week 8

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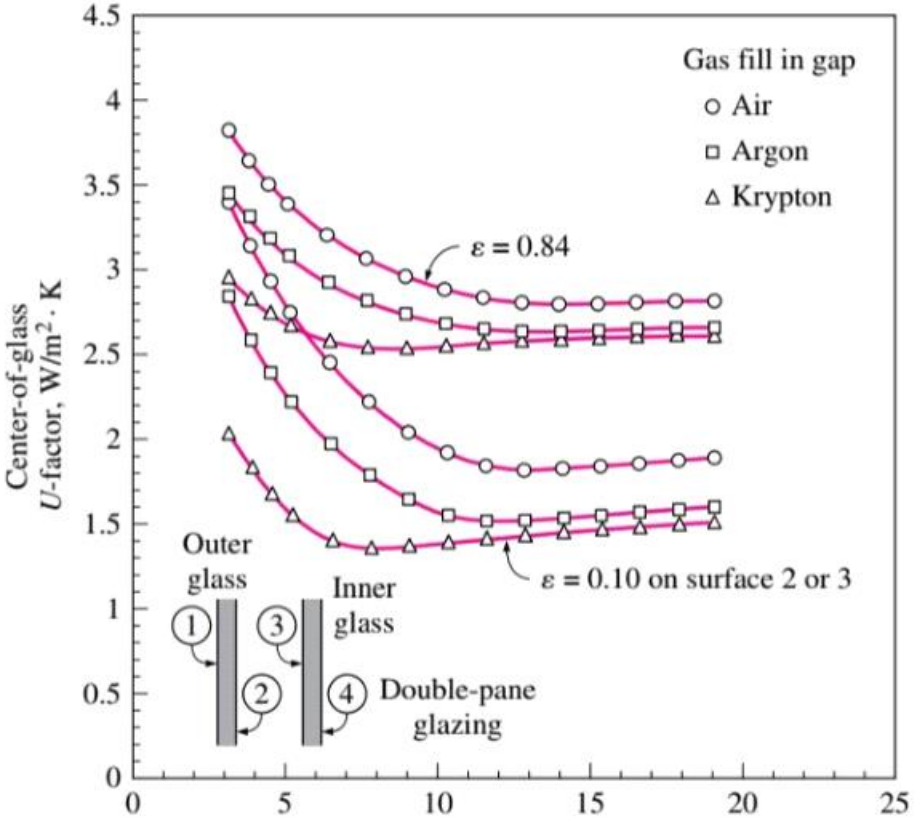
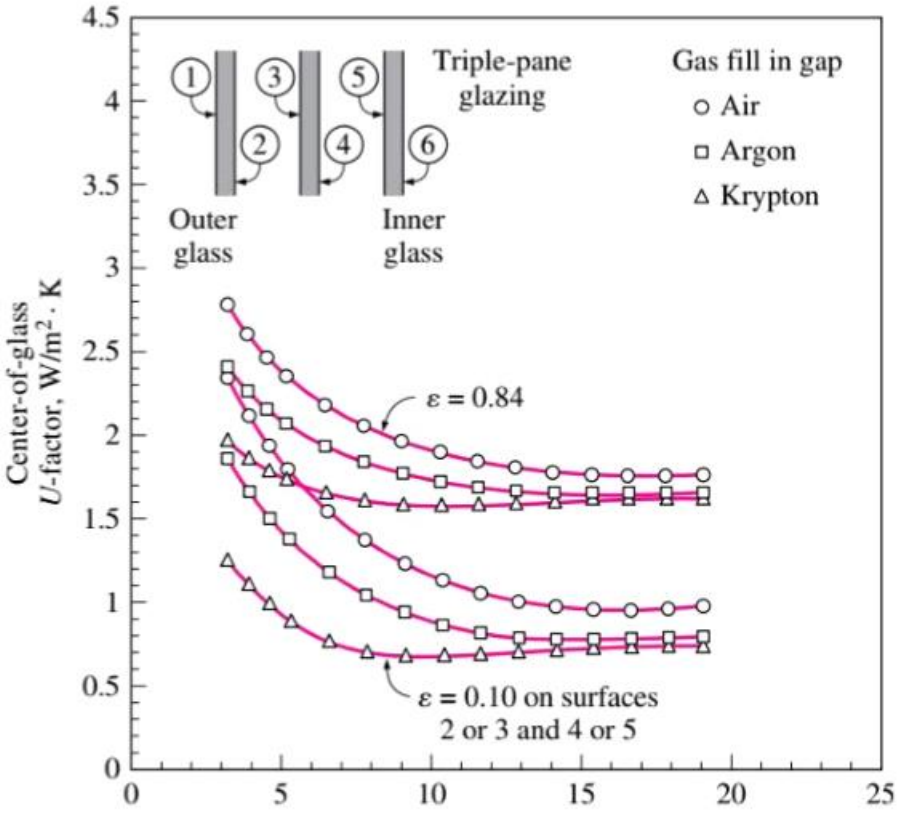
Question1)





