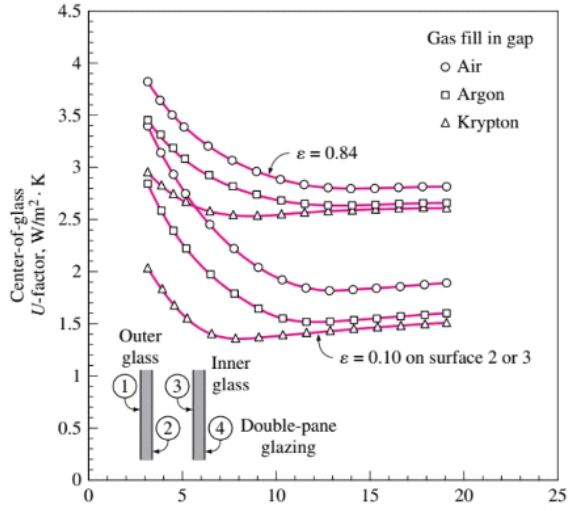
WEEK 8

Tuesday, November 26, 2019 9:50 PM

Politecnico di Milano
MSc. Sustainable Architecture and Landscape Design
Fabiola Anahí Mogrovejo León

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 thickens to be 13 mm)

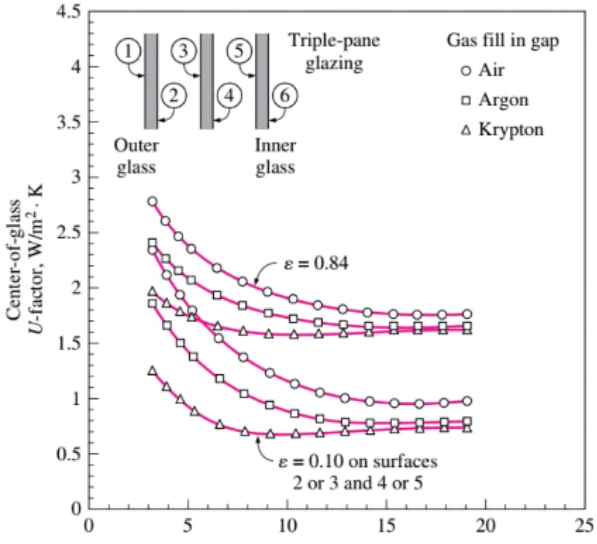


Changing the air to argon and krypton in a double-pane glazing without coating:

U_factor_withair= 2.8 W/m2 * K
U_factor_withArgon= 2.65 W/m2 * K, which is 5.35% less of Heat transfer.
U_factor_withKrypton= 2.55 W/m2 * K, which is 8.93% less of Heat transfer.

Changing the air to argon and krypton in a double-pane glazing with coating:

U_factor_withair= 1.8 W/m2 * K
U_factor_withArgon= 1.52 W/m2 * K, which is 15.55% less of Heat transfer.
U_factor_withKrypton= 1.4 W/m2 * K, which is 22.22% less of Heat transfer.



Changing the air to argon and krypton in a triple-pane glazing without coating:

U_factor_withair= 1.53 W/m2 * K
U_factor_withArgon= 1.515 W/m2 * K, which is 0.98% less of Heat transfer.
U_factor_withKrypton= 1.505 W/m2 * K, which is 1.63% less of Heat transfer.

Changing the air to argon and krypton in a triple-pane glazing with coating:

U_factor_withair= 1 W/m2 * K
U_factor_withArgon= 0.75 W/m2 * K, which is 25% less of Heat transfer.
U_factor_withKrypton= 0.6 W/m2 * K, which is 40% less of Heat transfer.

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 14.4 m2 on the west, fixed 3.6 m2 on the south and an operable 3.6 m2 on

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 aluminum?

