



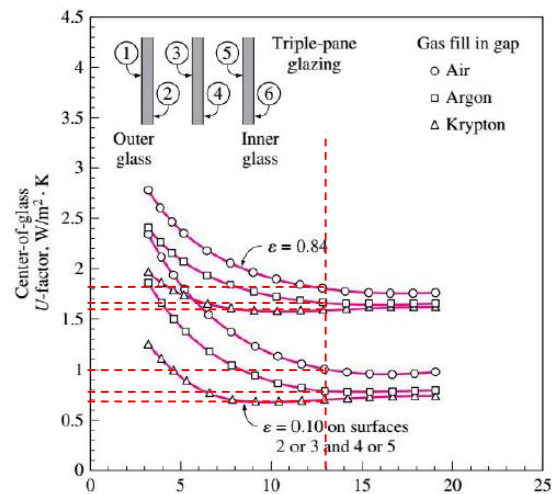
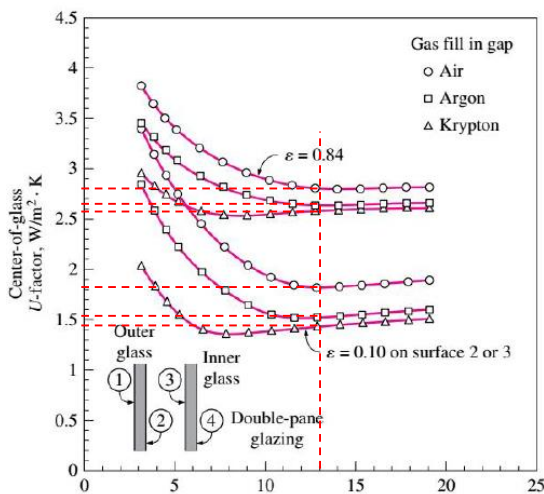
## WEEKLY SUBMISSION - TASK 08

**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).

**02.** Consider the house that we analyzed in the last two examples, calculate the heating and cooling load of the other windows which are fixed 14.4 m<sup>2</sup> on the west, fixed 3.6 m<sup>2</sup> on the south and an operable 3.6 m<sup>2</sup> 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 aluminum ?

### ANSWERS:

**01.**



TYPES OF PLANS	U	DIFFERENCE PERCENTAGE	
2 Parallel plans with Air	2,8 W/m <sup>2</sup>		
2 Parallel plans with Argon	2,65 W/m <sup>2</sup>	0,15 W/m <sup>2</sup>	5%
2 Parallel plans with Krypton	2,58 W/m <sup>2</sup>	0,22 W/m <sup>2</sup>	8%
2 Parallel plans with Air and Coating	1,82 W/m <sup>2</sup>	0,98 W/m <sup>2</sup>	35%
2 Parallel plans with Argon and Coating	1,52 W/m <sup>2</sup>	1,28 W/m <sup>2</sup>	46%
2 Parallel plans with Krypton and Coating	1,45 W/m <sup>2</sup>	1,35 W/m <sup>2</sup>	48%
3 Parallel plans with Air	1,8 W/m <sup>2</sup>	1 W/m <sup>2</sup>	36%
3 Parallel plans with Argon	1,68 W/m <sup>2</sup>	1,12 W/m <sup>2</sup>	40%
3 Parallel plans with Krypton	1,6 W/m <sup>2</sup>	1,2 W/m <sup>2</sup>	43%
3 Parallel plans with Air and Coating	1 W/m <sup>2</sup>	1,8 W/m <sup>2</sup>	64%
3 Parallel plans with Argon and Coating	0,8 W/m <sup>2</sup>	2 W/m <sup>2</sup>	71%
3 Parallel plans with Krypton and Coating	0,7 W/m <sup>2</sup>	2,1 W/m <sup>2</sup>	75%

02.

### COOLING:

#### West Window Fixed – Wooden Frame:

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

$$CF_{heattransfer} = U(\Delta T - 0.46DR)$$

$$CF_{heattransfer} = 2.84 (7,9 - 0,46 \times 11,9)$$

$$CF_{heattransfer} = 6,89 \frac{W}{m^2}$$

$$CF_{irradiation} = PXI \times SHGC \times IAC \times FF_s$$

$$CF_{irradiation} = 747 \times 0.54 \times 1 \times 0,56 = 225,89 \frac{W}{m^2}$$

