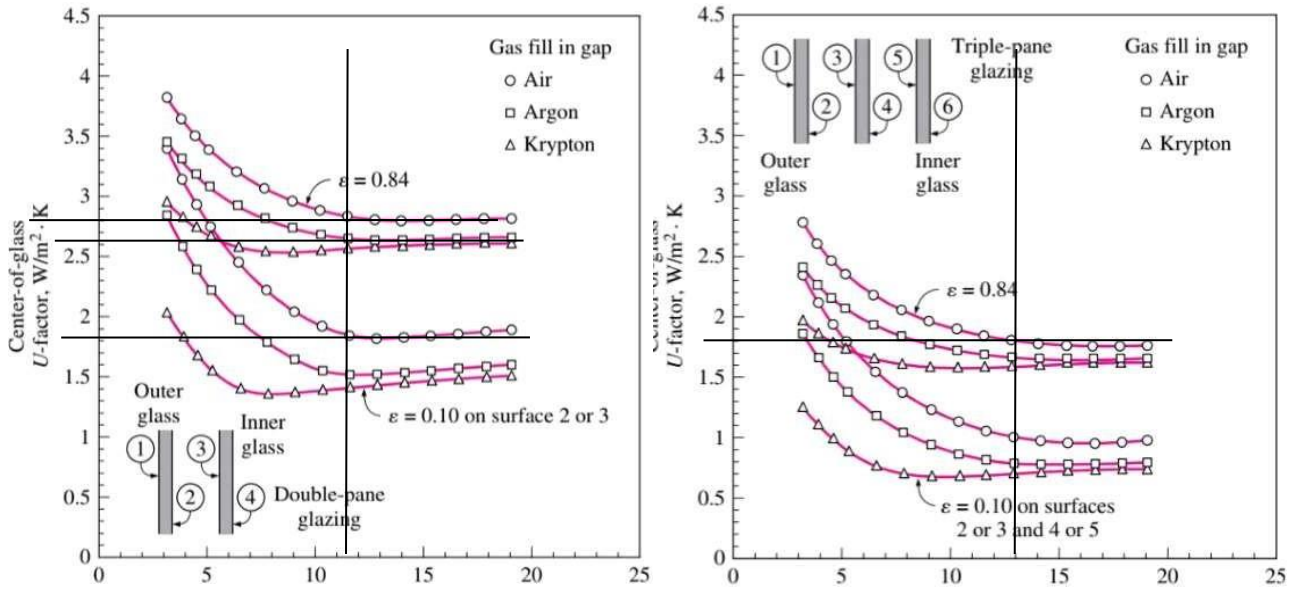
Week 8 Assignment

Task1:



benchmark case "double layer with air and no coating (thickness = 13mm)", U factor = 2.8.
changing the gas to Argon, U factor = 2.63 less than the benchmark case by 6%.
adding an extra pane, U factor = 1.8 less than the benchmark case by 36%.
using a low emissivity coating, U factor = 1.8 less than the benchmark case by 36%.

Task 2:

Form the previous examples,

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%			99%			0.4%		1%			
			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)

T_{SUMMER}= 24° and T_{WINTER}= 20°

COOLING DB/MCWB = 31,9, HEATING DB = -4,8 and DR = 11,9

$\Delta T_{cooling} = 31{,}9 - 24 = 7{,}9\ ^{\circ}C$
$\Delta T_{heating} = 20 - (-4{,}8) = 24{,}8\ ^{\circ}C$

EAST SIDE OF THE BUILDING 45° LATITUDE
No internal shading – AIC = 1 DR

WINDOW 1: fixed 14.4 m2 on the east.

Cooling load

$CF_{W1east} = U_{W1east}(\Delta T_{cooling} - (0.46)(DR)) = 2{,}84\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 6{,}9\ W/m^2$

$E_D = 559$, $E_d = 188$
East window of a detached house - FFS = 0.31 SHGC = 0.54
$PXI_{W1east} = E_D + E_d = 559 + 188 = 747$
$CF_{W1east} = (PXI)(SHGC)(IAC)(FF_{s)} = (747)(0.54)(1)(0.31) = 125.1$

$CF_{fenestration1east} = U_{w1east}(\Delta T_{cooling} - (0.46)(DR)) + (PXI)(SHGC)(IAC)(FF_s) = 6.9 + 125.1 = 132\ W/m^2$
$\dot{Q}_{w1east} = (CF_{fenestration1east})(A_{W1east)} = (132)(14.4) = 1900.8\ W$

Heating load

$U_{w1east} = 2{,}84\ W/m^2\ K$
$HF_{w1east} = U_{W1east}(\Delta T_{Heating}) = (2.84)(24.8) = 70.44\ W/m^2$
$Q_{w1east} = HF_{W1east}(A_{W1east}) = (70.44)(14.4) = 1014.2\ W$

WINDOW 2: fixed 14.4 m2 on the west.

