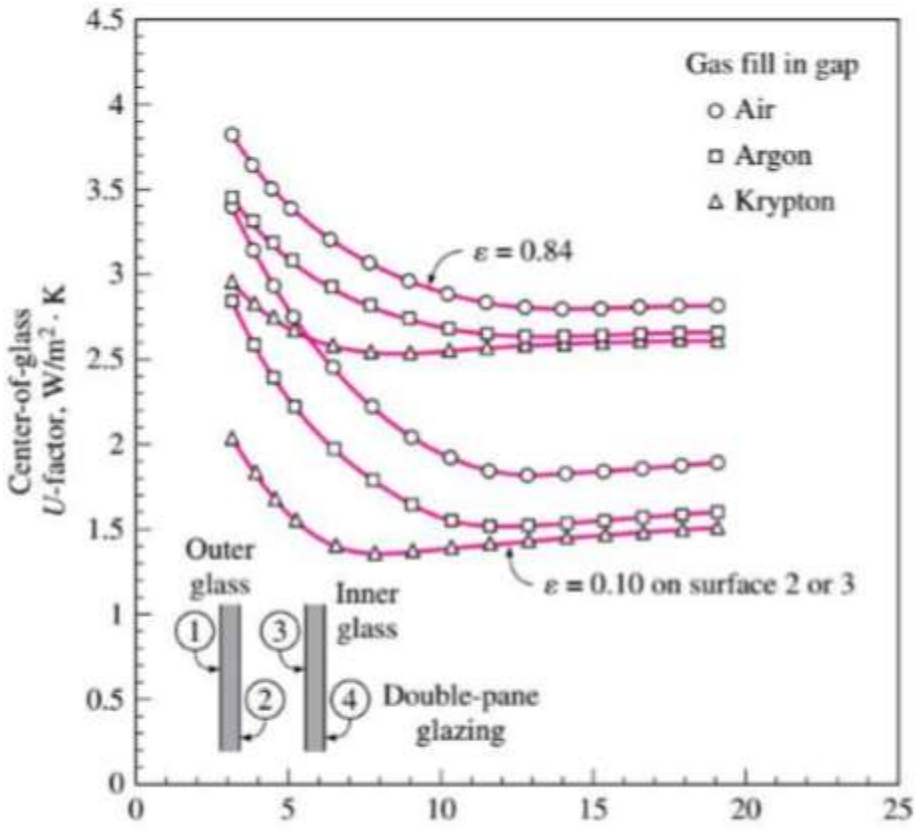
Farnaz Baadahang / 26 Nov 2019

WEEK 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 thickens to be 13 mm)
If we add a pane and we change the gas for argon or krypton we will have reduce the emissivity 50%.
In this table we can obtain the data that represents how the material and the gas will react with the heating or cooling conditions.

2 Parallel plans with Air	2.8		
2 Parallel plans with Argon	2.65	0.15	5%
2 Parallel plans with Krypton	2.58	0.22	8%
2 Parallel plans with Air and Coating	1.82	0.98	35%
2 Parallel plans with Argon and Coating	1.52	1.28	46%
2 Parallel plans with Krypton and Coating	1.45	1.35	48%
3 Parallel plans with Air	1.8	1	36%
3 Parallel plans with Argon	1.68	1.12	40%
3 Parallel plans with Krypton	1.6	1.2	43%
3 Parallel plans with Air and Coating	1	1.8	64%
3 Parallel plans with Argon and Coating	0.8	2	71%
3 Parallel plans with Krypton and Coating	0.7	2.1	75%



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 aluminum?

