

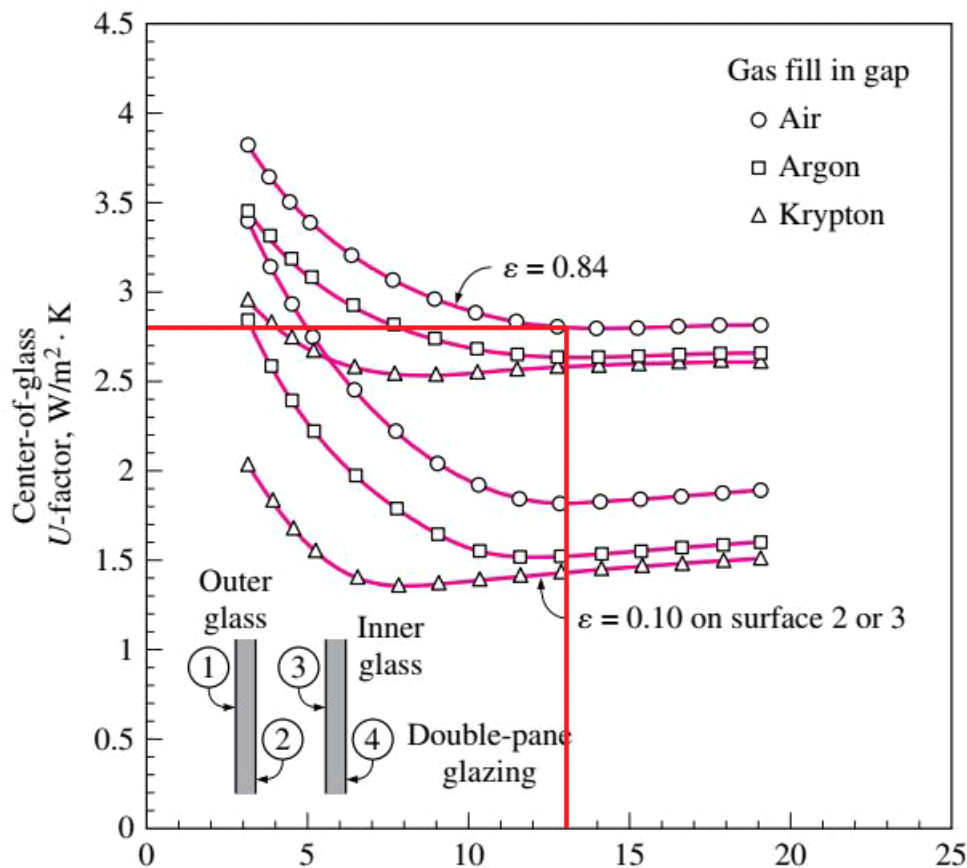
week8_MelissaMartinoli

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01. 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)

