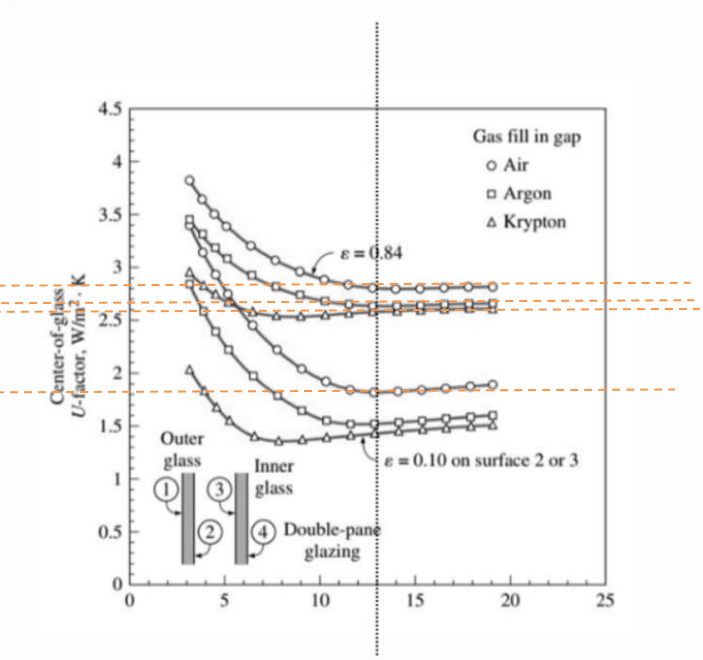
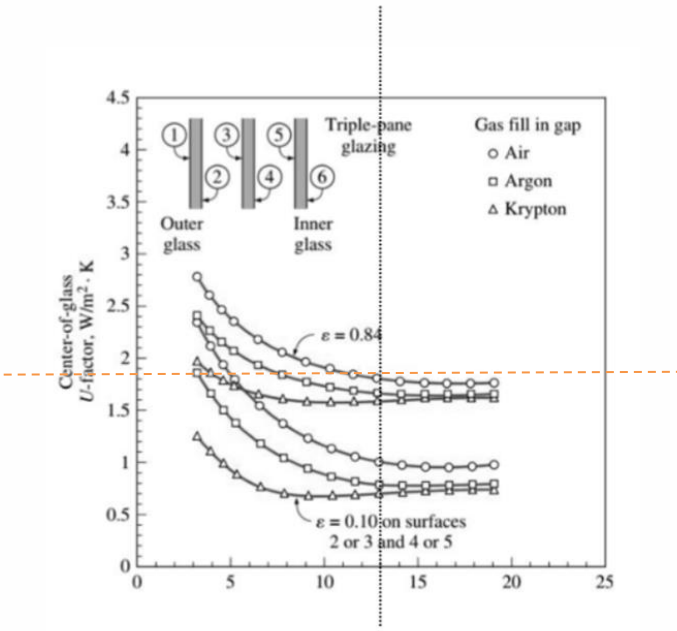
QUESTION 1

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 thickenss to be 13 mm)





double layer with air and no coating (thickness = 13mm)	changing the gas	adding an extra pane	using a low emissivity coating
(U_factor = 2.8) **100%**	• Argon : U_factor = 2.63 => **94% (-6%)** • Krypton : U_factor = 2.55 => **91% (-9%)**	U_factor = 1.8 => **64% (-36%)**	U_factor = 1.8 => **64% (-36%)**

QUESTION 2

Consider the house that we analysed in the alst 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 operable 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 ?