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%	99.6% DP	99.6% HR	99.6% MCDB	99% DP	99% HR	99% MCDB	0.4% WS	0.4% MCDB	1% WS	1% 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% DB	0.4% MCWB	1% DB	1% MCWB	2% DB	2% MCWB	0.4% WB	0.4% MCDB	1% WB	1% MCDB	2% WB	2% 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)

99%=-4.8 °C

1%=31.9°C

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

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

DR= 11.9°C

COOLING LOAD WEST WINDOW (SUMMER)

U= 2.84
SHGC=0.54
DR=11.9 °C
IAC= 1
FFs= 0.56

CF= U $(\Delta T - 0.46DR) + PXI + SHGC * IAC * FFs$

$CF = 2.84\ (7.9 - 0.46 * 11.9) = \ 6.89 \frac{W}{m2}$

PXI=ED + Ed= 559+188=747

$CF = 6.89\ (747 * 0.54 * 1 * 0.56) = \ 232.78\ \frac{W}{m2}$

$\dot{Q}\ window\ west$ = CF ×A $= 232.78 * 14.4 = 3352.032$ W

HEATING LOAD WEST (WINTER)

HF = UHeating $\times \Delta T_{heating} = 2.84\ * 24.8 = 70.432\ \frac{W}{m2}$

$\dot{Q}$ = HF ×A $= 70.432 * 14.4 = 1014.22$ W

ALUMINIUM FRAME

COOLING LOAD WEST WINDOW (SUMMER)

U=3.61 W/m k

SHGC= 0.56

CF= U $(\Delta T - 0.46DR) + PXI + SHGC * IAC * FFs$

$CF = 3.61\ (7.9 - 0.46 * 11.9) = \ 8.76 \frac{W}{m2}$

$CF = 8.76\ (747 * 0.54 * 1 * 0.56) = \ 243.02\ \frac{W}{m2}$

$\dot{Q}\ window\ west$ = CF ×A $= 232.78 * 14.4 = 3499.48$ W

HEATING LOAD WEST (WINTER)

HF = UHeating $\times \Delta T_{heating} = 3.61\ * 24.8 = 89.53\ \frac{W}{m2}$

$\dot{Q}$ = HF ×A $= 89.53 * 14.4 = 1289.23$ W

COOLING LOAD SOUTH FIXED WINDOW (SUMMER)

U= 2.84
SHGC=0.54
DR=11.9 °C
IAC= 1
FFs= 0.47
A = 3.6 m^2

$CF_{windowsouth} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowsouth\_heattransfer} = U(\Delta T - 0.46DR)$

$CF_{windowsouth\_heattransfer} = 2.84\ (7.9 - (0.46)\ (11.9)) = 6.89\ \frac{W}{m^2}$
$CF_{windowsouth\_irridiation} = PXI \times SHGC \times IAC \times FF_s$
$PXI = E_D - E_d = 348 + 209 = 557$
$CF_{windowsouth\_irridiation} = 557 \times 0.54 \times 1 \times 0.47 = 141.37\ \frac{W}{m^2}$
$CF_{windowsouth} = CF_{windowsouth\_heattransfer} + CF_{windowsouth\_irridiation}$
$CF_{windowsouth} = 6.89 + 141.37 = 148.26\ \frac{W}{m^2}$
$\dot{q}_{windowsouth} = A \times CF_{windowsouth} = 3.6 \times 148.26 = 533.74\ W$

HEATING LOAD SOUTH FIXED WINDOW (WINTER)

$\dot{q}_{windowsouth} = A \times HF_{windowsouth}$
$HF_{windowsouth} = U_{windowsouth} \times \Delta T_{heating}$
$HF_{windowsouth} = 2.84 \times 24.8 = 70.43\ \frac{W}{m^2}$
$\dot{q}_{windowsouth} = A \times HF_{windowsouth} = 3.6 \times 70.43 = 253.08\ W$

ALUMINIUM FRAME

COOLING LOAD SOUTH FIXED WINDOW

A = 3.6 m^2
U = 3.61
SHGC = 0.56
IAC = 1
$FF_s = 0.47$

$CF_{windowsouth} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowsouth\_heattransfer} = U(\Delta T - 0.46DR)$

