Week 8 weekly submission

CANLAS, GLEN CARLO

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)

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

Considering 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 sqm on the west, fixed 3.6 sqm on the south and an operable 3.6 sqm 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%			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)

Temperature difference calculation

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

$\Delta T_{heating} = 20 - (-4.8) = 24.8\ °C$
DR = 11.9 °C

WEST WINDOW (FIXED)

Cooling Load: Wooden Frame

$\dot{q}_{windowwest} = A \times CF_{windowwest}$
A = 14.4 m^2
$CF_{windowwest} = CF_{windowwest\_heattransfer} + CF_{windowwest\_irridiation}$
$CF_{windowwest} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowwest\_heattransfer} = U(\Delta T - 0.46DR)$
U = 2.84
$CF_{windowwest\_heattransfer} = 2.84\ (7.9 - (0.46)(11.9)) = 6.89\ \frac{W}{m^2}$
$CF_{windowwest\_irridiation} = PXI \times SHGC \times IAC \times FF_s$
$PXI = E_D - E_d = 559 + 188 = 747$
SHGC = 0.54
IAC = 1
$FF_s = 0.56$
$CF_{windowwest\_irridiation} = 747 \times 0.54 \times 1 \times 0.56 = 225.89\ \frac{W}{m^2}$
$CF_{windowwest} = CF_{windowwest\_heattransfer} + CF_{windowwest\_irridiation}$
$CF_{windowwest} = 6.89 + 225.89 = 232.78\ \frac{W}{m^2}$
$\dot{q}_{windowwest} = A \times CF_{windowwest} = 14.4 \times 232.78 = 3352.07\ W$

Cooling Load: Aluminum Frame

$\dot{q}_{windowwest} = A \times CF_{windowwest}$
A = 14.4 m^2
$CF_{windowwest} = CF_{windowwest\_heattransfer} + CF_{windowwest\_irridiation}$
$CF_{windowwest} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowwest\_heattransfer} = U(\Delta T - 0.46DR)$
U = 3.61
$CF_{windowwest\_heattransfer} = 3.61\ (7.9 - (0.46)(11.9)) = 8.76\ \frac{W}{m^2}$
$CF_{windowwest\_irridiation} = PXI \times SHGC \times IAC \times FF_s$
$PXI = E_D - E_d = 559 + 188 = 747$
SHGC = 0.56
IAC = 1
$FF_s = 0.56$
$CF_{windowwest\_irridiation} = 747 \times 0.56 \times 1 \times 0.56 = 234.26\ \frac{W}{m^2}$
$CF_{windowwest} = 8.76 + 234.26 = 243.02\ \frac{W}{m^2}$
$\dot{q}_{windowwest} = A \times CF_{windowwest} = 14.4 \times 243.02 = 3499.47\ W$

Heating Load: Wooden Frame

$\dot{q}_{windowwest} = A \times HF_{windowwest}$
A = 14.4 m^2
$HF_{windowwest} = U_{windowwest} \times \Delta T_{heating}$
U = 2.84
$HF_{windowwest} = 2.84 \times 24.8 = 70.43\ \frac{W}{m^2}$

$\dot{q}_{windowwest} = A \times HF_{windowwest} = 14.4 \times 70.43 = 1014.22\ W$

Heating Load: Aluminum Frame

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

$A = 14.4\ m^2$

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

$U = 3.61$

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

$\dot{q}_{windowwest} = A \times HF_{windowwest} = 14.4 \times 89.53 = 1289.20\ W$

Difference:

Cooling Load = 147.4 W

Heating Load = 274.98 W

SOUTH WINDOW (FIXED)

Cooling Load: Wooden Frame

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

$A = 3.6\ m^2$

$CF_{windowsouth} = CF_{windowsouth\_heattransfer} + CF_{windowsouth\_irridiation}$

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

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

$U = 2.84$

$CF_{windowsouth\_heattransfer} = 2.84\ (7.9 - (0.46)(11.9)) = 6.89\ \frac{W}{m^2}$

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

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

$SHGC = 0.54$

$IAC = 1$

$FF_s = 0.47$

$CF_{windowsouth\_irridiation} = 557 \times 0.54 \times 1 \times 0.47 = 141.37\ \frac{W}{m^2}$

$CF_{windowsouth} = CF_{windowsouth\_heattransfer} + CF_{windowsouth\_irridiation}$

$CF_{windowsouth} = 6.89 + 141.37 = 148.26\ \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \times CF_{windowsouth} = 3.6 \times 148.26 = 533.74\ W$

Cooling Load: Aluminum Frame

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

$A = 3.6\ m^2$

$CF_{windowsouth} = CF_{windowsouth\_heattransfer} + CF_{windowsouth\_irridiation}$

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

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

$U = 3.61$

$CF_{windowsouth\_heattransfer} = 3.61\ (7.9 - (0.46)(11.9)) = 8.76\ \frac{W}{m^2}$

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

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

$SHGC = 0.56$

$IAC = 1$

$FF_s = 0.47$

$CF_{windowsouth\_irridiation} = 557 \text{ x } 0.56 \text{ x } 1 \text{ x } 0.47 = 146.60 \frac{W}{m^2}$

$CF_{windowsouth} = 8.76 + 146.60 = 155.36 \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \text{ x } CF_{windowsouth} = 3.6 \text{ x } 155.36 = 559.30 \text{ W}$

Heating Load: Wooden Frame

$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth}$

$A = 3.6 \text{ m}^2$

$HF_{windowsouth} = U_{windowsouth} \text{ x } \Delta T_{heating}$

$U = 2.84$

$HF_{windowsouth} = 2.84 \text{ x } 24.8 = 70.43 \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth} = 3.6 \text{ x } 70.43 = 253.08 \text{ W}$

Heating Load: Aluminum Frame

$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth}$

$A = 3.6 \text{ m}^2$

$HF_{windowsouth} = U_{windowsouth} \text{ x } \Delta T_{heating}$

$U = 3.61$

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

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

Difference:

Cooling Load = 25.56 W

Heating Load = 69.23 W

SOUTH WINDOW (OPERABLE)

Cooling Load: Wooden Frame

$\dot{q}_{windowsouth} = A \text{ x } CF_{windowsouth}$

$A = 3.6 \text{ m}^2$

$CF_{windowsouth} = CF_{windowsouth\_heattransfer} + CF_{windowsouth\_irridiation}$

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

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

$U = 2.87$

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

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

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

$SHGC = 0.46$

$IAC = 1$

$FF_s = 0.47$

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

$CF_{windowsouth} = CF_{windowsouth\_heattransfer} + CF_{windowsouth\_irridiation}$

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

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

Cooling Load: Aluminum Frame

$\dot{q}_{windowsouth} = A \text{ x } CF_{windowsouth}$

A = 3.6 m^2

$CF_{windowsouth} = CF_{windowsouth\_heattransfer} + CF_{windowsouth\_irridiation}$

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

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

U = 4.62

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

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

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

SHGC = 0.55

IAC = 1

$FF_s = 0.47$

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

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

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

Heating Load: Wooden Frame

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

A = 3.6 m^2

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

U = 2.87

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

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

Heating Load: Aluminum Frame

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

A = 3.6 m^2

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

U = 4.62

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

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

Difference:

Cooling Load = 100.11 W

Heating Load = 156.24 W