Week 8

TASK 1

Using the diagrams given in the presentation, calculate how much (%) id 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 gas the gap thickness to be 13mm)

If we change the gas gap from air to argon, the U- value decreases from

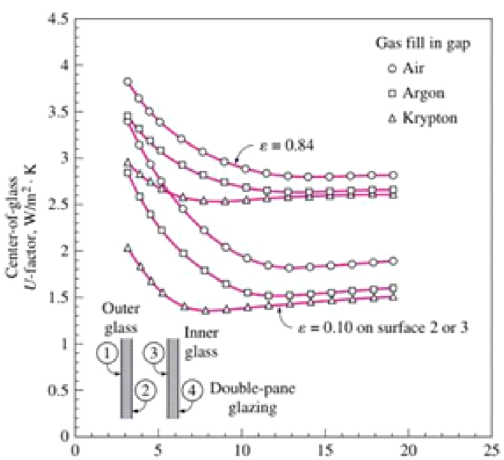
$2.8\frac{w}{m^2K}$ $to\ 2.8\frac{w}{m^2K}, and\ that\ means\ that\ U\ value\ decreases\ for\ about$ 5.36%

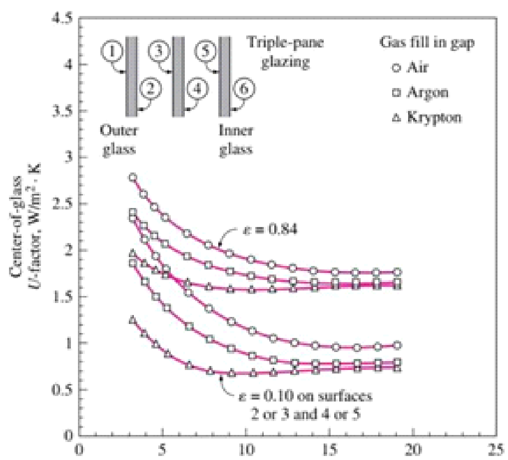
<u>Triple pane glazing, ε = 0,10</u>

The U value, using Argon = 0,8
The U value, using Krypton = 0,7

using air in the gap between panes, the factor increase **1**

When ε = 0,84 the values of Argon and Kripton are almost the same 1,6 ,while the U value of air is 1,8
Comparing double and triple pane glazing is visible that there's a significant change (up).





TASK 2

Consider the house we analyzed in the last two examples, calculate the heating and cooling load of the other windows which are fixed 14.4 on the west, fixed 3.6 on the south and an operable 3.6 on the south (same windows and frame type).
How much does the value change if I change the frame of the windows from wooden 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)

First, define the temperature:
$\Delta T_{cooling} = 31{,}9\ o_C$ - $24\ o_C = 7{,}9\ o_C = \ 7{,}9\ K$

$\Delta T_{heating} = 20\ o_C$ - $(-4.8 o_C) = 24{,}8\ o_C = 24{,}8\ K$
From the table DR is $11{,}9\ o_C = 11.9\ K$

For RFL method:

$$q_{opq} = A \times \mathrm{CF}_{opq}$$
$$\mathrm{CF}_{opq} = U(\mathrm{OF}_t \Delta t + \mathrm{OF}_b + \mathrm{OF}_r \mathrm{DR})$$

where

q_{opq} = opaque surface cooling load, W
A = net surface area, m^2
CF = surface cooling factor, W/m^2
U = construction U-factor, W/(m$^2 \cdot$K)
Δt = cooling design temperature difference, K
$\mathrm{OF}_t, \mathrm{OF}_b, \mathrm{OF}_r$ = opaque-surface cooling factors (see Table 7)
DR = cooling daily range, K

Surface Type	OF_t	OF_b, K	OF_r
Ceiling or wall adjacent to vented attic	0.62	$14.3\alpha_{roof} - 4.5$	−0.19
Ceiling/roof assembly	1	$38.3\alpha_{roof} - 7.0$	−0.36
Wall (wood frame) or door with solar exposure	1	8.2	−0.36
Wall (wood frame) or door (shaded)	1	0	−0.36
Floor over ambient	1	0	−0.06
Floor over crawlspace	0.33	0	−0.28
Slab floor (see Slab Floor section)			

α_{roof} = roof solar absorptance (see Table 8).

$T_{h.wall}$ = 105.8*5.175=547.558 $\frac{w}{m^2}$

$$CF_{opq} \ = 0.438\ (1 * 7.9 + 8.2 - 0.36\ * 11.9 = 5.175 \frac{w}{m^2}$$

$$Q_{cooling\ wall} \ = 105.8\ * 5.139 = 543.80 \frac{w}{m^2}$$
$$CF_{opq} \ = 0.435\ (1 * 7.9 + 8.2 - 0.36\ * 11.9 = 5.139 \frac{w}{m^2}$$

$$Q_{load\ south} \ = 3.6 * 5.175 = 18.63 \frac{w}{m^2}$$
$$CF_{opq} \ = 0.438\ (1 * 7.9 + 8.2 - 0.36\ * 11.9 = 5.175 \frac{w}{m^2}$$

$$Q_{load\ west} \ = 14.4 * 1891.79 = 127241.784 \frac{w}{m^2}$$
$$CF_{opqalluminium} \ = 10.1\ (1 * 7.9 + 8.2 - 0.36\ * 11.9 = 1891.79 \frac{w}{m^2}$$

$$q_{fen} = A \times CF_{fen}$$

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

where

q_{fen} = fenestration cooling load, W
A = fenestration area (including frame), m^2
CF_{fen} = surface cooling factor, W/m^2
U = fenestration NFRC *heating* U-factor, $W/(m^2 \cdot K)$
Δt = cooling design temperature difference, K
PXI = peak exterior irradiance, including shading modifications, W/m^2 [see Equations (26) or (27)]
SHGC = fenestration rated or estimated NFRC solar heat gain coefficient
IAC = interior shading attenuation coefficient, Equation (29)
FF_s = fenestration solar load factor, Table 13

Transparent Fenestration Surface

Exposure Single Family Detached Multifamily

North		0.44	0.27
Northeast		0.21	0.43
East		0.31	0.56
Southeast		0.37	0.54
South		0.47	0.53
Southwe	t	0.58	0.61
West		0.56	0.65
Northwest		0.46	0.57
Horizontal		0.58	0.73

East windows

$$U_{window_{east}} = 2.48\ \frac{w}{m^2}$$

$$HF_{window_{east}} = U + \ \Delta T = 2.84 * 24.8 = 70.432\ \frac{w}{m^2}$$

$$Q_{window_{east}} = HF_{window_{east}} * HF_{window_{east}} = 70.432 * 14.4 = 1014.22\ W$$

No inner shading

$$HF_{fen} = U(\Delta t - 0.46\ DR) + pxi\ * SHGC * IAC\ * FFs = 2.84\ (7.9 - 0.46 * 11.9) + (559 + 188) * 0.54 * 1 * 0.31 = 131.93\ \frac{w}{m^2}$$

$$Q_{window_{east}} = \ HF_{window_{east}}\ *\ A_{window_{east}} = 131.93 * 14.4 = 1899.90\ W$$