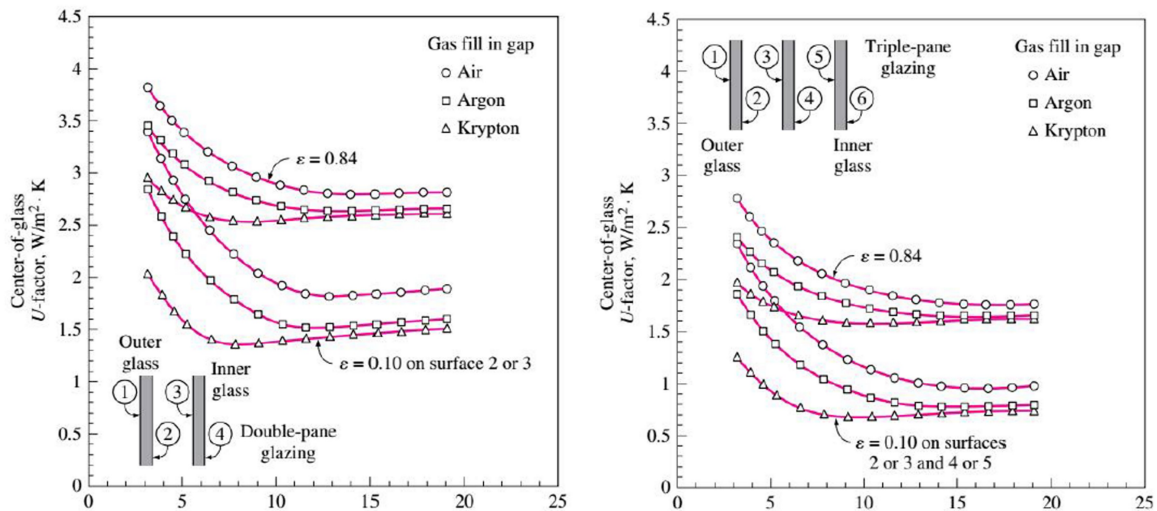


# Week 8

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**Task 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 thickness too be 13mm.



		U-Value 2 Parallel Planes	Difference	Percentage diff / U <sub>2air</sub>
2 Parallel Planes	w/ air	2.80 W/m²	0.00 W/m²	0.00%
	w/ Argon	2.65 W/m²	0.15 W/m²	5.36%
	w/ Krypton	2.60 W/m²	0.20 W/m²	7.14%
	w/ air and coating	1.80 W/m²	1.00 W/m²	35.71%
	w/ Argon and coating	1.50 W/m²	1.30 W/m²	46.43%
	w/ Krypton and coating	1.40 W/m²	1.40 W/m²	50.00%
3 Parallel Planes	w/ air	1.80 W/m²	1.00 W/m²	35.71%
	w/ Argon	1.70 W/m²	1.10 W/m²	39.29%
	w/ Krypton	1.60 W/m²	1.20 W/m²	42.86%
	w/ air and coating	1.00 W/m²	1.80 W/m²	64.29%
	w/ Argon and coating	0.80 W/m²	2.00 W/m²	71.43%
	w/ Krypton and coating	0.70 W/m²	2.10 W/m²	75.00%

**Task 2.** Consider the house that we analyzed in the last two examples, calculate the heating and cooling load of the other windows which are fixed