$$CF_{window} = CF_{heattransfer} + CF_{irradiation}$$

$$CF_{window} = 6,89 + 225,89 = 232,78 \frac{W}{m^2}$$

$$\dot{Q}_{westwindowfixedwooden} = A \times CF_{window}$$

$$\dot{Q}_{westwindowfixedwooden} = 14,4 \times 232,78 = 3352,03 \text{ W}$$

#### West Window Fixed – Aluminum Frame:

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

$$CF_{heattransfer} = U(\Delta T - 0.46DR)$$

$$CF_{heattransfer} = 3,61 (7,9 - 0,46 \times 11,9)$$

$$CF_{heattransfer} = 8,75 \frac{W}{m^2}$$

$$CF_{irradiation} = PXI \times SHGC \times IAC \times FF_s$$

$$CF_{irradiation} = 747 \times 0.56 \times 1 \times 0,56 = 234,26 \frac{W}{m^2}$$

$$CF_{window} = CF_{heattransfer} + CF_{irradiation}$$

$$CF_{window} = 8,75 + 234,26 = 243,01 \frac{W}{m^2}$$

$$\dot{Q}_{westwindowfixedwooden} = A \times CF_{window}$$

$$\dot{Q}_{westwindowfixedwooden} = 14,4 \times 243,01 = 3499,34 \text{ W}$$

#### Differences:

$$CF_{heattransfer} = 8,75 - 6,89 = 1,86 \frac{W}{m^2}$$

$$CF_{irradiation} = 234,26 - 225,89 = 8,37 \frac{W}{m^2}$$

$$CF_{window} = 243,01 - 232,78 = 10,23 \frac{W}{m^2}$$

$$\dot{Q}_{differencewestfixedwindow} = 3499,34 - 3352,03 = 147,31 \text{ W}$$

## COOLING:

### South Window Fixed – Wooden Frame:

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

$$CF_{heattransfer} = U(\Delta T - 0.46DR)$$

$$CF_{heattransfer} = 2.84 (7,9 - 0,46 \times 11,9)$$

$$CF_{heattransfer} = 6,89 \frac{W}{m^2}$$

$$CF_{irradiation} = PXI \times SHGC \times IAC \times FF_s$$

$$CF_{irradiation} = 557 \times 0.54 \times 1 \times 0,47 = 141,37 \frac{W}{m^2}$$

$$CF_{window} = CF_{heattransfer} + CF_{irradiation}$$

$$CF_{window} = 6,89 + 141,37 = 148,26 \frac{W}{m^2}$$

$$\dot{Q}_{southwindow_{fixedwooden}} = A \times CF_{window}$$

$$\dot{Q}_{southwindow_{fixedwooden}} = 3,6 \times 148,26 = 533,74 W$$

### South Window Fixed – Aluminum Frame:

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

$$CF_{heattransfer} = U(\Delta T - 0.46DR)$$

$$CF_{heattransfer} = 3,61 (7,9 - 0,46 \times 11,9)$$

$$CF_{heattransfer} = 8,75 \frac{W}{m^2}$$

$$CF_{irradiation} = PXI \times SHGC \times IAC \times FF_s$$

$$CF_{irradiation} = 557 \times 0.56 \times 1 \times 0,47 = 146,60 \frac{W}{m^2}$$

$$CF_{window} = CF_{heattransfer} + CF_{irradiation}$$

$$CF_{window} = 8,75 + 146,60 = 155,35 \frac{W}{m^2}$$

$$\dot{Q}_{southwindow_{fixedwooden}} = A \times CF_{window}$$

$$\dot{Q}_{southwindow_{fixedwooden}} = 3,6 \times 155,35 = 559,27 W$$

### Differences:

$$CF_{heattransfer} = 8,75 - 6,89 = 1,86 \frac{W}{m^2}$$

$$CF_{irradiation} = 146,60 - 141,37 = 5,23 \frac{W}{m^2}$$

$$CF_{window} = 155,35 - 148,26 = 7,09 \frac{W}{m^2}$$

$$\dot{Q}_{difference_{southfixedwindow}} = 559,27 - 533,74 = 25,53 W$$

## COOLING:

### South Operable Window– Wooden Frame:

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

$$CF_{heattransfer} = U(\Delta T - 0.46DR)$$

$$CF_{heattransfer} = 2.87 (7,9 - 0,46 \times 11,9)$$

$$CF_{heattransfer} = 6,96 \frac{W}{m^2}$$

$$CF_{irradiation} = PXI \times SHGC \times IAC \times FF_s$$

$$CF_{irradiation} = 557 \times 0.46 \times 1 \times 0,47 = 120,42 \frac{W}{m^2}$$

