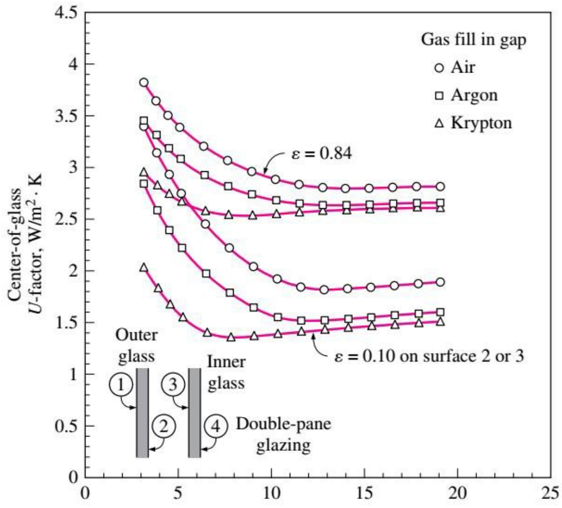
WEEK 8

martedì 3 dicembre 2019 19:35

TASK1

Double layer window with air, no coating, gap thickness = 13 mm
U = 2.8 W/m^{2}K
(changing the gas, adding an extra pane, using a low emissivity coating)

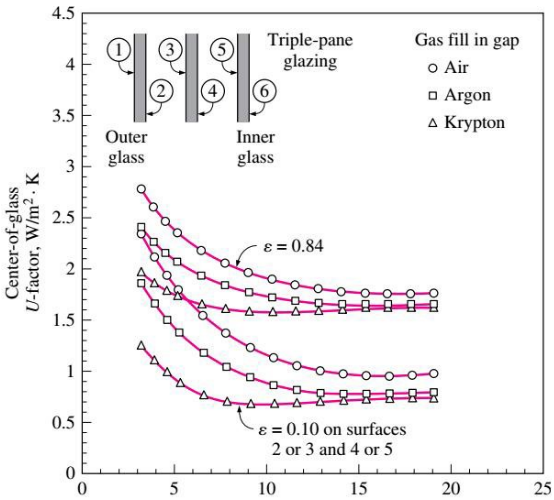


Double layer window with argon, no coating, gap thickness = 13 mm
U = 2.65 W/m^{2}K
Decreased by 5.36%

Double layer window with krypton, no coating, gap thickness = 13 mm
U = 2.6 W/m^{2}K
Decreased by 7.14%

Double layer window with air, coating, gap thickness = 13 mm
U = 1.8 W/m^{2}K
Decreased by 35.71%

Triple layer window with air, no coating, gap thickness = 13 mm



U = 1.85 W/m^{2}K
Decreased by 33.93%

Best solution: triple layer window with krypton, coating, gap thickness = 13
U = 0.7 W/m^{2}K
Decreased by 75%

TASK 2

1. Selected **fenestration heating U factor (W/m^{2}K)** and **fenestration rated or estimated solar heat gain coefficient SHGC** for fixed and operable window frame both made of wood and aluminium.

Glazing Type	Glazing Layers	ID[b]	Property[c,d]	Center of Glazing	Frame: Operable					Frame: Fixed				
					Aluminum	Aluminum with Thermal Break	Reinforced Vinyl/Aluminum Clad Wood	Wood/Vinyl	Insulated Fiberglass/Vinyl	Aluminum	Aluminum with Thermal Break	Reinforced Vinyl/Aluminum Clad Wood	Wood/Vinyl	Insulated Fiberglass/Vinyl
Clear	1	1a	*U*	5.91	7.24	6.12	5.14	5.05	4.61	6.42	6.07	5.55	5.55	5.35
			SHGC	0.86	0.75	0.75	0.64	0.64	0.64	0.78	0.78	0.75	0.75	0.75
	2	5a	*U*	2.73	4.62	3.42	3.00	2.87	5.83	3.61	3.22	2.86	2.84	2.72
			SHGC	0.76	0.67	0.67	0.57	0.57	0.57	0.69	0.69	0.67	0.67	0.67
	3	29a	*U*	1.76	3.80	2.60	2.25	2.19	1.91	2.76	2.39	2.05	2.01	1.93
			SHGC	0.68	0.60	0.60	0.51	0.51	0.51	0.62	0.62	0.60	0.60	0.60
Low-e, low-solar	2	25a	*U*	1.70	3.83	2.68	2.33	2.21	1.89	2.75	2.36	2.03	2.01	1.90
			SHGC	0.41	0.37	0.37	0.31	0.31	0.31	0.38	0.38	0.36	0.36	0.36
	3	40c	*U*	1.02	3.22	2.07	1.76	1.71	1.45	2.13	1.76	1.44	1.40	1.33
			SHGC	0.27	0.25	0.25	0.21	0.21	0.21	0.25	0.25	0.24	0.24	0.24
Low-e, high-solar	2	17c	U	1.99	4.05	2.89	2.52	2.39	2.07	2.99	2.60	2.26	2.24	2.13
			SHGC	0.70	0.62	0.62	0.52	0.52	0.52	0.64	0.64	0.61	0.61	0.61
	3	32c	*U*	1.42	3.54	2.36	2.02	1.97	1.70	2.47	2.10	1.77	1.73	1.66
			SHGC	0.62	0.55	0.55	0.46	0.46	0.46	0.56	0.56	0.54	0.54	0.54
Heat-absorbing	1	1c	*U*	5.91	7.24	6.12	5.14	5.05	4.61	6.42	6.07	5.55	5.55	5.35
			SHGC	0.73	0.64	0.64	0.54	0.54	0.54	0.66	0.66	0.64	0.64	0.64
	2	5c	*U*	2.73	4.62	3.42	3.00	2.87	2.53	3.61	3.22	2.86	2.84	2.72
			SHGC	0.62	0.55	0.55	0.46	0.46	0.46	0.56	0.56	0.54	0.54	0.54
	3	29c	*U*	1.76	3.80	2.60	2.25	2.19	1.91	2.76	2.39	2.05	2.01	1.93
			SHGC	0.34	0.31	0.31	0.26	0.26	0.26	0.31	0.31	0.30	0.30	0.30
Reflective	1	1l	*U*	5.91	7.24	6.12	5.14	5.05	4.61	6.42	6.07	5.55	5.55	5.35
			SHGC	0.31	0.28	0.28	0.24	0.24	0.24	0.29	0.29	0.27	0.27	0.27
	2	5p	*U*	2.73	4.62	3.42	3.00	2.87	2.53	3.61	3.22	2.86	2.84	2.72
			SHGC	0.29	0.27	0.27	0.22	0.22	0.22	0.27	0.27	0.26	0.26	0.26
	3	29c	*U*	1.76	3.80	2.60	2.25	2.19	1.91	2.76	2.39	2.05	2.01	1.93
			SHGC	0.34	0.31	0.31	0.26	0.26	0.26	0.31	0.31	0.30	0.30	0.30

