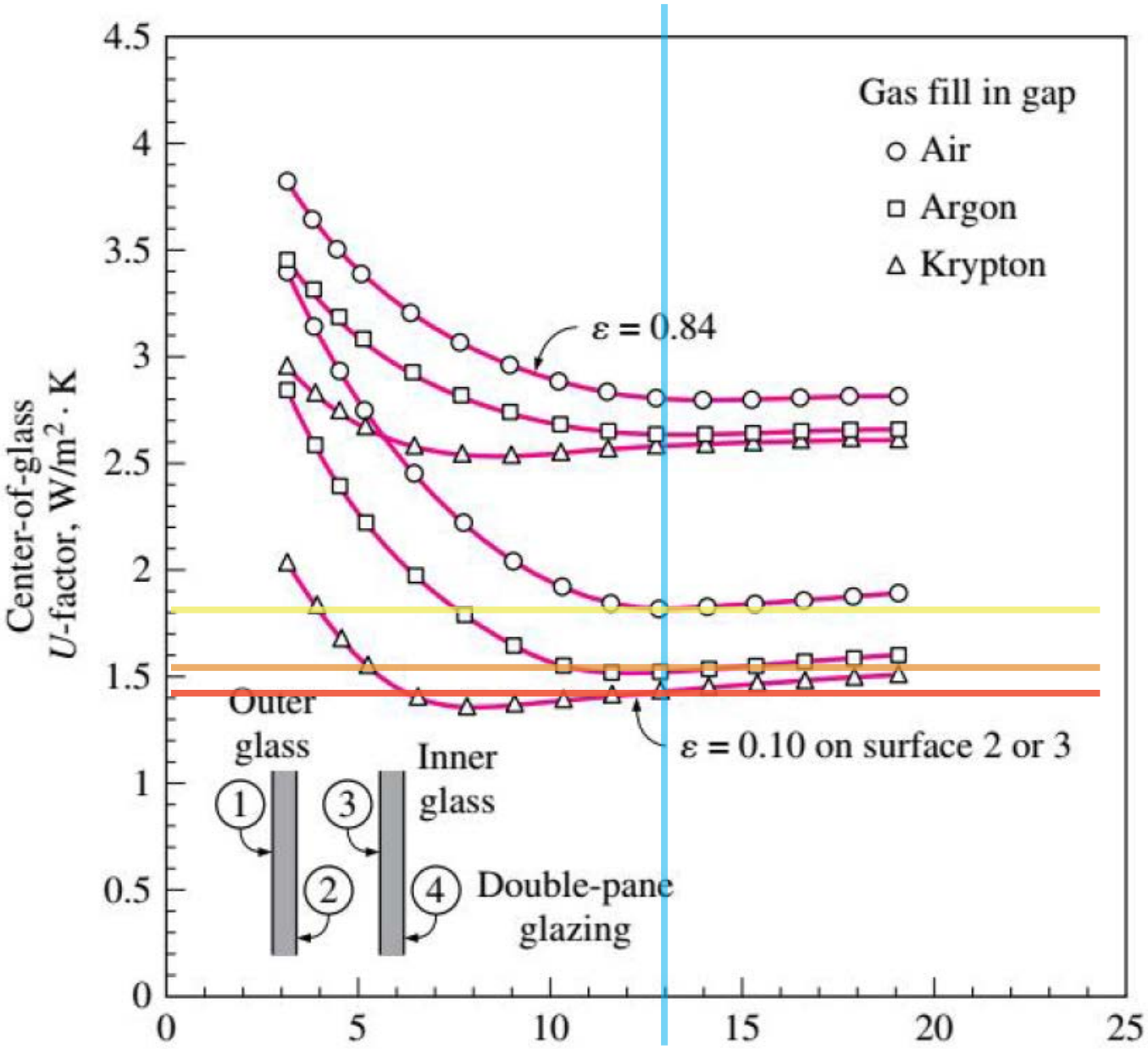
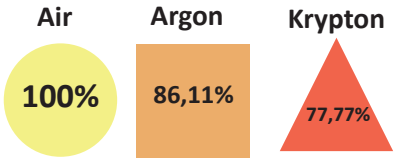
Task 1. Using the diagrams given in the presentation calculate how much (%) is the effect of applying different modifications (changing the gas, adding an extra panel, using a low emissivity coating) on the U value with respect to a benchmark case of double layer with air and no coating ? (keep the gap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

