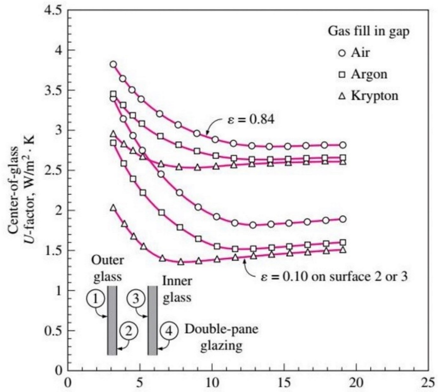
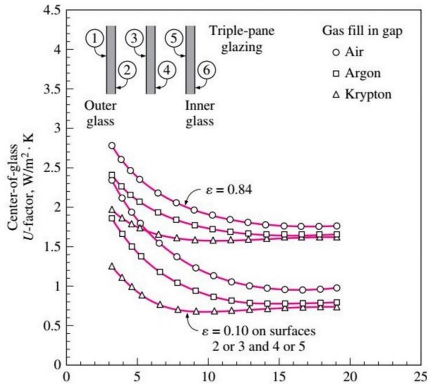
Demre Ertem Weekly Submission 8

26 Kasım 2019 Salı 21:38

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 thickenss to be 13 mm)





$$\dot{Q}_{window} = \dot{Q}_{center} + \dot{Q}_{edge} + \dot{Q}_{frame}$$
$$= U_{window} A_{window} (T_{indoors} - T_{outdoors})$$

$$U_{window} = (U_{center} A_{center} + U_{edge} A_{edge} + U_{frame} A_{frame}) / A_{window}$$

For the first graph, we can see the difference of materials. When the gas fill in the gap is air, U-value has the higher value. The value changed gradually for each material in the same order. When the gap filled with Krypton, the value has the least value among 3 types of gas. Secondly, while emissitive coating is rising, U-factor also increases.
At last, If we turn the double layer to the triple layer with the addition of a pane, on the contrary to emissitive coating, U-value decreases when the other elements are constant.

Task 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 ?

Wood

West fixed 14.4

$$CF_{window_{west}\downarrow heatTrasnferPart}$$

$$= \mathrm{U}_{window_{west}} (\Delta T_{cooling} - 0.46\, DR) = 2.84\,(7.9 - 0.46 * 11.9) = \; 6.9 \frac{W}{m2}$$

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

SHGC = 0.54
IAC = 1
FFs = 0.56

$$CF_{windwo_{west\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 747 * 0.54 * 1 * 0.56 = 225{,}8$$

$$CF_{windwo_{east}} = CF_{windwo_{east\downarrow heatTrasnferPart}} + CF_{windwo_{east\downarrow IrradiationPart}} = 6.9 + 225.8 = 232.7 \frac{W}{m^2}$$

$$Q_{windwo_{east}} = CF_{windwo_{east}} \times A_{window_{east}} = 232.7 * 14.4 = 3350\, W$$

South fixed 3.6

$$CF_{window_{south\downarrow heatTrasnferPart}}$$

$$= \mathrm{U}_{\mathrm{window}_{south}} (\Delta T_{cooling} - 0.46\, DR) = 2.84\, (7.9 - 0.46 * 11.9) = 6.9 \frac{W}{m2}$$

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

SHGC = 0.54
IAC = 1
FFs = 0.47

$$CF_{windwo_{south\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 557 * 0.54 * 1 * 0.47 = 141{,}4$$

$$CF_{windwo_{south}} = CF_{windwo_{south\downarrow heatTrasnferPart}} + CF_{windwo_{south\downarrow IrradiationPart}} = 6.9 + 141.4 = 148.3 \frac{W}{m^2}$$

$$Q_{windwo_{south}} = CF_{windwo_{south}} \times A_{window_{south}} = 148.3 * 3.6 = 533{,}9\, W$$

South operable 3.6f

$$CF_{window_{south\downarrow heatTrasnferPart}}$$

$$= \mathrm{U}_{\mathrm{window}_{south}} (\Delta T_{cooling} - 0.46\, DR) = 2.87\, (7.9 - 0.46 * 11.9) = 5.94 \frac{W}{m2}$$