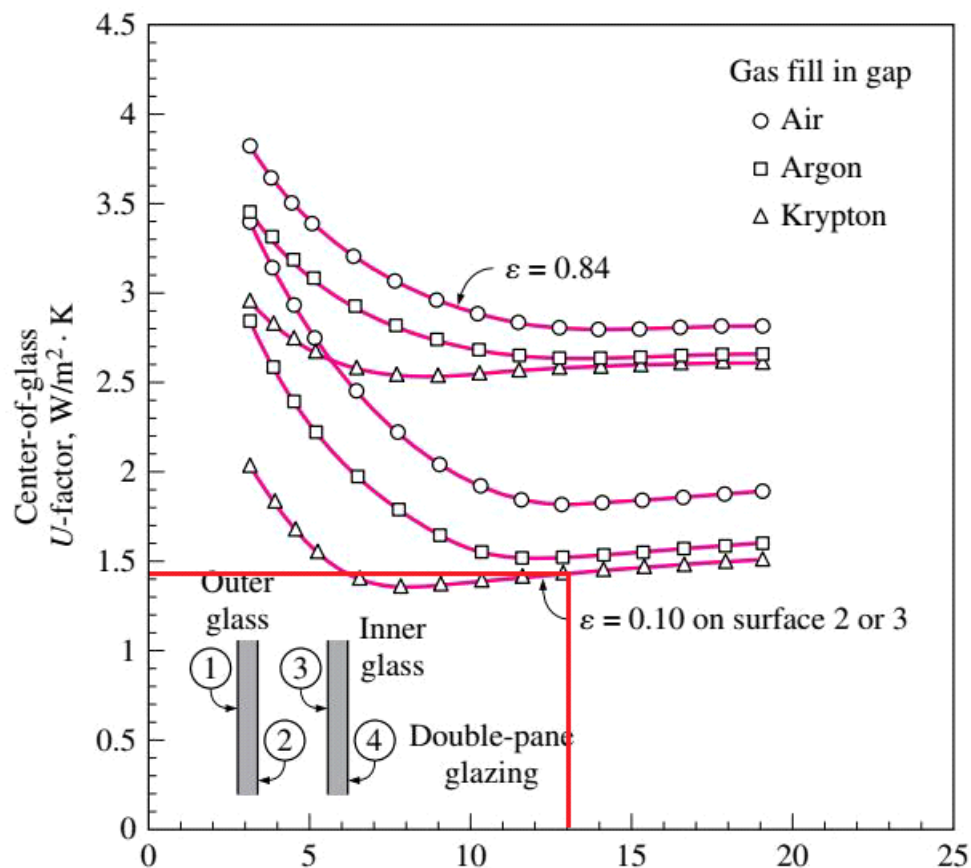
double-pane window (13 mm air gap) U value $\approx 2.8 \frac{W}{m^2 \cdot ^\circ C}$

Type	Glass section (glazing) only		Aluminum frame (without thermal break)			Wood or vinyl frame					
	Center-of-glass	Edge-of-glass	Fixed	Double door	Sloped skylight	Fixed	Double door	Sloped skylight	Fixed	Double door	Sloped skylight
Frame width →	(Not applicable)		32 mm (1½ in)	53 mm (2 in)	19 mm (¾ in)	41 mm (1⅝ in)	88 mm (3⅞ in)	23 mm (⅞ in)			
Spacer type →	—	Metal Insul.	All	All	All	Metal Insul.	Metal Insul.	Metal Insul.			
Glazing Type											
Single Glazing											
3 mm (⅛ in) glass	6.30	6.30	—	6.63	7.16	9.88	5.93	—	5.57	—	7.57
6.4 mm (¼ in) acrylic	5.28	5.28	—	5.69	6.27	8.86	5.02	—	4.77	—	6.57
3 mm (⅛ in) acrylic	5.79	5.79	—	6.16	6.71	9.94	5.48	—	5.17	—	7.63
Double Glazing (no coating)											
6.4 mm air space	3.24	3.71	3.34	3.90	4.55	6.70	3.26	3.16	3.20	3.09	4.37
12.7 mm air space	2.78	3.40	2.91	3.51	4.18	6.65	2.88	2.76	2.86	2.74	4.32
6.4 mm argon space	2.95	3.52	3.07	3.66	4.32	6.47	3.03	2.91	2.98	2.87	4.14
12.7 mm argon space	2.61	3.28	2.76	3.36	4.04	6.47	2.74	2.61	2.73	2.60	4.14



1. If we decide to change the typology of gas using the krypton we will see that the U value of the same kind of window will decrease.
In this situation, the gap has to be well sealed to prevent the gas from leaking outside.

double-pane window (13 mm krypton gap) U value $\approx 1.4 \frac{W}{m^2 \cdot ^\circ C}$
therefore, the U value would decrease by 50%



2. If we decide to add an extra pane, considering if it is an economical choice, we will see that the U value of the same kind of window will decrease.

