Week 8

PART 1

#1

Calculate % is the effect of applying different modifications (changing the gas, adding an extra pane, using low emissivity coating) on the U value with respect to a benchmark case of double layer w/ air and no coating? (13mm gap thickness)

U value of a window:

$$U_{window} = \frac{U_{center}A_{center} + U_{edge}A_{edge} + U_{frame}A_{frame}}{A_{window}}$$

If it's a dbl pane window, disregard thermal resistances of glass layers

$$\frac{1}{U_{dbl\,pane\ center\ region}} = \frac{1}{h_i} + \frac{1}{h_{space}} + \frac{1}{h_o}$$

$$h_{space} = h_{rad\,space} + h_{conv\,space}$$

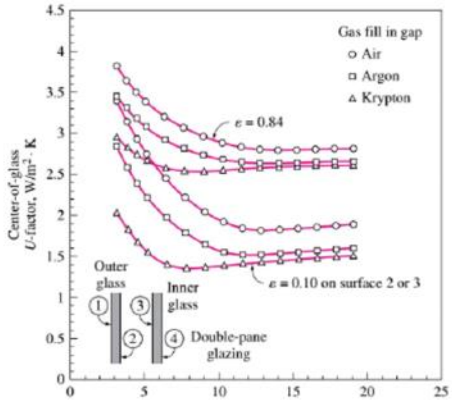
- Air to Argon → U value of center decreases from 2.8 W/m^2K to 2.65 $\frac{W}{m^2K}$
  ↳ U value decreases about 6.43%
- Air to Krypton → U value of center decreases from 2.8 W/m^2K to 2.6 W/m^2K
  ↳ U value decreases about 7.14%

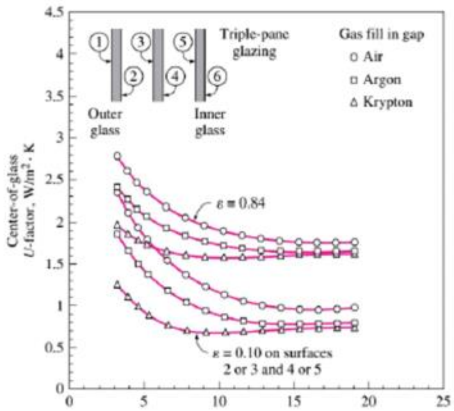
When adding extra pane, U value of center decreases from 2.8 W/m^2K to 1.8 W/m^2K

↳ U value decreases about 55.6%

Coating glass surfaces w/ film w/ emissivity of 0.1, U value of center of the glass decreases from 2.8 to 1.8 W/m^2K,

↳ U value decreases about 55.6%





PART 2

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)

#2

Heating and Cooling of other windows fixed to 14.4m² on west, 3.6m² south, operable 3.6m² on south (same window and frame type)
Total value change if frame changes from wood to aluminium?

① Net area of walls (excluding doors and windows) of building located in Piacenza is 105.8 m², calculated U value is
0.438 W/m²K for winter
0.435 W/m²K for summer

↳ Find corresponding heating and cooling load

② fixed heat absorbing dbl layer glass w/ wooden frame @ east side building in Piacenza surface of 14.4 m² (no internal and external shading factors)
calculate heating and cooling load

COOLING $\boxed{\text{WEST WINDOW}}$

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

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

From table → $DR = 11.9°C = 11.9K$

$q_{\substack{window\\west}} = A(CF_{window\,west})$ $A = 14.4m^2$

$CF_{\substack{window\\west}} = U_{\substack{window\\west}}(\Delta T_{cooling} - 0.46\,DR)$

$U_{window_{west}} = 2.84\ W/m^2K$

$CF_{\substack{window\\west}} = 2.84(7.9 - 0.46 \times 11.9)$
$= 6.89\ W/m^2$

$PXI = E_D + E_d = 559 + 188 = 747$

$SHGC = 0.54$

no internal shading ∴ $IAC = 1$ $FF_s = 0.$

⇓

$CF_{\substack{window\\west}} = PXI\,(SHGC)(IAC)(FF_s)$
$= 747(0.54)(1)(0.56)$
$= 225.8928$