2. Selected **peak exterior irradiance PXI (W/m^2)** for south and west exposure for a single family detached house

$PXI = E_D + E_d$

Table 10 Peak Irradiance, W/m^2

Exposure		Latitude: 20°	25°	30°	35°	40°	45°	50°	55°	60°
North	E_D	125	106	92	84	81	85	96	112	136
	E_d	128	115	103	93	84	76	69	62	55
	E_t	253	221	195	177	166	162	164	174	191
Northeast/Northwest	E_D	460	449	437	425	412	399	386	374	361
	E_d	177	169	162	156	151	147	143	140	137
	E_t	637	618	599	581	563	546	529	513	498
East/West	E_D	530	543	552	558	560	**559**	555	547	537
	E_d	200	196	193	190	189	**188**	187	187	187
	E_t	730	739	745	748	749	747	742	734	724
Southeast/Southwest	E_D	282	328	369	405	436	463	485	503	517
	E_d	204	203	203	204	205	207	210	212	215
	E_t	485	531	572	609	641	670	695	715	732
South	E_D	0	60	139	214	283	**348**	408	464	515
	E_d	166	193	196	200	204	**209**	214	219	225
	E_t	166	253	335	414	487	557	622	683	740
Horizontal	E_D	845	840	827	806	776	738	691	637	574
	E_d	170	170	170	170	170	170	170	170	170
	E_t	1015	1010	997	976	946	908	861	807	744

3. Assuming that there is no internal shading: **interior shading attenuation coefficient IAC = 1**

4. Selected **fenestration solar load factor FF_S** for south and west exposure for a single family detached house

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
Southwest	0.58	0.61
West	0.56	0.65
Northwest	0.46	0.57
Horizontal	0.58	0.73

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)

Δ $\mathbf{T_{COOLING}}$ = 31.9 −24 ($T_{INSIDEDURINGSUMMER}$) = 7.9 °C

Δ $\mathbf{T_{HEATING}}$ = 20 ($T_{INSIDEDURINGWINTER}$) − (−4.8) = 24.8 °C

DR = 11.9 °C

HEATING:

$Q_{HEATING}$ (fenestration heating load) = HF x A

HF (surface heating factor) = U x $\Delta T_{HEATING}$

COOLING:

$Q_{COOLING}$ (fenestration cooling load) = CF x A

CF (surface cooling factor) = $CF_{HEATTRANSFERPART}$ + $CF_{IRRADIATIONPART}$

$CF_{HEATTRANSFERPART}$ = U x ($\Delta T_{COOLING}$ – 0.46 DR)

$CF_{IRRADIATIONPART}$ = PXI x SHGC x IAC x FF_S

PXI = E_D + E_d

1.

