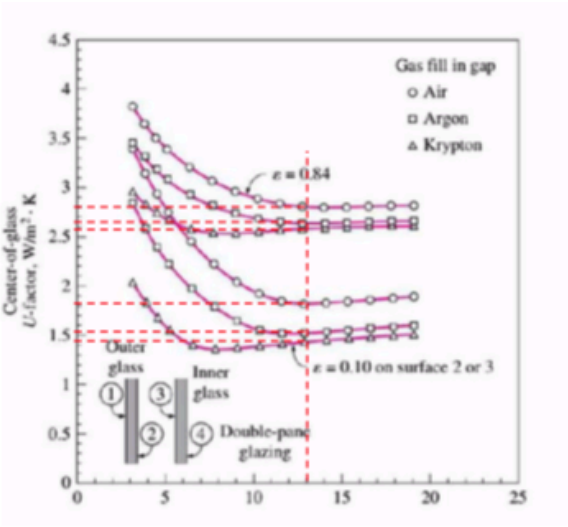
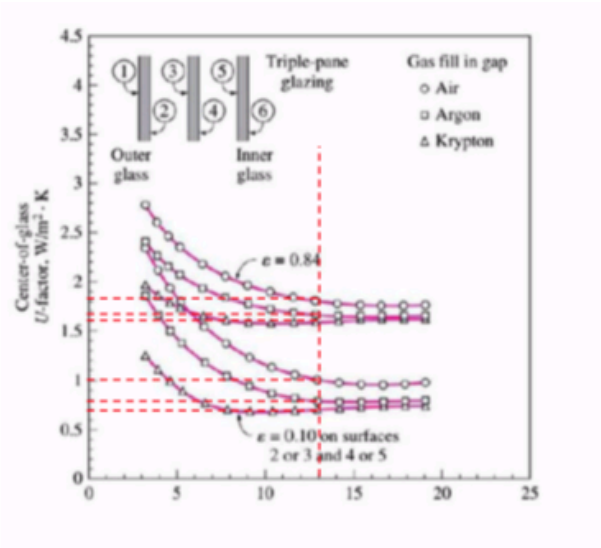
Technical environmental system – Weekly submission VIII

Nicholas Beloso – 10673057

Task I

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).





TYPES OF PLANS	U	DIFFERENCE	PERCENTAGE
2 Parallel plans with Air	2,8 W/m²		
2 Parallel plans with Argon	2,65 W/m²	0,15 W/m²	5%
2 Parallel plans with Krypton	2,58 W/m²	0,22 W/m²	8%
2 Parallel plans with Air and Coating	1,82 W/m²	0,98 W/m²	35%
2 Parallel plans with Argon and Coating	1,52 W/m²	1,28 W/m²	46%
2 Parallel plans with Krypton and Coating	1,45 W/m²	1,35 W/m²	48%
3 Parallel plans with Air	1,8 W/m²	1 W/m²	36%
3 Parallel plans with Argon	1,68 W/m²	1,12 W/m²	40%
3 Parallel plans with Krypton	1,6 W/m²	1,2 W/m²	43%
3 Parallel plans with Air and Coating	1 W/m²	1,8 W/m²	64%
3 Parallel plans with Argon and Coating	0,8 W/m²	2 W/m²	71%
3 Parallel plans with Krypton and Coating	0,7 W/m²	2,1 W/m²	75%

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 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 ?

02.

COOLING: West Window Fixed – Wooden Frame:

$CF_{heattransfer}$ = U(ΔT - 0.46DR) $CF_{heattransfer}$ = 2.84 (7,9 – 0,46 x 11,9)

$CF_{irradiation}$ = PXI x SHGC x IAC x FF_S

$\dot{Q}_{westwindow_{fixedwooden}}$ = A x CF_{window}

West Window Fixed – Aluminum Frame:

$CF_{heattransfer}$ = U(ΔT - 0.46DR) $CF_{heattransfer}$ = 3,61 (7,9 – 0,46 x 11,9)

$CF_{irradiation}$ = PXI x SHGC x IAC x FF_S

$\dot{Q}_{westwindow_{fixedwooden}}$ = A x CF_{window}

Differences:

$CF_{win\ \ ow}$ = $CF_{heattransfer}$ + $CF_{irradiation}$

$\overline{CF_{window}}$ = U(ΔT - 0.46DR) + PXI x SHGC x IAC x FF_S

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

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

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

$\dot{Q}_{westwindow_{fixedwooden}}$ = 14,4 x 232,78 = 3352,03 W

CF_{window} = U(ΔT - 0.46DR) + PXI x SHGC x IAC x FF_S

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

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

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

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

$Q_{westwindow_{fixedwooden}} = 14{,}4 \ x \ 243{,}01 = 3499{,}34 \ W$

$CF_{heattransfer} = 8{,}75 - 6{,}89 = 1{,}86 \ \frac{W}{m^2}$
$CF_{irradiation} = 234{,}26 - 225{,}89 = 8{,}37 \ \frac{W}{m^2}$

