TES Technical Environmental System

Tuesday, November 26, 2019 8:33 PM

Week # 8 Assignment **Professor:** Dr. Behzad Najafi

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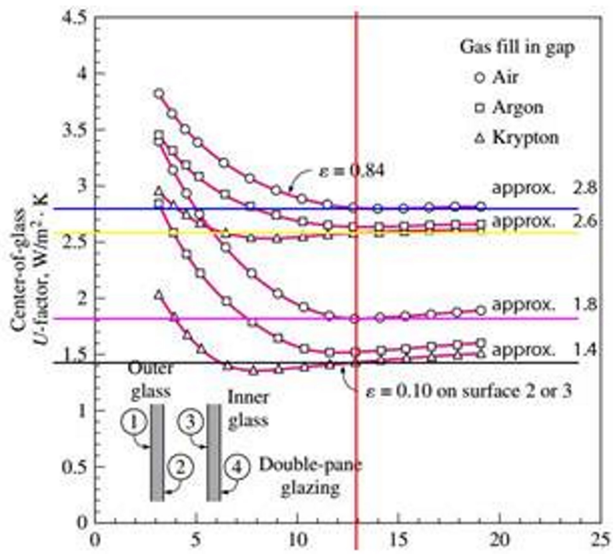
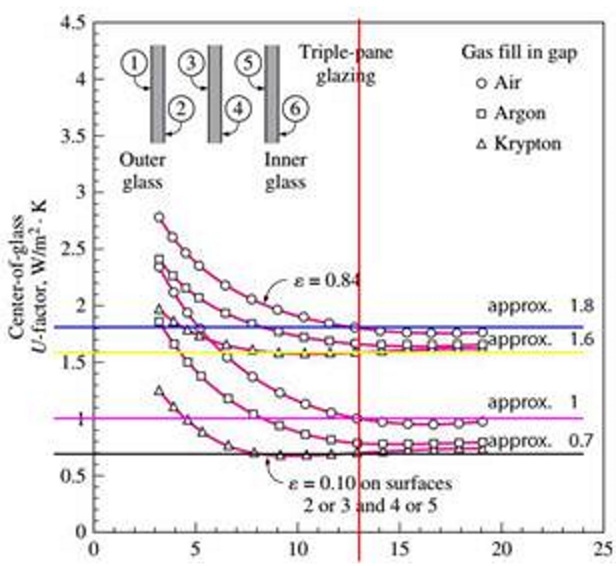
Task 1: Using the diagrams given in the presentation calculate how much (%) is the effect of applying different modifications (changing the gas, adding an extra pane, using a low emissivity coating) on the U value with respect to a benchmark case of double layer with air and no coating ? (keep the gap thickness to be 13 mm)

Using the graphs from the lecture, with some added lines.





In the two graphs showed above, the red lines represent the mark of 13mm airgap, from which we will reach or designated U-factors.

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In the left diagram, some notable data:

- benchmark case of double layer with air and no coating (U-factor = 2.8 W/m². k)
- first modification of changing the gas (i.e. Krypton) (U-factor = 2.6 W/m². k)
- second modification of using a low emissivity coating ε=0.1 (U-factor = 1.8 W/m². k)

In the right diagram, some notable data:

- third modification using a triple glazing pane system with air, no coating (U-factor = 1.8 W/m². k)

Type of glazing	U-factors	Difference	Percentage
Double Glazing + air	2.8		benchmark case
Double glazing + Krypton	2.6	=2.8 - 2.6= 0.2	=0.2*100/2.8= 7%
Double Glazing + air + low e coating	1.8	=2.8 - 1.8= 1	35%
Double Glazing + krypton + low e coating	1.4	=2.8 – 1.4= 1.4	50%
Triple glazing + air	1.8	=2.8 - 1.8= 1	35%
Triple glazing + Krypton	1.6	=2.8 – 1.6= 1.2	43%
Triple glazing + air+ low e coating	1	=2.8 - 1= 1.8	65%
Triple glazing + Krypton+ low e coating	0.7	=2.8 - 0.7=2.1	75%

This table show us the percentage of efficiency of thermal resistance of the window with each of the example modifications showed above compared to a double pane window, with air gap, and no low e coating.