WEST - FIXED - WOOD FRAME (A = 14.4 m^2)

HF = 2.84 x 24.8 °C = 70.43 W/m^2

$Q_{HEATING}$ = 70.43 W/m^2 x 14.4 m^2 = 1014.22 W

$CF_{HEATTRANSFERPART}$ = 2.84 x (7.9 °C – 0.46 x 11.9 °C) = 6.89 W/m^2

PXI = 559 + 188 = 747 W/m^2

$CF_{IRRADIATIONPART}$ = 747 W/m^2 x 0.54 x 1 x 0.56 = 255.89 W/m^2

CF = 6.89 + 255.89 = 232.78 W/m^2

$Q_{COOLING}$ = 232.78 W/m^2 x 14.4 m^2 = 3352.07 W

WEST - FIXED - ALLUMINIUM FRAME (A = 14.4 m^2)

HF = 3.61 x 24.8 °C = 89.53 W/m^2

$Q_{HEATING}$ = 89.53 W/m^2 x 14.4 m^2 = 1289.2 W **($Q_{HEATINGalluminium}$ > $Q_{HEATINGwood}$)**

$CF_{HEATTRANSFERPART}$ = 3.61 x (7.9 °C – 0.46 x 11.9 °C) = 8.76 W/m^2

PXI = 559 + 188 = 747 W/m^2

$CF_{IRRADIATIONPART}$ = 747 W/m^2 x 0.56 x 1 x 0.56 = 234.26 W/m^2

CF = 8.76 + 234.26 = 243.02 W/m^2

$Q_{COOLING}$ = 243.02 W/m^2 x 14.4 m^2 = 3499.46 W **($Q_{COOLINGalluminium}$ > $Q_{COOLINGwood}$)**

2.

SOUTH - FIXED - WOOD FRAME (A = 3.6 m^2)

HF = 2.84 x 24.8 °C = 70.43 W/m^2

$Q_{HEATING}$ = 70.43 W/m^2 x 3.6 m^2 = 253.55 W

$\mathbf{CF_{HEATTRANSFERPART}}$ = 2.84 x (7.9 °C – 0.46 x 11.9 °C) = 6.89 W/m^2

PXI = 348 + 209 = 557 W/m^2

$\mathbf{CF_{IRRADIATIONPART}}$ = 557 W/m^2 x 0.54 x 1 x 0.47 = 141.37 W/m^2

CF = 6.89 +141.37 = 148.26 W/m^2

$\mathbf{Q_{COOLING}}$ = 148.26 W/m^2 x 3.6 m^2 = 533.74 W

SOUTH - FIXED - ALLUMINIUM FRAME (A = 3.6 m^2)

HF = 3.61 x 24.8 °C = 89.53 W/m^2

$\mathbf{Q_{HEATING}}$ = 89.53 W/m^2 x 3.6 m^2 = 322.31 W   **($Q_{HEATINGalluminium} > Q_{HEATINGwood}$)**

$\mathbf{CF_{HEATTRANSFERPART}}$ = 3.61 x (7.9 °C – 0.46 x 11.9 °C) = 8.76 W/m^2

PXI = 348 + 209 = 557 W/m^2

$\mathbf{CF_{IRRADIATIONPART}}$ = 557 W/m^2 x 0.56 x 1 x 0.47 = 146.6 W/m^2

CF = 8.76 + 146.6 = 155.36 W/m^2

$\mathbf{Q_{COOLING}}$ = 155.36 W/m^2 x 3.6 m^2 = 559.3 W   **($Q_{COOLINGalluminium} > Q_{COOLINGwood}$)**

3.

SOUTH - OPERABLE - WOOD FRAME (A = 3.6 m^2)

HF = 2.87 x 24.8 °C = 71.18 W/m^2

$\mathbf{Q_{HEATING}}$ = 71.18 W/m^2 x 3.6 m^2 = 256.23 W

$\mathbf{CF_{HEATTRANSFERPART}}$ = 2.87 x (7.9 °C – 0.46 x 11.9 °C) = 6.96 W/m^2

PXI = 348 + 209 = 557 W/m^2

$\mathbf{CF_{IRRADIATIONPART}}$ = 557 W/m^2 x 0.46 x 1 x 0.47 = 120.42 W/m^2

CF = 6.96 + 120.42 = 127.38 W/m^2

$\mathbf{Q_{COOLING}}$ = 127.38 W/m^2 x 3.6 m^2 = 458.58 W

SOUTH - OPERABLE - ALLUMINIUM FRAME (A = 3.6 m^2)

HF = 4.62 x 24.8 °C = 114.58 W/m^2

$\mathbf{Q_{HEATING}}$ = 114.58 W/m^2 x 3.6 m^2 = 412.47 W   **($Q_{HEATINGalluminium} > Q_{HEATINGwood}$)**

$\mathbf{CF_{HEATTRANSFERPART}}$ = 4.62 x (7.9 °C – 0.46 x 11.9 °C) = 11.21 W/m^2

PXI = 348 + 209 = 557 W/m^2

$\mathbf{CF_{IRRADIATIONPART}}$ = 557 W/m^2 x 0.55 x 1 x 0.47 = 143.98 W/m^2

CF = 11.21 + 143.98 = 155.19 W/m^2

$\mathbf{Q_{COOLING}}$ = 155.19 W/m^2 x 3.6 m^2 = 558.7 W   **($Q_{COOLINGalluminium} > Q_{COOLINGwood}$)**