triple-pane window (13 mm air gap) U value $\approx 1.8 \frac{W}{m^2 \cdot ^\circ C}$

therefore, the U value would decrease by 33%

Type	Glass section (glazing) only		Aluminum frame (without thermal break)			Wood or vinyl frame					
	Center-of-glass	Edge-of-glass	Fixed	Double door	Sloped skylight	Fixed	Double door	Sloped skylight	Fixed	Double door	Sloped skylight
Frame width →	(Not applicable)		32 mm (1½ in)	53 mm (2 in)	19 mm (¾ in)	41 mm (1⅝ in)	88 mm (3⅞ in)	23 mm (⅞ in)			
Spacer type →	—	Metal Insul.	All	All	All	Metal Insul.	Metal Insul.	Metal Insul.			
Glazing Type											
Single Glazing											
3 mm (⅛ in) glass	6.30	6.30	—	6.63	7.16	9.88	5.93	—	5.57	—	7.57
6.4 mm (¼ in) acrylic	5.28	5.28	—	5.69	6.27	8.86	5.02	—	4.77	—	6.57
3 mm (⅛ in) acrylic	5.79	5.79	—	6.16	6.71	9.94	5.48	—	5.17	—	7.63
Double Glazing (no coating)											
6.4 mm air space	3.24	3.71	3.34	3.90	4.55	6.70	3.26	3.16	3.20	3.09	4.37
12.7 mm air space	2.78	3.40	2.91	3.51	4.18	6.65	2.88	2.76	2.86	2.74	4.32
6.4 mm argon space	2.95	3.52	3.07	3.66	4.32	6.47	3.03	2.91	2.98	2.87	4.14
12.7 mm argon space	2.61	3.28	2.76	3.36	4.04	6.47	2.74	2.61	2.73	2.60	4.14
Double Glazing [$\epsilon = 0.1$, coating on one of the surfaces of air space (surface 2 or 3, counting from the outside toward inside)]											
6.4 mm air space	2.44	3.16	2.60	3.21	3.89	6.04	2.59	2.46	2.60	2.47	3.73
12.7 mm air space	1.82	2.71	2.06	2.67	3.37	6.04	2.06	1.92	2.13	1.99	3.73
6.4 mm argon space	1.99	2.83	2.21	2.82	3.52	5.62	2.21	2.07	2.26	2.12	3.32
12.7 mm argon space	1.53	2.49	1.83	2.42	3.14	5.71	1.82	1.67	1.91	1.78	3.41
Triple Glazing (no coating)											
6.4 mm air space	2.16	2.96	2.35	2.97	3.66	5.81	2.34	2.18	2.36	2.21	3.48
12.7 mm air space	1.76	2.67	2.02	2.62	3.33	5.67	2.01	1.84	2.07	1.91	3.34
6.4 mm argon space	1.93	2.79	2.16	2.77	3.47	5.57	2.15	1.99	2.19	2.04	3.25
12.7 mm argon space	1.65	2.58	1.92	2.52	3.23	5.53	1.91	1.74	1.98	1.82	3.20

3. If we decide to use a low emissivity coating with $\epsilon = 0.1$ we will see that the U value of the same kind of window will decrease.

double-pane window (coating $\epsilon = 0.1$) U value $\approx 1.8 \frac{\text{W}}{\text{m}^2 \cdot ^\circ\text{C}}$
therefore, the U value would decrease by 36%

Type	Glass section (glazing) only			Aluminum frame (without thermal break)			Wood or vinyl frame					
	Center-of-glass		Edge-of-glass	Fixed	Double door	Sloped skylight	Fixed		Double door		Sloped skylight	
	(Not applicable)			32 mm (1½ in)	53 mm (2 in)	19 mm (¾ in)	41 mm (1⅝ in)		88 mm (3⅞ in)		23 mm (⅞ in)	
Frame width →												
Spacer type →	—	Metal	Insul.	All	All	All	Metal	Insul.	Metal	Insul.	Metal	Insul.
Glazing Type												
Single Glazing												
3 mm (⅛ in) glass	6.30	6.30	—	6.63	7.16	9.88	5.93	—	5.57	—	7.57	—
6.4 mm (¼ in) acrylic	5.28	5.28	—	5.69	6.27	8.86	5.02	—	4.77	—	6.57	—
3 mm (⅛ in) acrylic	5.79	5.79	—	6.16	6.71	9.94	5.48	—	5.17	—	7.63	—
Double Glazing (no coating)												
6.4 mm air space	3.24	3.71	3.34	3.90	4.55	6.70	3.26	3.16	3.20	3.09	4.37	4.22
12.7 mm air space	2.78	3.40	2.91	3.51	4.18	6.65	2.88	2.76	2.86	2.74	4.32	4.17
6.4 mm argon space	2.95	3.52	3.07	3.66	4.32	6.47	3.03	2.91	2.98	2.87	4.14	3.97
12.7 mm argon space	2.61	3.28	2.76	3.36	4.04	6.47	2.74	2.61	2.73	2.60	4.14	3.97
Double Glazing [$\epsilon = 0.1$, coating on one of the surfaces of air space (surface 2 or 3, counting from the outside toward inside)]												
6.4 mm air space	2.44	3.16	2.60	3.21	3.89	6.04	2.59	2.46	2.60	2.47	3.73	3.53
12.7 mm air space	1.82	2.71	2.06	2.67	3.37	6.04	2.06	1.92	2.13	1.99	3.73	3.53
6.4 mm argon space	1.99	2.83	2.21	2.82	3.52	5.62	2.21	2.07	2.26	2.12	3.32	3.09
12.7 mm argon space	1.53	2.49	1.83	2.42	3.14	5.71	1.82	1.67	1.91	1.78	3.41	3.19