Task 2:

Consider the house that we analyzed in the last two examples,

Calculate the heating and cooling load of the other windows (the same window and frame type):

A. Fixed 14.4 m2 on the west
B. Fixed 3.6 m2 on the south
C. operable 3.6 m2 on the south

How much does the total value change if I change the frame of the window from wooden one to aluminum ?

ΔT heating = 24.8 °C

ΔT cooling = 7.9 °C
DR = 11.9

We calculated previously the heating and cooling load for an east facing window. Now we will for two other windows facing west and south.

A- Fixed windows on the west, 14.4 m2

1- Wooden Frame example

U = 2.84

Let's start with Heating load:

$HF = U_{heating} \times \Delta T_{heating}$ =2.84*24.8=70.432 W/m^2

$Q_{heating_{wall}} = HF \times A_{wall_{net}} = 70.432 * 14.4 = 1014.22\ W$

Cooling load Wooden frame:

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

$PXI = E_D + E_d = 559 + 188 = 747$
SHGC = 0.54
IAC = 1
$FF_s = 0.56$

$CF_{windowwest\ heattransfer} = U(\Delta T - 0.46DR)$
$CF_{windowwest\ heattransfer} = 2.84\ (7.9 - (0.46 \times 11.9)) = 6.89\ W/m^2$
$CF_{windowwest\ irridiation} = PXI \times SHGC \times IAC \times FF_s$

$CF_{windowwest\ irridiation} = 747 \times 0.54 \times 1 \times 0.56 = 225.89\ W/m^2$

$CF_{windowwest} = CF_{windowwest\ heattransfer} + CF_{windowwest\ irridiation}$

$CF_{windowwest} = 6.89 + 225.89 = 232.78\ W/m^2$

$\dot{Q}_{windowwest} = A \times CF_{windowwest} = 14.4 \times 232.78 = 3352.032\ W$

2- Aluminum Frame example

U = 3.61

Let's start with Heating load:

$HF = U_{heating} \times \Delta T_{heating}$ =3.61*24.8=89.52 W/m^2

$Q_{heating_{wall}} = HF \times A_{wall_{net}}$ = $89.52 * 14.4 = 1289.08\ W$

Cooling Load: Aluminum Frame

PXI = $E_D + E_d$ = 559 + 188 = 747
SHGC = 0.56
IAC = 1
FF_s = 0.56

$CF_{windowwest} = CF_{windowwest\ heattransfer} + CF_{windowwest\ irridiation}$
$CF_{windowwest}$ = U(ΔT - 0.46DR) + PXI x SHGC x IAC x FF_s
$CF_{windowwest\ heattransfer}$ = U(ΔT - 0.46DR)

$CF_{windowwest\ heattransfer}$ = 3.61 (7.9 - (0.46x11.9)) = 8.76 W/m^2

$CF_{windowwest\ irridiation}$ = PXI x SHGC x IAC x FF_s

$CF_{windowwest\ irridiation}$ = 747 x 0.56 x 1 x 0.56 = 234.26 W/m^2

$CF_{windowwest}$ = 8.76 + 234.26 = 243.02 W/m^2

$\dot{Q}_{windowwest}$ = A x $CF_{windowwest}$ = 14.4 x 243.02 = 3499.47 W

The Total value changes around 147.3 W in cooling load and 275 W in heating load

B- Fixed windows on the south, 3.6 m2

1- Wooden Frame example U = 2.84

Let's start with Heating load:
$HF = U_{heating} \times \Delta T_{heating}$ =2.84*24.8=70.432 W/m^2

$Q_{heating_{wall}} = HF \times A_{wall_{net}}$ = $70.432 * 3.6 = 253.55\ W$

Cooling load Wooden frame:

$CF_{windowsouth} = CF_{windowsouth\ heattransfer} + CF_{windowsouth\ irridiation}$
$CF_{windowsouth}$ = U(ΔT - 0.46DR) + PXI x SHGC x IAC x FF_s

PXI = $E_D + E_d$ = 348 + 209 = 557
SHGC = 0.54
IAC = 1

FF_s = 0.47

$CF_{windowwest\ heattransfer} = U(\Delta T - 0.46DR)$
$CF_{windowwest\ heattransfer} = 2.84\ (7.9 - (0.46 \times 11.9)) = 6.89\ W/m^2$
$CF_{windowwest\ irridiation} = PXI \times SHGC \times IAC \times FF_s$