$q_{\substack{window\\west}} = A\,(CF_{w.w.}) = 14.4(225.8928)$
$= 3352.07\ W$

HEATING WEST WINDOW

$q_{\substack{window\\west}} = A\,(HF) = A(U_{w.w.}\,\Delta T)$
$= 14.4\,(2.84)(24.8)$
$= 1014.22\ W$

FRAME ALUMINUM : $U_{\substack{window\\west}} = 3.61$
$HSGC = 0.56$

$CF_{w.w} = U_{w.w}(\Delta T - 0.46\,DR)$
$= 3.61(7.9 - 0.46 \times 11.9)$
$= 8.76\ W/m^2$

cooling $load_{w.w} = A(CF)$
$= 14.4(8.76 + 747 \times 0.56 \times 1 \times 0.56)$
$= 3499.48$

heating $load_{ww}$ $q' = A(HF) = A(U_{w.w})(\Delta T)$
$= 14.4\,(3.61)(24.8)$
$= 1289.20\ W$

$\boxed{\text{South wall}}$ $q_{\substack{south\\window}} = A\,(CF_{\substack{south\\window}})$

$A = 3.6\ m^2$ $CF = U_{s.w}(\Delta T - 0.46\,DR)$
$U = 2.84\ W/m^2K$

$CF_{s.w.} = 2.84(7.9 - 0.46 \times 11.9)$
$= 6.89\ W/m^2$

$PXI_{s.w} = E_D + E_d = 348 + 209 = 557$

$SHGC = 0.55$ $IAC = 1$ $FF_s = 0.47$

⇓

COOLING LOAD SOUTH

$CF_{w.s.} = PXI(SHGC)(IAC)(FF_s)$
$= 557(0.55)(1)(0.47)$
$= 143.9845$

$q_{w.s.} = A(CF)$
$= 3.6(6.89 + 143.9845)$
$= 553.72$ W

HEATING LOAD SOUTH

$q_{w.s.} = A(HF) = A(U_{w.s.}\ \Delta T)$

$= 3.6(2.84)(24.8)$
$= 253.56$ W

ALUMINUM FRAME

$U_{w.s.} = 3.61 \quad HSGC = 0.56$

$CF_{w.s.} = U_{w.s}(\Delta T - 0.46 DR)$
$= 3.61(7.9 - 0.46(11.9))$
$= 8.76$ W/m²

cooling load $q' = A(CF)$
$= 3.6(8.79 + (557)(0.56)(1)(0.47))$
$= 559.30$ W

heating load $q' = A(HF) = A(U_{window\ south}\ \Delta T)$
$= 3.6(3.61)(24.8)$
$= 322.30$ W

$\boxed{\text{Operable South Window}}$ COOLING

$q_{w.s.} = A(CF) \quad A = 3.6 \quad U = 2.87$ W/m²K

$CF_{s.w} = 2.87(7.9 - 0.46 \times 11.9)$
$= 6.96$ W/m²

$PXI = 348 + 209 = 557 \quad SHGC = 0.46$
$IAC = 1 \quad FF_s = 0.47$

$CF_{ws} = 557(0.46)(1)(0.47) = 143.9845$

$q_{ws} = A(CF) = 3.6(6.96) + 120.4234)$
$= 553.98$ W

HEATING LOAD

$q_{w.s} = A(HF) = A(U)(\Delta T)$
$= 3.6(2.87)(24.8)$
$= 256.23$ W

ALUMINUM FRAME

$U_{ws} = 4.62 \quad HSGC = 0.55$

$CF = U(\Delta T - 0.46)$
$= 4.62(7.9 - 0.46 \times 11.9) = 11.21$ W/m²

cooling $q' = A(CF)$
$= 3.6(11.21 + 143.98)$
$= 558.70$ W

Heating $q' = A(U')(\Delta T)$
$= 3.6(4.62)(24.8)$
$= 412.47$ W