$\Delta T_{cooling} = 31.9 - 24 = 7.9\,°C$

$\Delta T_{heating} = 20 - (-4.8) = 24.8\,°C$

DR =11.9 °C
From the table:
U= 2.84
SHGC= 0.54

- **Fixed on the west 14.4 m2**

$U_{window_{west}} = 2.84 \frac{W}{m2K}$

Heating factor:

$HF_{windwow_{west}} = U_{window_{west}}(\Delta T_{heating}) = 2.84\ (24.8) = \ 70.432 \frac{W}{m2}$

$Q_{windwow_{west}} = HF_{windwow_{west}} \times A_{window_{west}} = 70.432 * 14.4 = \mathbf{1014.2\ W}$

Cooling factor:

$CF_{windwow_{west\_heatTrasnferPart}} = U_{window_{west}}(\Delta T_{cooling} - 0.46\ DR) = 2.84\ (7.9 - 0.46 * 11.9)$
$= \ 6.9 \frac{W}{m2}$

$PXI_{window_{west}} = E_D + E_d = 559 + 188 = 747$

SHGC = 0.54
NO internal shading so IAC = 1

From the table for western window of a detached house FFs = 0.56

$CF_{windwow_{west\_IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = \ 747 * 0.54 * 1 * 0.56 = 225.9\ W/m2$

$CF_{windwow_{west}} = CF_{windwow_{west\_heatTrasnferPart}} + CF_{windwow_{west\_IrradiationPart}} = \ 6.9 + 225.9$
$= 232.8\ \frac{W}{m^2}$

$Q_{windwow_{west}} = \ CF_{windwow_{west}} \times A_{window_{west}} = 238.8 * 14.4 = \mathbf{3438.72\ W}$

If the frame is aluminium:

$U_{window_{west}} = 3.61\ \frac{W}{m2K}$
SHGC= 0.56

Heating factor:

$HF_{windwow_{west}} = U_{window_{west}}(\Delta T_{heating}) = 3.61\ (24.8) = \ 89.53\frac{W}{m2}$

$Q_{windwow_{west}} = HF_{windwow_{west}} \times A_{window_{west}} = 89.53\ * 14.4 = \mathbf{1289.23\ W}$

Cooling factor:

$CF_{windwow_{west\_heatTrasnferPart}} = U_{window_{west}}(\Delta T_{cooling}\ - 0.46\ DR) = 3.61\ (7.9 - 0.46 * 11.9)$
$= \ 8.76\frac{W}{m2}$

$PXI_{window_{west}} = E_D + E_d = 559 + 188 = 747$

SHGC = 0.56
NO internal shading so IAC = 1

From the table for western window of a detached house FFs = 0.56

$CF_{windwow_{west\_IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = \ 747\ * 0.56\ * 1\ * 0.56 = 234.26\ W/m2$

$CF_{windwow_{west}} = CF_{windwow_{west\_heatTrasnferPart}} + \ CF_{windwow_{west\_IrradiationPart}} = \ 8.76 + 234.26$
$= 243.02\ \frac{W}{m^2}$

$Q_{windwow_{west}} = \ CF_{windwow_{west}} \times A_{window_{west}} = 243.02\ * 14.4 = \mathbf{3499.49\ W}$

- **Fixed on the south 3.6 m2**

$U_{window_{south}} = 2.84\frac{W}{m2K}$

Heating factor:

$HF_{windwow_{south}} = U_{window_{south}}(\Delta T_{heating}) = 2.84\ (24.8) = \ 70.432\frac{W}{m2}$

$Q_{windwow_{south}} = HF_{windwow_{south}} \times A_{window_{south}} = 70.432\ * 3.6 = \mathbf{253.56\ W}$

Cooling factor:

$CF_{windwow_{south\_heatTrasnferPart}} = U_{window_{south}}(\Delta T_{cooling}\ - 0.46\ DR) = 2.84\ (7.9 - 0.46 * 11.9)$
$= \ 6.9\frac{W}{m2}$

$PXI_{window_{south}} = E_D + E_d = 348 + 209 = 557$

SHGC = 0.54
NO internal shading so IAC = 1

From the table for southern window of a detached house FFs = 0.47

$CF_{windwow_{south\_IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = \ 557 \ * 0.54 \ * 1 \ * 0.47 = 141.36 \, W/m2$

$CF_{windwow_{south}} = CF_{windwow_{south\_heatTrasnferPart}} + \ CF_{windwow_{south\_IrradiationPart}} = \ 6.9 + 141.36 = 148.26 \ \frac{W}{m^2}$

$Q_{windwow_{south}} = \ CF_{windwow_{south}} \times A_{window_{south}} = 148.26 \ * 3.6 = \mathbf{533.74 \ W}$

If the frame is aluminium:

$U_{window_{south}} = 3.61 \ \frac{W}{m2K}$

SHGC= 0.56

Heating factor:

$HF_{windwow_{south}} = U_{window_{south}}(\Delta T_{heating}) = 3.61 \ (24.8) = \ 89.53 \frac{W}{m2}$

$Q_{windwow_{south}} = HF_{windwow_{south}} \times A_{window_{south}} = 89.53 \ * 3.6 = \mathbf{322.3 \ W}$

Cooling factor:

$CF_{windwow_{south\_heatTrasnferPart}} = U_{window_{south}}(\Delta T_{cooling} \ - 0.46 \ DR) = 3.61 \ (7.9 - 0.46 * 11.9) = \ 8.76 \frac{W}{m2}$

$PXI_{window_{south}} = E_D + E_d = 348 + 209 = 557$

SHGC = 0.56
NO internal shading so IAC = 1

From the table for southern window of a detached house FFs = 0.47

$CF_{windwow_{south\_IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = \ 557 \ * 0.56 \ * 1 \ * 0.47 = 146.6 \, W/m2$

$CF_{windwow_{south}} = CF_{windwow_{south\_heatTrasnferPart}} + \ CF_{windwow_{south\_IrradiationPart}} = \ 8.76 \ + 146.6 = 155.36 \ \frac{W}{m^2}$

$Q_{windwow_{south}} = \ CF_{windwow_{south}} \times A_{window_{south}} = 155.36 \ * 3.6 = \mathbf{559.3 \ W}$

- **Operable window on the south 3.6 m2**

$U_{window_{south}} = 2.84 \frac{W}{m2K}$

Heating factor:

$HF_{windwow_{south}} = U_{window_{south}}(\Delta T_{heating}) = 2.84 \ (24.8) = \ 70.432 \frac{W}{m2}$

$Q_{windwow_{south}} = HF_{windwow_{south}} \times A_{window_{south}} = 70.432 * 3.6 = \mathbf{253.56\ W}$

Cooling factor:

$CF_{windwow_{south\_heatTrasnferPart}} = U_{window_{south}}(\Delta T_{cooling} - 0.46\ DR) = 2.84\ (7.9 - 0.46 * 11.9) = 6.9 \frac{W}{m2}$

$PXI_{window_{south}} = E_D + E_d = 348 + 209 = 557$

SHGC = 0.46
NO internal shading so IAC = 1

From the table for southern window of a detached house FFs = 0.47

$CF_{windwow_{south\_IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 557 * 0.46 * 1 * 0.47 = 120.42\ W/m2$

$CF_{windwow_{south}} = CF_{windwow_{south\_heatTrasnferPart}} + CF_{windwow_{south\_IrradiationPart}} = 6.9 + 120.42 = 127.32\ \frac{W}{m^2}$

$Q_{windwow_{south}} = CF_{windwow_{south}} \times A_{window_{south}} = 127.32 * 3.6 = \mathbf{458.35\ W}$

If the frame is aluminium:

$U_{window_{south}} = 4.62\ \frac{W}{m2K}$
SHGC= 0.55

Heating factor:

$HF_{windwow_{south}} = U_{window_{south}}(\Delta T_{heating}) = 4.62\ (24.8) = 114.57 \frac{W}{m2}$

$Q_{windwow_{south}} = HF_{windwow_{south}} \times A_{window_{south}} = 114.57 * 3.6 = \mathbf{412.45\ W}$

Cooling factor:

$CF_{windwow_{south\_heatTrasnferPart}} = U_{window_{south}}(\Delta T_{cooling} - 0.46\ DR) = 4.62\ (7.9 - 0.46 * 11.9) = 11.21 \frac{W}{m2}$

$PXI_{window_{south}} = E_D + E_d = 348 + 209 = 557$

SHGC = 0.55
NO internal shading so IAC = 1

From the table for southern window of a detached house FFs = 0.47

$CF_{windwow_{south\_IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 557 * 0.55 * 1 * 0.47 = 143.98\ W/m2$

$CF_{windwow_{south}} = CF_{windwow_{south\_heatTrasnferPart}} + CF_{windwow_{south\_IrradiationPart}} = 11.21 + 143.98 = 155.19 \frac{W}{m^2}$

$Q_{windwow_{south}} = CF_{windwow_{south}} \times A_{window_{south}} = 155.19 * 3.6 = \mathbf{558.68\ W}$