$CF_{windowwest\ irridiation} = 557 \times 0.54 \times 1 \times 0.47 = 141.36\ W/m^2$

$CF_{windowwest} = CF_{windowwest\ heattransfer} + CF_{windowwest\ irridiation}$

$CF_{windowwest} = 6.89 + 141.36 = 148.25\ W/m^2$

$\dot{Q}_{windowwest} = A \times CF_{windowwest} = 3.6 \times 148.25 = 533.7\ W$

2- Aluminum Frame example

U = 3.61

Let's start with Heating load:
$HF = U_{heating} \times \Delta T_{heating}$ =3.61*24.8=89.52 W/m^2

$Q_{heating_{wall}} = HF \times A_{wall_{net}} = 89.52 * 3.6 = 322.27\ W$

Cooling Load: Aluminum Frame

$PXI = E_D + E_d = 348 + 209 = 557$
SHGC = 0.56
IAC = 1
FF_s = 0.47

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

$CF_{windowwest\ heattransfer} = 3.61\ (7.9 - (0.46 \times 11.9)) = 8.76\ W/m^2$

$CF_{windowwest\ irridiation} = PXI \times SHGC \times IAC \times FF_s$

$CF_{windowwest\ irridiation} = 557 \times 0.56 \times 1 \times 0.47 = 146.60\ W/m^2$

$CF_{windowwest} = 8.76 + 146.60 = 155.36\ W/m^2$

$\dot{Q}_{windowwest} = A \times CF_{windowwest} = 3.6 \times 155.36 = 559.30\ W$

The Total value changes around 25.6 W in cooling load and 68.72 W in heating load

C- Operable windows on the south, 3.6 m2

1- Wooden Frame example

U = 2.87

Let's start with Heating load:

$HF = U_{heating} \times \Delta T_{heating}$ =2.87*24.8=71.176 W/m^2

$Q_{heating_{wall}} = HF \times A_{wall_{net}} = 71.176 * 3.6 = 256.23\ W$

Cooling load Wooden frame:

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

$PXI = E_D + E_d = 348 + 209 = 557$
SHGC = 0.46
IAC = 1
$FF_s = 0.47$

$CF_{windowwest\ heattransfer} = U(\Delta T - 0.46DR)$
$CF_{windowwest\ heattransfer} = 2.87\ (7.9 - (0.46 \times 11.9)) = 6.96\ W/m^2$
$CF_{windowwest\ irridiation} = PXI \times SHGC \times IAC \times FF_s$

$CF_{windowwest\ irridiation} = 557 \times 0.46 \times 1 \times 0.47 = 120.42\ W/m^2$

$CF_{windowwest} = CF_{windowwest\ heattransfer} + CF_{windowwest\ irridiation}$

$CF_{windowwest} = 6.96 + 120.42 = 127.38\ W/m^2$

$\dot{Q}_{windowwest} = A \times CF_{windowwest} = 3.6 \times 127.38 = 458.56\ W$

2- Aluminum Frame example

U = 4.62

Let's start with Heating load:

$HF = U_{heating} \times \Delta T_{heating}$ =4.62*24.8= 114.57 W/m^2

$Q_{heating_{wall}} = HF \times A_{wall_{net}} = 114.57 * 3.6 = 412.45\ W$

Cooling Load: Aluminum Frame

$PXI = E_D + E_d = 348 + 209 = 557$
$SHGC = 0.55$
$IAC = 1$
$FF_s = 0.47$

$CF_{windowwest} = CF_{windowwest\ heattransfer} + CF_{windowwest\ irridiation}$
$CF_{windowwest} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowwest,I,heattransfer} = U(\Delta T - 0.46DR)$

$CF_{windowwest\ heattransfer} = 4.62\ (7.9 - (0.46 \times 11.9)) = 11.21\ W/m^2$

$CF_{windowwest\ irridiation} = PXI \times SHGC \times IAC \times FF_s$

$CF_{windowwest,I,irridiation} = 557 \times 0.55 \times 1 \times 0.47 = 143.98\ W/m^2$

$CF_{windowwest} = 11.21 + 143.98 = 155.19\ W/m^2$

$\dot{Q}_{windowwest} = A \times CF_{windowwest} = 3.6 \times 155.19 = 558.68\ W$

The Total value changes around 100.12 W in cooling load and 156.22 W in heating load