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

$Q_{difference_{westfixedwindow}} = 3499{,}34 - 3352{,}03 = 147{,}31 W$

COOLING:

South Window Fixed – Wooden Frame:

$CF_{heattransfer}$ = U(ΔT - 0.46DR) $CF_{heattransfer}$ = 2.84 (7,9 – 0,46 x 11,9)

$CF_{irradiation}$ = PXI x SHGC x IAC x FF_S

$Q_{southwindow_{fixedwooden}}$ = A x CF_{window}

South Window Fixed – Aluminum Frame:

$CF_{heattransfer}$ = U(ΔT - 0.46DR) $CF_{heattransfer}$ = 3,61 (7,9 – 0,46 x 11,9)

$CF_{irradiation}$ = PXI x SHGC x IAC x FF_S

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

Differences:

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

CF_{window} = U(ΔT - 0.46DR) + PXI x SHGC x IAC x FF_S

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

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

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

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

CF_{window} = U(ΔT - 0.46DR) + PXI x SHGC x IAC x FF_S

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

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

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

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

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

$CF_{heattransfer}$ = 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 = 25,53W

COOLING:

South Operable Window– Wooden Frame:

$CF_{heattransfer}$ = U(ΔT - 0.46DR) $CF_{heattransfer}$ = 2.87 (7,9 − 0,46 x 11,9)

$CF_{irradiation}$ = PXI x SHGC x IAC x FF_S

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

South Operable Window– Aluminum Frame:

$CF_{heattransfer}$ = U(ΔT - 0.46DR) $CF_{heattransfer}$ = 4,62 (7,9 − 0,46 x 11,9)

$CF_{irradiati\ n}$ = PXI x SHGC x IAC x FF_S

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

Differences:

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

CF_{window} = U(ΔT - 0.46DR) + PXI x SHGC x IAC x FF_S

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

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

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

∴ $Q_{southwindow_{operablewooden}}$ = 3,6 x 127,38 = 458,57 W

CF_{window} = U(ΔT - 0.46DR) + PXI x SHGC x IAC x FF_S

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

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

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

∴ $Q_{southwindow_{operablewooden}}$ = 3,6 x 155,19 = 558,68 W

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

∴ $Q_{difference_{southoperablewindow}}$ = 558,68 − 458,57 = 100,11W

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

HEATING:

West Window Fixed – Wooden Frame:

HF = 2.84 x 24.8

∴ $Q_{westwindow_{fixedwooden}}$ = A x HF

West Window Fixed – Aluminum Frame:

HF = 3,61 x 24.8

∴ $Q_{westwindow_{fixedwooden}}$ = A x HF

Differences:_____

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

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

∴ $Q_{westwindow_{fixedwooden}}$ = 70,43 x 14,4 = 1014,19 W

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

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

∴ $Q_{westwindow_{fixedwooden}}$ = 89,53 x 14,4 = 1289,23 W

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

∴ $Q_{difference_{westfixedwindow}}$ = 1289,23 − 1014,19 = 275,04W

HEATING:

South Window Fixed – Wooden Frame:

HF = 2.84 x 24.8

$\dot{Q}_{southwindow_{fixedwooden}}$ = A x HF

South Window Fixed – Aluminum Frame:

HF = 3,61 x 24.8

$\dot{Q}_{southwindow_{fixedwooden}}$ = A x HF

Differences:

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

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

$\dot{Q}_{southwindow_{fixedwooden}}$ = 70,43 x 3,6 = 253,55 W

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

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

$\dot{Q}_{southwindow_{fixedwooden}}$ = 89,53 x 3,6 = 322,31 W

HF = 9,53 – 70,43 = 19,10 $\frac{W}{m^2}$

$\dot{Q}_{difference_{southfixedwindow}}$ = 322,31 – 253,55 = 68,76W

HEATING:

South Operable Window– Wooden Frame:

HF = 2.87 x 24.8

$\dot{Q}_{southwindow_{fixedwooden}}$ = A x HF

South Operable Window– Aluminum Frame:

HF = 4,62 x 24.8

⇳ $Q_{southwindow_{fixedwooden}}$ = A x HF

Differences:

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

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

⇳ $Q_{southwindow_{operablewooden}}$ = 71,18 x 3,6 = 256,25 W

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

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

⇳ $Q_{southwindow_{operablewooden}}$ = 114,58 x 3,6 = 412,49 W

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