As we are asked in this question i`m going to interperet these tables.
At first, by comparing the benchmark with the first case where krypton has been changed, the U FACTOR value decreases about seven percent and also we have the improving of thermal transmittance of the window.
On the other hand, when we use a low emissivity coating, the U FACTOR value is improving about 36% improving the thermal transmittance in compare with the benchmark.
Overall,by the help of adding an extra pane, the U FACTOR value decreases by 36%.

Question2) the information of the base city(Piacenza)

HEATING DB 99%: - 4,8
COOLING DB/MCWB 1%: 31,9

$\Delta T_{cooling} = 31{,}9 - 24 = 7{,}9\ °C$

$\Delta T_{heating} = 20 - (-4{,}8) = 24{,}8\ °C$

EAST SIDE OF THE BUILDING

45° LATITUDE

No internal shading – AIC = 1

DR = 11,9

ELEV :138

T_{SUMMER}: 24°

T_{WINTER}: 20°

HEATING DB 99%: - 4,8

Wood Frame Section

WINDOW 1

$A_{W1east} = 14{,}4\ m^2$

EAST FIXED
FRAME

Heating:

$U_{w1east} = 2{,}84\ W/m^2\ K$

$HF_{w1east} = U_{W1east}\ (\Delta T_{cooling}) = (2.84\ )(24.8) = 70.44$

$Q_{w1east} = HF_{W1east}\ (A_{W1east}) = (70.44)\quad (14.4) = 1014.2\ W$

Cooling

$CF_{W1east} = U_{W1east}\ (\Delta T_{cooling} - (\ 0.46)\ (\ DR)) = 2{,}84\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 6{,}9$

W/m^2

Irradiation:

$E_D = 559$

$E_d = 188$

East window of a detached house - FFS = 0.31

SHGC= 0.54

$PXI_{W1east} = E_D + E_d = 559 + 188 = 747$

$CF_{W1east} = (PXI)(SHGC)(IAC)(FF_{s)} = (747)(0.54)(1)(0.31) = 125.1$

$CF_{fenestration1east} = U_{w1east}(\Delta T_{cooling} - (0.46)(DR)) + (PXI)(SHGC)(IAC)(FF_{s)} = 6.9 + 125.1 = 132\ W/m^2$

$\dot{Q}_{w1east} = (CF_{fenestration1east})(A_{W1east)} = (132)(14.4) = 1900.8\ W$

WINDOW 2

$A_{W2west} = 14{,}4\ m^2$

WEST FIXED FRAME

Heating:

$U_{W2west} = 2{,}84\ W/m^2\,K$

$HF_{W2west} = (U_{W2west})(\Delta T_{cooling}) = (2.84)(24.8) = 70.44$

$Q_{W2west} = (HF_{W2west})(A_{W2west}) = (70.44)(14.4) = 1014.2\ W$

Cooling

Heat transfer:

$CF_{W2west} = U_{W2west}(\Delta T_{cooling} - (0.46)(DR)) = 2{,}84\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 6{,}9\ W/m^2$

$E_D = 559$

$E_d = 188$

West window of a detached house - FFS = 0.31

SHGC= 0.54

$PXI_{W2west} = E_D + E_d = 559 + 188 = 747$

$CF_{W2west} = (PXI)(SHGC)(IAC)(FF_{s)}=(747)(0.54)(1)(0.56)=225.9$

$CF_{fenestration2west}= U_{w2west}(\Delta T_{cooling} – (0.46)(DR)) +(PXI)(SHGC)(IAC)(FF_s) = 6.9+225.9=232.8\ W/m^2$

$\dot{Q}_{W2west} = CF_{fenestration2west}\ (A_{W2west)} = 232.8\ (\ 14.4) = 3352.32\ W$

WINDOW 3

$A_{W3south}= 3.6\ m^2$

SOUTH FIXED FRAME

Heating:

$U_{W3south=}\ 2{,}84\ W/m^2\ K$

$HF_{W3south=}\ U_{W3south}\ (\ \Delta T_{cooling}) = (2.84)(24.8) = 70.44\ W/\ m^2$