Cooling load
$CF_{W2west} = U_{W2west}(\Delta T_{cooling} - (0.46)(DR)) = 2{,}84(7{,}9 - 0{,}46 \cdot 11{,}9) = 6{,}9\ W/m^2$

$E_D = 559$ $E_d = 188$
West window of a detached house - FFS = 0.31 SHGC = 0.54
$PXI_{W2west} = E_D + E_d = 559 + 188 = 747$
$CF_{W2west} = (PXI)(SHGC)(IAC)(FF_s) = (747)(0.54)(1)(0.56) = 225.9$
$CF_{fenestration2west} = U_{w2west}(\Delta T_{cooling} - (0.46)(DR)) + (PXI)(SHGC)(IAC)(FF_s) = 6.9 + 225.9 = 232.8\ W/m^2$
$\dot{Q}_{W2west} = CF_{fenestration2west}(A_{W2west}) = 232.8\ (14.4) = 3352.32\ W$

Heating load

$U_{W2west} = 2{,}84\ W/m^2\ K$
$HF_{W2west} = (U_{W2west})(\Delta T_{Heating}) = (2.84)(24.8) = 70.44\ W/m^2$ $Q_{W2west} = (HF_{W2west})(A_{W2west}) = (70.44)(14.4) = 1014.2\ W$

WINDOW 3: fixed 3.6 m2 on the south.

Cooling load

$CF_{W3south} = U_{W3south}(\Delta T_{cooling} - (0.46)\ (DR)) = 2{,}84(7{,}9 - 0{,}46 \cdot 11{,}9) = 6{,}9\ W/m^2$

$E_D = 348$

$E_d = 209$

South window of a detached house - FFS = 0.31 SHGC= 0.54

$PXI_{W3south} = E_D + E_d = 348 + 209 = 557$

$CF_{W3south} = (PXI)(SHGC)(IAC)(FF_s) = (557)\ (0.54)\ (1)\ (0.47) = 141.4$

$CF_{fenestration3south} = U_{w3south}(\Delta T_{cooling} - (0.46)\ (DR)) + (PXI)\ (SHGC)(IAC)\ (FF_s) = 6.9 + 141.4 = 148.3\ W/m^2$

$\dot{Q}_{w3south} = CF_{fenestration3south}\ (A_{W3south}) = (148.3)\ (3.6) = 533.88\ W$

Heating load

$U_{W3south} = 2{,}84\ W/m^2\ K$

$HF_{W3south} = U_{W3south}\ (\Delta T_{Heating}) = (2.84)\ (24.8) = 70.44\ W/\ m^2$

$Q_{W3south} = (HF_{W3south})\ (A_{W3south}) = (70.44)\ (3.6) = 253.6\ W$

WINDOW 4: operable 3.6 m2 on the south.

Cooling load

$CF_{W4south} = U_{W4south}(\Delta T_{cooling} - (0.46)(DR)) = 2{,}87(7{,}9 - 0{,}46 \cdot 11{,}9) = 6{,}96\ W/m^2$

$E_D = 348$

$E_d = 209$

South window of a detached house - FFS = 0.47 SHGC = 0.46

$PXI_{W4south} = E_D + E_d = 348 + 209 = 557$

$CF_{W4south} = (PXI)*(SHGC)*(IAC)*(FF_s) = (557)\ (0.46)\ (1)\ (0.47) = 120.4$

$CF_{fenestration4south} = U_{w3south}(\Delta T_{cooling} - (0.46)\ (DR)) + (PXI)\ (SHGC)(IAC)\ (FF_s) = 6.9 + 120.4 = 127.3\ W/m^2$

$\dot{Q}_{w4south} = CF_{fenestration4south}\ (A_{W4south}) = (127.3)\ (3.6) = 458.28\ W$

Heating load

$U_{W4south} = 2{,}87\ W/m^2\ K$

$HF_{W4south} = U_{W4south}(\Delta T_{cooling}) = (2.87)(24.8) = 71.17\ W/m^2$

$Q_{W4south} = HF_{W4south}(A_{W4south}) = (71.17)(3.6) = 256.2\ W$

For all WINDOWS:

QTotal windows Cooling wood frame = 1900,.8 + 3352.32 + 533.88 + 458.28 = 6245.3 W

QTotal windows Heating wood frame = 1014.2+1014.2+253.6+256.2=2538.2 W

For Aluminum Frame:

WINDOW 1: fixed 14.4 m2 on the east.

Cooling load

$CF_{W1east} = U_{W1east}\ (\Delta T_{cooling} - (0.46)(DR)) = 3.61\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 8.7\ W/m^2$

$E_D = 559$, $E_d = 188$

East window of a detached house - FFS = 0.31 SHGC = 0.56

$PXI_{W1east} = E_D + E_d = 559 + 188 = 747$

$CF_{W1east} = (PXI)(SHGC)(IAC)(FF_{s)} = (747)\ (0.56)\ (1)\ (0.31) = 129.6$

$CF_{fenestration1east} = U_{w1east}(\Delta T_{cooling} - (0.46)(DR)) + (PXI)\ (SHGC)(IAC)\ (FF_s) = 8.7 + 129.6 = 138.3\ W/m^2$

$\dot{Q}_{w1east} = (CF_{fenestration1east})\ (A_{W1east)} = (138.3)\ (14.4) = 1991.5\ W$

Heating load

$U_{w1east=}$ 3.61 W/m^2 K
$HF_{w1east=}$ U_{W1east} ($\Delta T_{Heating}$) = (3.61) (24.8) = 89.52 W/m^2
Q_{w1east}= HF_{W1east} (A_{W1east}) = (89.52) (14.4) = 1289.1 W

WINDOW 2: fixed 14.4 m2 on the west.