$CF_{windowsouth\_heattransfer} = 3.61\ (7.9 - (0.46)(11.9)) = 8.76\ \frac{W}{m^2}$
$CF_{windowsouth\_irridiation} = PXI \times SHGC \times IAC \times FF_s$
$PXI = E_D - E_d = 348 + 209 = 557$
$CF_{windowsouth\_irridiation} = 557 \times 0.56 \times 1 \times 0.47 = 146.60\ \frac{W}{m^2}$
$CF_{windowsouth} = 8.76 + 146.60 = 155.36\ \frac{W}{m^2}$
$\dot{q}_{windowsouth} = A \times CF_{windowsouth} = 3.6 \times 155.36 = 559.30\ W$

HEATING LOAD SOUTH FIXED WINDOW

$HF_{windowsouth} = U_{windowsouth} \times \Delta T_{heating}$

$HF_{windowsouth} = 3.61 \times 24.8 = 89.53 \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \times HF_{windowsouth} = 3.6 \times 89.53 = 322.31\ W$

COOLING LOAD SOUTH OPERABLE WINDOW

$A = 3.6\ m^2$

$U = 2.87$

$IAC = 1$

$FF_s = 0.47$

$SHGC = 0.46$

$CF_{windowsouth} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$

$CF_{windowsouth\_heattransfer} = U(\Delta T - 0.46DR)$

$CF_{windowsouth\_heattransfer} = 2.87\ (7.9 - (0.46)(11.9)) = 6.96 \frac{W}{m^2}$

$CF_{windowsouth\_irridiation} = PXI \times SHGC \times IAC \times FF_s$

$PXI = E_D - E_d = 348 + 209 = 557$

$CF_{windowsouth\_irridiation} = 557 \times 0.46 \times 1 \times 0.47 = 120.42 \frac{W}{m^2}$

$CF_{windowsouth} = 6.96 + 120.42 = 127.38 \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \times CF_{windowsouth} = 3.6 \times 127.38 = 458.57\ W$

HEATING LOAD SOUTH OPERABLE WINDOW

$\dot{q}_{windowsouth} = A \times HF_{windowsouth}$

$HF_{windowsouth} = U_{windowsouth} \times \Delta T_{heating}$

$HF_{windowsouth} = 2.87 \times 24.8 = 71.18 \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \times HF_{windowsouth} = 3.6 \times 71.18 = 256.23\ W$

ALUMINIUM FRAME

COOLING LOAD SOUTH OPERABLE WINDOW

$\dot{q}_{windowsouth} = A \times CF_{windowsouth}$

$A = 3.6\ m^2$

$U = 4.62$

$SHGC = 0.55$

$IAC = 1$

$FF_s = 0.47$

$CF_{windowsouth} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$

$CF_{windowsouth\_heattransfer} = U(\Delta T - 0.46DR)$

$CF_{windowsouth\_heattransfer} = 4.62\ (7.9 - (0.46)(11.9)) = 11.21 \frac{W}{m^2}$

$CF_{windowsouth\_irridiation} = PXI \times SHGC \times IAC \times FF_s$

$PXI = E_D - E_d = 348 + 209 = 557$

$$CF_{windowsouth\_irridiation} = 557 \times 0.55 \times 1 \times 0.47 = 143.98 \frac{W}{m^2}$$

$$CF_{windowsouth} = 11.21 + 143.98 = 155.19 \frac{W}{m^2}$$

$$\dot{q}_{windowsouth} = A \times CF_{windowsouth} = 3.6 \times 155.19 = 558.68\ W$$

HEATING LOAD SOUTH OPERABLE WINDOW

$$\dot{q}_{windowsouth} = A \times HF_{windowsouth}$$

$$HF_{windowsouth} = U_{windowsouth} \times \Delta T_{heating}$$

$$HF_{windowsouth} = 4.62 \times 24.8 = 114.58 \frac{W}{m^2}$$

$$\dot{q}_{windowsouth} = A \times HF_{windowsouth} = 3.6 \times 114.58 = 412.47\ W$$