$Q_{W3south}= (HF_{W3south})(A_{W3south}) = (70.44)(3.6) = 253.6\ W$

Cooling

Heat transfer:

$CF_{W3south} = U_{W3south}\ (\Delta T_{cooling} – (0.46)(\ DR)) = 2{,}84\ (7{,}9 — 0{,}46 \cdot 11{,}9) = 6{,}9\ W/m^2$

Irradiation:

$E_D = 348$

$E_d= 209$

South window of a detached house - FFS = 0.31

SHGC= 0.54

$PXI_{\ W3south} = E_D + E_d = 348 + 209 = 557$

$CF_{\ W3south} = (PXI)(SHGC)(IAC)(FF_{s)}= (557)(0.54)(1)(0.47)=141.4$

$CF_{fenestration3south}= U_{w3south}\ (\Delta T_{cooling} – (0.46)(DR)) +(PXI)(SHGC)(IAC)(\ FF_s) = 6.9 +141.4=148.3\ W/m^2$

$\dot{Q}_{w3south} = CF_{fenestration3south} (A_{W3south)} = (148.3)(3.6) = 533.88$ W

WINDOW 4

$A_{W4south} = 3.6$ m^2

SOUTH OPERABLE FRAME

Heating:

$U_{W4south=}$ 2,87 W/m^2 K

$HF_{W4south=} U_{W4south} (\Delta T_{cooling)} = (2.87)(24.8) = 71.17$ W/ m^2

$Q_{W4south} = HF_{W4south} (A_{W4south}) = (71.17) (3.6) = 256.2$ W

Cooling

Heat transfer:

$CF_{W4south} = U_{W4south} (\Delta T_{cooling} – (0.46) (DR)) = 2,87 (7,9 — 0,46 \cdot 11,9) = 6,96$ W/m^2

Irradiation

$E_D = 348$

$E_d = 209$

South window of a detached house - FFS = 0.47

SHGC= 0.46

$PXI_{W4south} = E_D + E_d = 348 + 209 = 557$

$CF_{W4south} = (PXI)*(SHGC)*(IAC)*(FF_s) = (557)(0.46)(1)(0.47)=120.4$

$CF_{fenestration4south} = U_{w3south} (\Delta T_{cooling} – (0.46)(DR)) +(PXI)(SHGC)(IAC)(FF_s) = 6.9 +120.4=127.3$ W/m^2

$\dot{Q}_{w4south} = CF_{fenestration4south} (A_{W4south}) = (127.3)(3.6) = 458.28$ W

$\dot{Q}_{\text{Total windows Cooling wood frame}}$ = 1900,.8 + 3352.32 + 533.88 + 458.28 = 6245.3 W

$\dot{Q}_{\text{Total windows Heating wood frame}}$ = 1014.2+1014.2+253.6+256.2=2538.2 W

Aluminium Frame Section

Window 1

A_{W1east}= 14,4 m^2

EAST FIXED Aluminium

Heating:

$U_{w1east=}$ 3.61 W/m^2 K

$HF_{w1east=}$ U_{W1east} ($\Delta T_{cooling}$) = (3.61) (24.8) = 89.52 W/m^2

Q_{w1east}= HF_{W1east} (A_{W1east}) = (89.52) (14.4) = 1289.1 W

Cooling:

Heat transfee:

CF_{W1east} = U_{W1east} ($\Delta T_{cooling}$ – (0.46)(DR)) = 3.61(7,9 − 0,46 · 11,9) = 8.7 W/m^2

Irradiation:

E_D = 559

E_d= 188

East window of a detached house - FFS = 0.31

SHGC= 0.56

PXI_{W1east} = E_D + E_d = 559 + 188 = 747

CF_{W1east} = (PXI)(SHGC)(IAC)(FF_s)= (747)(0.56)(1)(0.31)=129.6

$CF_{fenestration1east}$= U_{w1east}($\Delta T_{cooling}$ – (0.46)(DR)) +(PXI)(SHGC)(IAC)(FF_s) = 8.7 +129.6

=138.3 W/m^2

$\dot{Q}_{w1east} = CF_{fenestration1east}\ (A_{W1east}) = (138.3)(14.4) = 1991.5$ W

WINDOW 2

A_{W2west}= 14,4 m^2

WEST FIXED FRAME

Heating:

$U_{W2west=}$ 3.61 $W/m^2 K$

$HF_{W2west=}\ (U_{W2west})(\Delta T_{cooling}) = (3.61)(24.8) = 70.44$

$Q_{W2west}= (HF_{W2west})(A_{W2west}) = (89.52)(14.4) = 1289.1$ W

Cooling:

