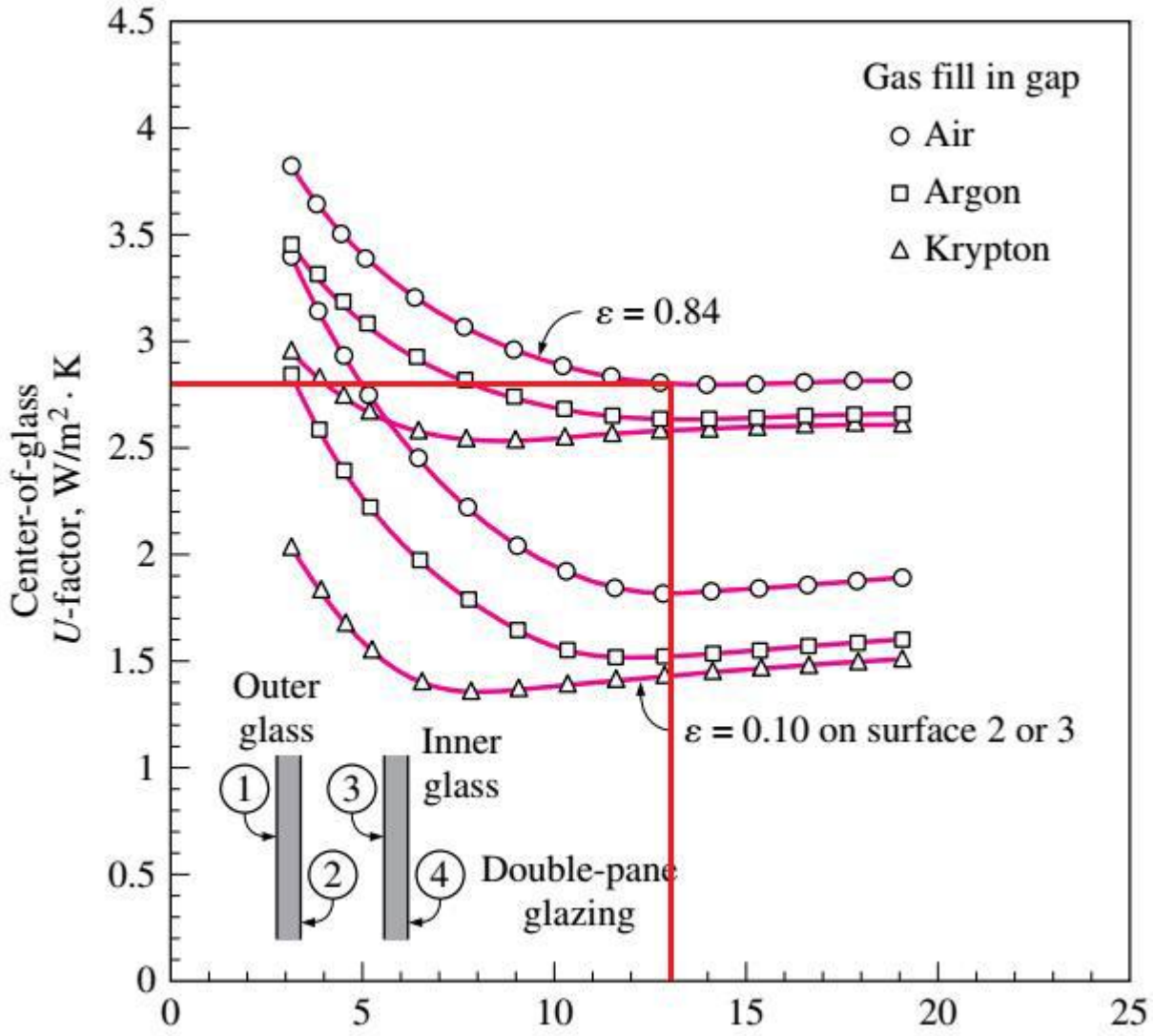
# 8th *WEEK'S* SUBMISSION

*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)