Cooling load
$CF_{W2west}=U_{W2west}(\Delta T_{cooling}-(0.46)\ (DR))= 3.61(7{,}9-0{,}46\cdot 11{,}9)=8.7$ W/m^2

E_D= 559 E_d= 188
West window of a detached house - FFS = 0.31 SHGC= 0.56
PXI_{W2west} = E_D + E_d = 559 + 188 = 747
CF_{W2west}= (PXI)(SHGC)(IAC)(FF_s) = (747) (0.56) (1) (0.56) = 234.26
$CF_{fenestration2west}$= U_{w2west} ($\Delta T_{cooling}$ – (0.46) (DR)) +(PXI) (SHGC)(IAC)(FF_s) = 8.7+ 234.26 = 242.96 W/m^2
Q_{W2west} = $CF_{fenestration2west}$ (A_{W2west}) = 242.96 (14.4) = 3498.6 W

Heating load

$U_{W2west=}$ 3.61 W/m^2 K
$HF_{W2west=}(U_{W2west})(\Delta T_{Heating})=(3.61)(24.8)=89.52$W/$m^2$ $Q_{W2west}=(HF_{W2west})(A_{W2west})=$ (89.52)(14.4) = 1289.1

WINDOW 3: fixed 3.6 m2 on the south.

Cooling load

$CF_{W3south} = U_{W3south}(\Delta T_{cooling} - (0.46)\,(DR)) = 3.61\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 8.7\ W/m^2$

$E_D = 348$

$E_d = 209$

South window of a detached house - FFS = 0.31 SHGC = 0.56

$PXI_{W3south} = E_D + E_d = 348 + 209 = 557$

$CF_{W3south} = (PXI)(SHGC)(IAC)(FF_s) = (557)\ (0.56)\ (1)\ (0.47) = 146.6$

$CF_{fenestration3south} = U_{w3south}\,(\Delta T_{cooling} - (0.46)\,(DR)) + (PXI)\ (SHGC)(IAC)\ (FF_s) = 8.7 + 146.6 = 155.3\ W/m^2$

$\dot{Q}_{w3south} = CF_{fenestration3south}\ (A_{W3south}) = (155.3)\ (3.6) = 559.08\ W$

Heating load

$U_{W3south} = 3.61\ W/m^2\ K$

$HF_{W3south} = U_{W3south}\ (\Delta T_{Heating}) = (3.61)\ (24.8) = 89.52\ W/m^2$

$Q_{W3south} = (HF_{W3south})(A_{W3south}) = (89.52)(3.6) = 322.2\ W$

WINDOW 4: operable 3.6 m2 on the south.

Cooling load
$CF_{W4south}=U_{W4south}(\Delta T_{cooling}-(0.46)(DR))=4.62(7,9-0,46\cdot 11,9)=11.2\ W/m^2$
$E_D= 348$
$E_d= 209$
Southwindowofadetachedhouse-FFS=0.47 SHGC= 0.55
$PXI_{W4south} = E_D + E_d = 348 + 209 = 557$
$CF_{W4south}= (PXI)*(SHGC)*(IAC)*(FF_s)=(557)\ (0.55)\ (1)\ (0.47) = 143.95$

$CF_{fenestration4south}=U_{w3south}(\Delta T_{cooling}-(0.46)\ (DR))+(PXI)\ (SHGC)(IAC)\ (FF_s)=11.2$
$+143.98 =155.18\ W/m^2$
$\dot{Q}w4south = CFfenestration4south\ (AW4south) = (155.18)\ (3.6) = 558.65\ W$

Heating load

$U_{W4south=}\ 4.62\ W/m^2\ K$
$HF_{W4south=}U_{W4south}(\Delta T_{heating})=(4.62)(24.8)=114.57\ W/m^2$
$Q_{W4south}=HF_{W4south}(A_{W4south})=(114.57)(3.6) = 412.4\ W$

For all WINDOWS:
QTotal windows Cooling Aluminum frame = 1991.5 + 3498.6 + 559.08 + 558.65 = 6607.8 W
QTotal windows Heating Aluminum frame = 1289.1 + 1289.1 + 322.2 + 412.4 = 3312.8 W

Result:

QTotal windows Cooling Aluminum frame (6607 W) > QTotal windows Cooling wood frame (6245.3 W)
QTotal windows Heating Aluminum frame (3312.8 W) > QTotal windows Heating wood frame (2538.2 W)

wood is a better material to use for the frames than aluminum since it has better resistance in cooling and heating aspects