Heat transfer:

$CF_{W2west} = U_{W2west}(\Delta T_{cooling} – (0.46)(DR)) = 3.61\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 8.7\ W/m^2$

$E_D = 559$

E_d= 188

West window of a detached house - FFS = 0.56

SHGC= 0.56

$PXI_{W2west} = E_D + E_d = 559 + 188 = 747$

$CF_{W2west} = (PXI)(SHGC)(IAC)(FF_s)=(747)(0.56)(1)(0.56)=234.26$

$CF_{fenestration2west}= U_{w2west}(\Delta T_{cooling} – (0.46)(DR)) +(PXI)(SHGC)(IAC)(\ FF_s) =$ 8.7+234.26=242.96 W/m^2

$\dot{Q}_{W2west} = CF_{fenestration2west}\ (A_{W2west}) = (242.96)(14.4) = 3498.6$ W

WINDOW 3

$A_{W3south}$= 3.6 m^2

SOUTH FIXED FRAME

Heating:

$U_{W3south=}$ 3.61 $W/m^2 K$

$HF_{W3south=} U_{W3south}$ $(\Delta T_{cooling})$ = (3.61)(24.8) = 89.52 W/ m^2

$Q_{W3south}$= $HF_{W3south}$($A_{W3south}$) = (89.52)(3.6) = 322.2 W

Cooling:

Heat transfer:

$CF_{W3south} = U_{W3south}(\Delta T_{cooling} – (0.46)(DR))$ = 3.61 (7,9 — 0,46 · 11,9) = 8.7 W/m^2

Irradiation:

E_D = 348

E_d= 209

South window of a detached house - FFS = 0.47

SHGC= 0.56

$PXI_{W3south} = E_D + E_d$ = 348 + 209 = 557

$CF_{W3south}$ = (PXI)(SHGC)(IAC)(FF_s)= (557)(0.56)(1)(0.47)=146.6

$CF_{fenestration3south}= U_{w3south}(\Delta T_{cooling} – (0.46)(DR))$ +(PXI)(SHGC)(IAC)($FF_{s)}$ = 8.7 +146.6=155.3 W/m^2

$\dot{Q}_{w3south} = CF_{fenestration3south}$ ($A_{W3south}$) = (155.3)(3.6) = 559.08 W

WINDOW 4

$A_{W4south}$= 3.6 m^2

SOUTH OPERABLE FRAME

Heating:

$U_{W4south=}$ 4.62 W/m^2 K

$HF_{W4south=}$ $(U_{W4south})(\Delta T_{cooling})$=(4.62)(24.8) = 114.57 W/ m^2

$Q_{W4south}$= $HF_{W4south}$ $(A_{W4south})$ = (114.57)(3.6) = 412.4 W

Cooling:

Heat transfer

$CF_{W4south}$ = $U_{W4south}$ $(\Delta T_{cooling} - (0.46)(DR))$ = 4.62 (7,9 — 0,46 · 11,9) = 11.2 W/m^2

Irradiation

E_D = 348

E_d= 209

South window of a detached house - FFS = 0.47

SHGC= 0.55

$PXI_{W4south}$ = E_D + E_d = 348 + 209 = 557

$CF_{W4south}$ = (PXI)(SHGC)(IAC)(FF_s)= (557)(0.55)(1)(0.47)=143.95

$CF_{fenestration4south}$= $U_{w3south}$ $(\Delta T_{cooling} - (0.46)(DR))$ +(PXI)(SHGC)(IAC)(FF_s) = 11.2 +143.98=155.18 W/m^2

$\dot{Q}_{w4south}$ = $CF_{fenestration4south}$ $(A_{W4south})$ = (155.18)(3.6) = 558.65 W

$\dot{Q}_{Total\ windows\ Cooling\ Aluminium\ frame}$ = 1991.5 + 3498.6 + 559.08 + 558.65 = 6607.8 W

$\dot{Q}_{Total\ windows\ Heating\ Aluminium\ frame}$ = 1289.1 + 1289.1 + 322.2 + 412.4 = 3312.8 W

SO:

$\dot{Q}_{\text{Total windows Cooling Aluminium frame}}$ (6607 W) **is bigger in value than** $\dot{Q}_{\text{Total windows Cooling wood frame}}$ (6245.3 W)

$\dot{Q}_{\text{Total windows Heating Aluminium frame}}$ (3312.8 W) **is bigger in value than** $\dot{Q}_{\text{Total windows Heating wood frame}}$ (2538.2 W)

based on what we saw above **:wood is better material than aluminium in this case.**