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

SHGC = 0.46
IAC = 1
FFs = 0.47

$$CF_{windwo_{south\downarrow IrradiationPart}} = PXI \times SHGC \times IAC \times FF_S = 557 * 0.46 * 1 * 0.47 = 120{,}4$$

$CF_{windwo_{south}} = CF_{windwo_{south\downarrow}heatTrasnferPart} + CF_{windwo_{south\downarrow}IrradiationPart}$
$= 5.94 + 120.42 = 126.36\frac{W}{m^2}$

$Q_{windwo_{south}} = CF_{windwo_{south}} \times A_{window_{south}} = 126.36 * 3.6 = 454{,}9\, W$

Aluminium

West fixed 14.4

$CF_{window_{west\downarrow}heatTrasnferPart}$

$= \mathrm{U}_{\mathrm{window}_{west}}(\Delta T_{cooling} - 0.46\, DR) = 3.61(7.9 - 0.46 * 11.9) = 8.76\frac{W}{m2}$

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

SHGC = 0.56
IAC = 1
FFs = 0.56

$CF_{windwo_{west\downarrow}IrradiationPart} = PXI \times SHGC \times IAC \times FF_S = 747 * 0.56 * 1 * 0.56$
$= 234{,}26$

$CF_{windwo_{east}} = CF_{windwo_{east\downarrow}heatTrasnferPart} + CF_{windwo_{east\downarrow}IrradiationPart}$
$= 8.76 + 234.26 = 243.02\frac{W}{m^2}$

$Q_{windwo_{east}} = CF_{windwo_{east}} \times A_{window_{east}} = 243.02 * 14.4 = 3499.5\, W$

South fixed 3.6

$CF_{window_{south\downarrow}heatTrasnferPart}$

$= \mathrm{U}_{\mathrm{window}_{south}}(\Delta T_{cooling} - 0.46\, DR) = 3.61\,(7.9 - 0.46 * 11.9) = 8.76\frac{W}{m2}$

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

SHGC = 0.56
IAC = 1
FFs = 0.47

$CF_{windwo_{south\downarrow}IrradiationPart} = PXI \times SHGC \times IAC \times FF_S = 557 * 0.56 * 1 * 0.47$
$= 146{,}6$

$CF_{windwo_{south}} = CF_{windwo_{south\downarrow}heatTrasnferPart} + CF_{windwo_{south\downarrow}IrradiationPart}$
$= 8.76 + 146.6 = 155.36\frac{W}{m^2}$
$Q_{windwo_{south}} = CF_{windwo_{south}} \times A_{window_{south}} = 155.36 * 3.6 = 559{,}3\, W$

South operable 3.6

$CF_{window_{south}\downarrow heatTrasnferPart}$

$= \mathrm{U_{window}}_{south}\left(\Delta T_{cooling} - 0.46\, DR\right) = 4.62\ (7.9 - 0.46 * 11.9) = \ 11.2 \frac{W}{m2}$

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

SHGC = 0.55
IAC = 1
FFs = 0.47

$CF_{windwo_{south}\downarrow IrradiationPart} = PXI \times SHGC \times IAC \times FF_S = \ 557 * 0.55 * 1 * 0.47$
$= 143{,}98$

$CF_{windwo_{south}} = CF_{windwo_{south}\downarrow heatTrasnferPart} + CF_{windwo_{south}\downarrow IrradiationPart}$
$= \ 11.2 + 143.98 = 155.18 \frac{W}{m^2}$
$Q_{windwo_{south}} = CF_{windwo_{south}} \times A_{window_{south}} = 155.18 * 3.6 = 558{,}78\, W$

Considering each calculations , aluminium as a frame material will be a better choice than wood for all conditions.
If we compared fixed and operable frames, fixed always has the best protection, but the difference inbetween aluminium great less than the ones of woods.
Direction of the building also is significant, for the west facade,the effect is dramatically higher than south.