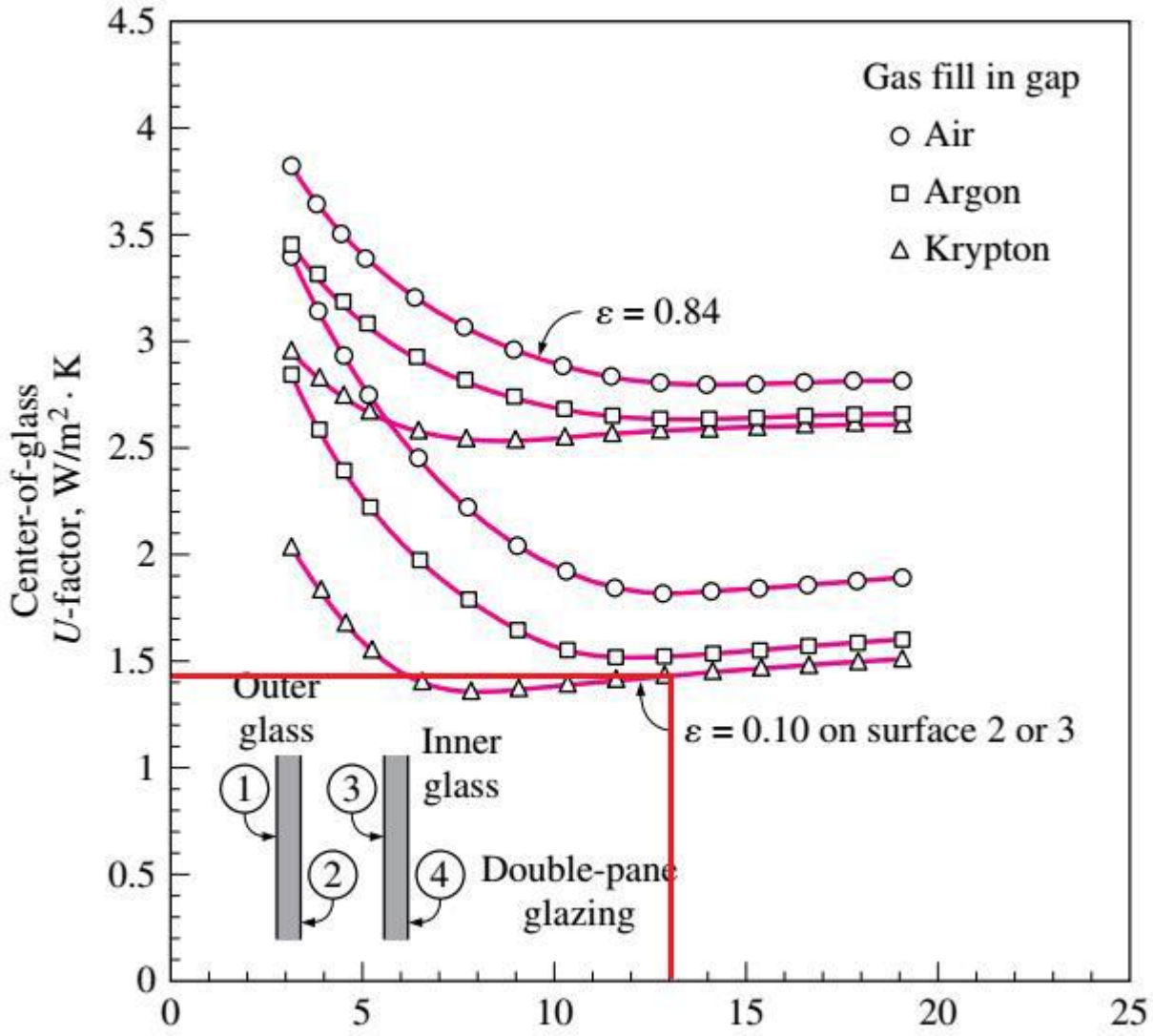
double-pane window (13 mm air gap) U value ≈ 2.8 $\frac{W}{m^2\,°C}$

| | *Glass section (glazing) only* | | | *Aluminum frame (without thermal break)* | | | *Wood or vinyl frame* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | Center-of-glass | | Edge-of-glass | Fixed | Double door | Sloped skylight | Fixed | | Double door | | Sloped skylight | |
| Frame width → | (Not applicable) | | | 32 mm (1¼ in) | 53 mm (2 in) | 19 mm (¾ in) | 41 mm (1⅝ in) | | 88 mm (3 7/16 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 | 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 |