(A) • Cooling load of the fixed window on the west

we have : $q = A \times CF$

$= A \times [U(\Delta t - 0,46\ DR) + PXI * SHGC \times IAC \times FFs]$

$\begin{cases} A = 14,4\ m^2 \\ U : \text{heat absorbing} \rightarrow \text{double layer glass wooden frame} = 2,84 \frac{W}{m^2 \cdot K} \\ \Delta t = 31,9°C - 24°C = 7,9°C = 7,9\ K \\ DR = 11,9°C = 11,9\ K \end{cases}$

$\begin{cases} PXI = 559 + 188 = 747 \quad (\text{west}) \\ SHGC = 0,54 \quad (\text{Fixed wooden frame}) \\ IAC = 1 \quad (\text{no internal shading}) \\ FFs = 0,56 \quad (\text{west}) \end{cases}$

$\Rightarrow q = 14,4 \times [2,84(7,9 - 0,46 \times 11,9) + 747 \times 0,54 \times 1 \times 0,56]$

$\boxed{q_{\text{cooling (window west)}} \approx 3352,1\ W}$

• Heating load of the fixed window on the west

$q = A \times HF$

$= A \times U \times \Delta t$

$\begin{cases} A = 14,4\ m^2 \\ U = 2,84\ W/m^2K \\ \Delta t = 20 - (-4,8) = 24,8°C = 24,8\ K \end{cases}$

$\boxed{q_{\text{heating (window west}} = 1014,2\ W}$

• cooling and heating load for an aluminium frame

we have : $\begin{cases} U_{\text{aluminum (double glaze window)}} = 3,61 \frac{W}{m^2K} \\ SHGC = 0,56 \end{cases}$

$\Rightarrow \boxed{\begin{array}{l} q_{\text{cooling (window west with aluminium frame)}} = 3499,5\ W \\ q_{\text{Heating (" ")}} = 1289,2\ W \end{array}}$

(B) • Cooling Load of the fixed window on the South

↳ Same value for the window on the west except:

$$\begin{cases} A = 3{,}6\ m^2 \\ PXI = 348 + 209 = 557 \\ FFS = 0{,}47 \end{cases}$$

$$q_{cooling\ (window\ south)} = 3{,}6 \times [2{,}84\ (7{,}9 - 0{,}146 \times 11{,}9 + 557 \times 0{,}54 \times 1 \times 0{,}47]$$

$$\boxed{q_{cooling\ (window\ south)} = 553{,}7\ W}$$

• Heating Load of the fixed window on the South

$$q = A \times U \times \Delta t$$
$$= 3{,}6 \times 2{,}84 \times 24{,}8$$

$$\boxed{q_{heating\ (window\ south)} = 253{,}5\ W}$$

• Cooling and Heating Load for an aluminum frame

↳ Same values for the wooden frame except:

$$\begin{cases} U_{alum} = 3{,}61\ W/m^2.K \\ 1 + SaC = 0{,}56 \end{cases}$$

$$\Rightarrow \boxed{\begin{array}{l} q_{cooling\ load\ (window\ south)} = 559{,}3\ W \\ q_{heating\ "\ (\ "\ "\ )} = 322{,}3\ W \end{array}}$$

(2) • Cooling Load of the operable window on the south
↳ same values for the fixed window on the south
except : $\begin{cases} U = 2,87 \text{ w/m}^2\text{.k} \\ SHGC = 0,46 \end{cases}$

$$q_{cooling} = 3,6 \times [2,87 (7,9 - 0,46 \times 11,9 + 557 \times 0,46 \times 1 \times 0,47]$$

$$\boxed{q_{cooling\ (operable\ WS)} = 553,9 \text{ w}}$$

• Heating Load of the operable window on the south

$$q = A \times U \times \Delta T$$
$$= 3,6 \times 2,87 \times 24,8$$

$$\boxed{q_{Heating\ (operable\ WS)} = 256,2 \text{ w}}$$

• Cooling and Heating when the frame is with Aluminium
↳ same values for (3) except :

$$\begin{cases} U = 4,162 \text{ w/m}^2\text{.k} \\ HSGC = 0,55 \end{cases}$$

$$\Rightarrow \begin{cases} q_{cooling} = 3,6 \times [4,162 (7,9 - 0,46 \times 11,9 + 557 \times 0,55 \times 1 \times 0,47] \\ q_{Heating} = 3,6 \times 4,162 \times 24,8 \end{cases}$$

$$\Rightarrow \boxed{\begin{array}{l} q_{cooling\ (operable\ WS\ /\ Aluminium\ frame)} \simeq 558,7 \text{ w} \\ q_{Heating\ (\ "\ "\ /\ "\ )} \simeq 412,4 \text{ w} \end{array}}$$