## COOLING

### WEST WINDOW

#### Fixed - Wooden

$$CF_{ht} = U(R_{cooling} - 0.46DR)$$

$$CF_{ht} = 2.84 \text{ W/m}^2\text{K}(7.90\text{K} - 0.46 * 11.9)$$

$$CF_{ht} = 6.90 \text{ W/m}^2$$

$$CF_{ip} = PXI * SHGC * IAC * FF_s$$

$$CF_{ip} = 747 * 0.54 * 1 * 0.56$$

$$CF_{ip} = 217.82 \text{ W/m}^2$$

$$CF_{total} = 6.9 + 217.82 = 224.72 \text{ W/m}^2$$

$$Q_{cooling} = CF_{total} * Area = 224.72 * 14.4 \text{ m}^2$$

$$Q_{cooling} = 3235.96 \text{ W}$$

#### Fixed - Aluminum

$$CF_{ht} = U(T_{cooling} - 0.46DR)$$

$$CF_{ht} = 3.61 \text{ W/m}^2 \text{ K}(7.9 \text{ K} - 0.46 * 11.9)$$

$$CF_{ht} = 8.75 \text{ W/m}^2$$

$$CF_{ip} = PXI * SHGC * IAC * FF_s$$

$$CF_{ip} = 747 * 0.56 * 1 * 0.56$$

$$CF_{ip} = 234.25 \text{ W/m}^2$$

$$CF_{total} = 8.75 + 234.25 = 243 \text{ W/m}^2$$

$$Q_{cooling} = CF_{total} * Area = 243 * 14.4 \text{ m}^2$$

$$Q_{cooling} = 3499.33 \text{ W}$$

#### Differences

$$CF_{ht} = 8.75 - 6.90 = 1.85 \text{ W/m}^2$$

$$CF_{ip} = 234.25 - 217.82 = 16.43 \text{ W/m}^2$$

$$CF_{total} = 243 - 224.72 = 18.28 \text{ W/m}^2$$

$$Q_{cooling} = 3499.33 - 3235.96 = 263.37 \text{ W}$$

#### SOUTH WINDOW

##### Fixed - Wooden

$$CF_{ht} = U(T_{cooling} - 0.46DR)$$

$$CF_{ht} = 2.84 \text{ W/m}^2 \text{ K}(7.9 \text{ K} - 0.46 * 11.9)$$

$$CF_{ht} = 6.90 \text{ W/m}^2$$

$$CF_{ip} = PXI * SHGC * IAC * FF_s$$

$$CF_{ip} = 557 * 0.54 * 1 * 0.47$$

$$CF_{ip} = 141.36 \text{ W/m}^2$$

$$CF_{total} = 6.90 + 141.36 = 148.26 \text{ W/m}^2$$

$$Q_{cooling} = CF_{total} * Area = 148.26 * 3.6 \text{ m}^2$$

$$Q_{cooling} = 533.73 \text{ W}$$

##### Fixed - Aluminum

$$CF_{ht} = U(T_{cooling} - 0.46DR)$$

$$CF_{ht} = 3.61 \text{ W/m}^2 \text{ K}(7.9 \text{ K} - 0.46 * 11.9)$$

$$CF_{ht} = 8.75 \text{ W/m}^2$$

$$CF_{ip} = PXI * SHGC * IAC * FF_s$$

$$CF_{ip} = 557 * 0.56 * 1 * 0.47$$

$$CF_{ip} = 146.6 \text{ W/m}^2$$

$$CF_{total} = 8.75 + 146.6 = 155.35 \text{ W/m}^2$$

$$Q_{cooling} = CF_{total} * Area = 155.35 * 3.6 \text{ m}^2$$

$$Q_{cooling} = 559.2 \text{ W}$$

#### Differences

$$CF_{ht} = 8.75 - 6.90 = 1.85 \text{ W/m}^2$$

$$CF_{ip} = 146.6 - 141.36 = 5.24 \text{ W/m}^2$$

$$CF_{total} = 155.35 - 148.26 = 7.09 \text{ W/m}^2$$

$$Q_{cooling} = 559.20 - 533.73 = 25.47 \text{ W}$$

#### SOUTH WINDOW

##### Operable - Wooden

$$CF_{ht} = U(T_{cooling} - 0.46DR)$$

$$CF_{ht} = 2.87 \text{ W/m}^2 \text{ K}(7.9 \text{ K} - 0.46 * 11.9)$$

$$CF_{ht} = 6.96 \text{ W/m}^2$$

$$CF_{ip} = PXI * SHGC * IAC * FF_s$$

$$CF_{ip} = 557 * 0.46 * 1 * 0.47$$