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 ≈ 1.4 $\frac{\mathrm{W}}{\mathrm{m}^2\,^\circ\mathrm{C}}$
   therefore, the U value would decrease by 50%


Gas fill in gap
Air
Argon
Krypton
ε = 0.84
ε = 0.10 on surface 2 or 3
Outer glass
Inner glass
Double-pane glazing
1
2
3
4
Center-of-glass U-factor, W/m² · K
0
0.5
1
1.5
2
2.5
3
3.5
4
4.5
0
5
10
15
20
25

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 ≈ 1.8 $\frac{W}{m^2\,°C}$
   therefore, the U value would decrease by 33%

| | *Glass section (glazing) only* | | | *Aluminum frame (without thermal break)* | | | *Wood or vinyl frame* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | Center-of-glass | | Edge-of-glass | Fixed | Double door | Sloped skylight | Fixed | | Double door | | Sloped skylight | |
| Frame width → | (Not applicable) | | | 32 mm (1¼ in) | 53 mm (2 in) | 19 mm (¾ in) | 41 mm (1⅝ in) | | 88 mm (3 7/18 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 | 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 [$\varepsilon$ = 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 |
| 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 | 3.24 |
| 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 | 3.09 |
| 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 | 3.00 |
| 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 | 2.95 |

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

   double-pane window (coating Є = 0.1) U value ≈ 1.8 $\frac{W}{m^2\,°C}$
   therefore, the U value would decrease by 36%

| | *Glass section (glazing) only* | | | *Aluminum frame (without thermal break)* | | | *Wood or vinyl frame* | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Type | Center-of-glass | | Edge-of-glass | Fixed | Double door | Sloped skylight | Fixed | | Double door | | Sloped skylight | |
| Frame width → | (Not applicable) | | | 32 mm (1¼ in) | 53 mm (2 in) | 19 mm (¾ in) | 41 mm (1⅝ in) | | 88 mm (3 7/16 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 | 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 [$\varepsilon$ = 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 |

2. 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 $M^2$ ON THE WEST, FIXED 3.6 M2 ON THE SOUTH AND AN OPERABLE 3.6 $M^2$ 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:

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

   For calculating the COOLING load for a transparent surface we use the following formula:

   Q= A x CF

   and

   CF= U ($\Delta T_{cooling}$ – 0,46xDR) + PXI x SHGC x IAC x $FF_3$

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

   1) $PXI_{westwindows=}$ $E_D$ + $E_d$ = 559 + 188 = 747

   SHGC= 0,54

   No internal shading so IAC= 1

   $FF_3$= 0,56

   so

   $CF_{westwindows}$= 2,84 ( 7,9°C – 0.46x11,9°C) + 747 x 0,54 x 1 x 0,56 = 232,78 $\frac{W}{m^2}$

   Q= 14,4 m2 x 232,78 = 3352 W

2) $PXI_{southwindows=} E_D + E_d = 348 + 209 = 557$

SHGC= 0,54

No internal shading so IAC= 1

$FF_3$= 0,47

so

$CF_{southwindows}$= 2,84 ( 7,9°C – 0.46x11,9°C) + 557 x 0,54 x 1 x 0,47 = 148,26 $\frac{W}{m^2}$

Q= 3.6 m2 x 232,78 = 533.74 W

3) $PXI_{southwindowsoperable=} E_D + E_d = 348 + 209 = 557$

SHGC= 0,46

No internal shading so IAC= 1

$FF_3$= 0,47

so

$CF_{southwindows}$= 2,87 ( 7,9°C – 0.46x11,9°C) + 557 x 0,46 x 1 x 0,47 = 127,38 $\frac{W}{m^2}$

Q= 3.6 m2 x 232,78 = 456.58 W

For calculating the HEATING load for a transparent surface we use the following formula:

Q= A x HF

HF= U x $\Delta T_{heating}$

1) HF=