02. Consider the house that we analysed in the last two examples, calculate the heating and cooling load of the other windows which are fixed 14.4 m² on the west, fixed 3.6 m² on the south and an openable 3.6 m² 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 aluminium?

From the table we know that:

The heating DB in Piacenza is -4,8°C

The cooling DB in Piacenza is 31,9°C

DR (hottest month DB range) = 11,9°C

So we can calculate:

$$\Delta t_{\text{cooling}} = 31,9^{\circ}\text{C} - 24^{\circ}\text{C} = 7,9^{\circ}\text{C}$$

$$\Delta t_{\text{heating}} = 20^{\circ}\text{C} - (-4,8^{\circ}\text{C}) = 24,8^{\circ}\text{C}$$

To calculate the cooling load related to a transparent surface we can use the following formula:

$$Q = A \times CF$$

$$CF = U (\Delta T_{\text{cooling}} - 0,46 \times DR) + PXI \times SHGC \times IAC \times FF3$$

We have 3 different windows, so we have 3 different CF and 3 different Q

$$1. \quad PXI_{\text{westwindows}} = ED + Ed = 559 + 188 = 747$$

$$SHGC = 0,54$$

$$\text{No internal shading so } IAC = 1$$

$$FF3 = 0,56$$

$$CF_{\text{westwindows}} = 2,84 (7,9^{\circ}\text{C} - 0,46 \times 11,9^{\circ}\text{C}) + 747 \times 0,54 \times 1 \times 0,56$$

$$CF_{\text{westwindows}} = 232,78 \frac{\text{W}}{\text{m}^2}$$

$$Q = 14,4 \text{ m}^2 \times 232,78 = 3352 \text{ W}$$

$$2. \quad PXI_{\text{southwindows}} = ED + Ed = 348 + 209 = 557$$

$$SHGC = 0,54$$

$$\text{No internal shading so } IAC = 1$$

$$FF3 = 0,47$$

$$CF_{\text{southwindows}} = 2,84 (7,9^{\circ}\text{C} - 0,46 \times 11,9^{\circ}\text{C}) + 557 \times 0,54 \times 1 \times 0,47$$

$$CF_{\text{southwindows}} = 148,26 \frac{\text{W}}{\text{m}^2}$$

$$Q = 3,6 \text{ m}^2 \times 232,78 = 533,74 \text{ W}$$

$$3. \quad PXI_{\text{southwindowsoperable}} = ED + Ed = 348 + 209 = 557$$

$$SHGC = 0,46$$

$$\text{No internal shading so } IAC = 1$$

$$FF3 = 0,47$$

$$CF_{\text{southwindows}} = 2,87 (7,9^{\circ}\text{C} - 0,46 \times 11,9^{\circ}\text{C}) + 557 \times 0,46 \times 1 \times 0,47$$

$$CF_{\text{southwindows}} = 127,38 \frac{\text{W}}{\text{m}^2}$$

$$Q = 3,6 \text{ m}^2 \times 232,78 = 456,58 \text{ W}$$