$$CF_{ip} = 120.40W/m^2$$

$$CF_{total} = 6.96 + 120.4 = 127.38W/m^2$$

$$Q_{cooling} = CF_{total} * Area = 127.38 * 3.6m^2$$

$$Q_{cooling} = 458.58W$$

#### Operable - Aluminum

$$CF_{ht} = U(T_{cooling} - 0.46DR)$$

$$CF_{ht} = 4.62 W/m^2K(7.9K - 0.46 * 11.9)$$

$$CF_{ht} = 11.20 W/m^2$$

$$CF_{ip} = PXI * SHGC * IAC * FF_s$$

$$CF_{ip} = 557 * 0.55 * 1 * 0.47$$

$$CF_{ip} = 143.98 W/m^2$$

$$CF_{total} = 11.20 + 143.98 = 155.18W/m^2$$

$$Q_{cooling} = CF_{total} * Area = 155.18 * 3.6m^2$$

$$Q_{cooling} = 558.6W$$

#### Differences

$$CF_{ht} = 11.20 - 6.96 = 4.24W/m^2$$

$$CF_{ip} = 143.98 - 120.40 = 23.58W/m^2$$

$$CF_{total} = 155.18 - 127.38 = 27.8W/m^2$$

$$Q_{cooling} = 558.6 - 458.58 = 100.02W$$

### HEATING

#### WEST WINDOW

##### Fixed - Wooden

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

$$HF = 2.84 W/m^2K \times 24.80K$$

$$HF = 70.40 W/m^2$$

$$Q_{heating} = HF \times Area$$

$$Q_{heating} = 70.40 W/m^2 * 14.40m^2$$

$$Q_{heating} = 1014.20W$$

##### Fixed - Aluminum

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

$$HF = 3.61 W/m^2K \times 24.8K$$

$$HF = 89.52 W/m^2$$

$$Q_{heating} = HF \times Area$$

$$Q_{heating} = 89.52 W/m^2 * 14.40m^2$$

$$Q_{heating} = 1289.20W$$

#### Differences

$$HF = 89.52 - 70.40 = 19.12W/m^2$$

$$Q_{heating} = 1289.20 - 1014.20 = 275W$$

#### SOUTH WINDOW

##### Fixed - Wooden

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

$$HF = 2.84 W/m^2K \times 24.80K$$

$$HF = 70.40 W/m^2$$

$$Q_{heating} = HF \times Area$$

$$Q_{heating} = 70.40 W/m^2 * 3.60m^2$$

$$Q_{heating} = 253.40W$$

##### Fixed - Aluminum

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

$$HF = 3.61 W/m^2K \times 24.8K$$

$$HF = 89.52 W/m^2$$

$$Q_{heating} = HF \times Area$$

$$Q_{heating} = 89.52 W/m^2 * 3.60m^2$$

$$Q_{heating} = 322.30W$$

**Differences**

$$HF = 89.52 - 70.40 = 19.12W/m^2$$

$$Q_{heating} = 322.30 - 253.40 = 68.90W$$

**SOUTH WINDOW****Operable - Wooden**

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

$$HF = 2.87 W/m^2K \times 24.80K$$

$$HF = 71.87 W/m^2$$

$$Q_{heating} = HF \times Area$$

$$Q_{heating} = 71.87 W/m^2 * 3.60m^2$$

$$Q_{heating} = 256.20W$$

**Operable - Aluminum**

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

$$HF = 4.62 W/m^2K \times 24.80K$$

$$HF = 114.57 W/m^2$$

$$Q_{heating} = HF \times Area$$

$$Q_{heating} = 114.57 W/m^2 * 3.60m^2$$

$$Q_{heating} = 412.45W$$

**Differences**

$$HF = 114.57 - 71.87 = 42.70W/m^2$$

$$Q_{heating} = 412.45 - 256.20 = 156.25W$$