$$CF_{window} = CF_{heattransfer} + CF_{irradiation}$$

$$CF_{window} = 6,96 + 120,42 = 127,38 \frac{W}{m^2}$$

$$\dot{Q}_{southwindow_{operablewooden}} = A \times CF_{window}$$

$$\dot{Q}_{southwindow_{operablewooden}} = 3,6 \times 127,38 = 458,57 W$$

### South Operable Window– Aluminum Frame:

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

$$CF_{heattransfer} = U(\Delta T - 0.46DR)$$

$$CF_{heattransfer} = 4,62 (7,9 - 0,46 \times 11,9)$$

$$CF_{heattransfer} = 11,21 \frac{W}{m^2}$$

$$CF_{irradiation} = PXI \times SHGC \times IAC \times FF_s$$

$$CF_{irradiation} = 557 \times 0.55 \times 1 \times 0,47 = 143,98 \frac{W}{m^2}$$

$$CF_{window} = CF_{heattransfer} + CF_{irradiation}$$

$$CF_{window} = 11,21 + 143,98 = 155,19 \frac{W}{m^2}$$

$$\dot{Q}_{southwindow_{operablewooden}} = A \times CF_{window}$$

$$\dot{Q}_{southwindow_{operablewooden}} = 3,6 \times 155,19 = 558,68 W$$

### Differences:

$$CF_{heattransfer} = 11,21 - 6,96 = 4,25 \frac{W}{m^2}$$

$$CF_{irradiation} = 143,98 - 120,42 = 23,56 \frac{W}{m^2}$$

$$CF_{window} = 155,19 - 127,38 = 27,81 \frac{W}{m^2}$$

$$\dot{Q}_{difference_{southoperablewindow}} = 558,68 - 458,57 = 100,11 W$$

## HEATING:

### West Window Fixed – Wooden Frame:

$$HF = U \times \Delta T_{\text{heating}}$$

$$HF = 2.84 \times 24.8$$

$$HF = 70,43 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{westwindowfixedwooden}} = A \times HF$$

$$\dot{Q}_{\text{westwindowfixedwooden}} = 70,43 \times 14,4 = 1014,19 \text{ W}$$

### West Window Fixed – Aluminum Frame:

$$HF = U \times \Delta T_{\text{heating}}$$

$$HF = 3,61 \times 24.8$$

$$HF = 89,53 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{westwindowfixedwooden}} = A \times HF$$

$$\dot{Q}_{\text{westwindowfixedwooden}} = 89,53 \times 14,4 = 1289,23 \text{ W}$$

### Differences:

$$HF = 89,53 - 70,43 = 19,10 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{differencewestfixedwindow}} = 1289,23 - 1014,19 = 275,04 \text{ W}$$

## HEATING:

### South Window Fixed – Wooden Frame:

$$HF = U \times \Delta T_{\text{heating}}$$

$$HF = 2.84 \times 24.8$$

$$HF = 70,43 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{southwindowfixedwooden}} = A \times HF$$

$$\dot{Q}_{\text{southwindowfixedwooden}} = 70,43 \times 3,6 = 253,55 \text{ W}$$

### South Window Fixed – Aluminum Frame:

$$HF = U \times \Delta T_{\text{heating}}$$

$$HF = 3,61 \times 24.8$$

$$HF = 89,53 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{southwindowfixedwooden}} = A \times HF$$

$$\dot{Q}_{\text{southwindowfixedwooden}} = 89,53 \times 3,6 = 322,31 \text{ W}$$

### Differences:

$$HF = 89,53 - 70,43 = 19,10 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{difference}_{\text{southfixedwindow}}} = 322,31 - 253,55 = 68,76 \text{ W}$$

## HEATING:

### South Operable Window– Wooden Frame:

$$HF = U \times \Delta T_{\text{heating}}$$

$$HF = 2.87 \times 24.8$$

$$HF = 71,18 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{southwindow}_{\text{fixedwooden}}} = A \times HF$$

$$\dot{Q}_{\text{southwindow}_{\text{operablewooden}}} = 71,18 \times 3,6 = 256,25 \text{ W}$$

### South Operable Window– Aluminum Frame:

$$HF = U \times \Delta T_{\text{heating}}$$

$$HF = 4,62 \times 24.8$$

$$HF = 114,58 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{southwindow}_{\text{fixedwooden}}} = A \times HF$$

$$\dot{Q}_{\text{southwindow}_{\text{operablewooden}}} = 114,58 \times 3,6 = 412,49 \text{ W}$$

## Differences:

$$HF = 114,58 - 71,18 = 43,40 \frac{\text{W}}{\text{m}^2}$$

$$\dot{Q}_{\text{difference}_{\text{southoperablewindow}}} = 412,49 - 256,25 = 156,24 \text{ W}$$