.46 IAC=1 $FF_s = 0.47$

$CF_{window_{west}} = PXI * SHGC * IAC * FF_s$

$q_{window_{west}} = A * CF_{window_{west}} = A * \left(CF_{window_{west}(heat)} + CF_{window_{(irradiation)}}\right)$

$\approx 3.6m^2 * (6.96 + 557 * 0.46 * 1 * 0.47)\frac{W}{m^2K} = 458.58W$

<u>The heating load of the operable window on the south:</u>

$q_{window_{south}} = A * HF_{window_{south}} = A * U_{window_{south}} \Delta T_{heating}$

$=3.6m^2 * 2.87\frac{W}{m^2K} * 24.8K = 256.23W$

When Aluminium:

$U_{window_{west}} = 4.62\frac{W}{m^2K}$

$CF_{window_{west}} = 4.62\frac{W}{m^2K} * (7.9K - 0.46 * 11.9K) = 11.21\frac{W}{m^2K}$

Cooling load $q_{window_{west}} = A * CF_{window_{west}} = 558.70\ W$

Heating load $q_{window_{west}} = A * CF_{window_{west}} = A * \left(CF_{window_{west}(heat)} + CF_{window_{(irradiation)}}\right) = 412.47\ W$