Study case changing the Gas

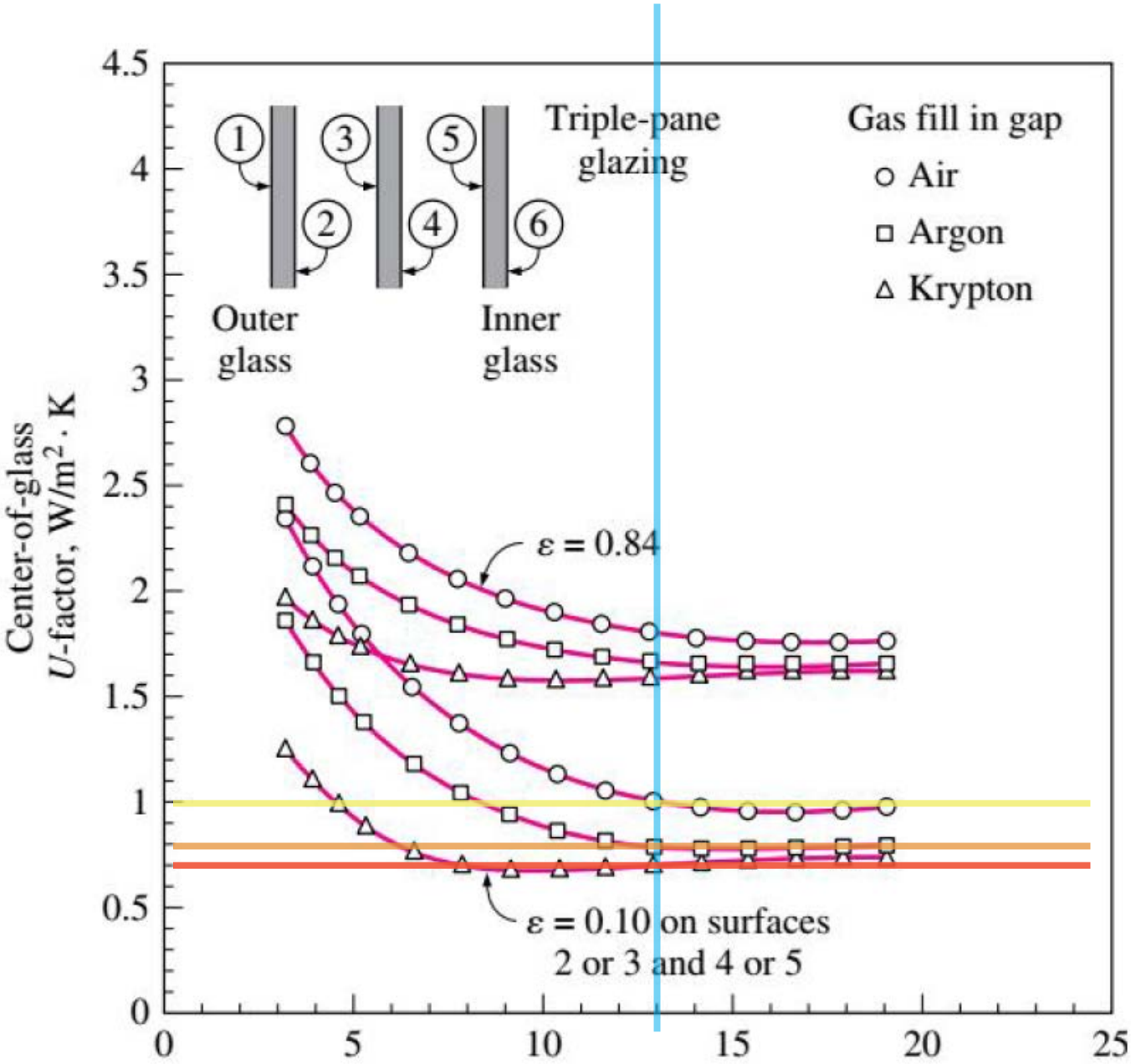


1,80 W/m².k _____ 100%
1,55 W/m².k _____ 86,11%
1,40 W/m².k _____ 77,77%

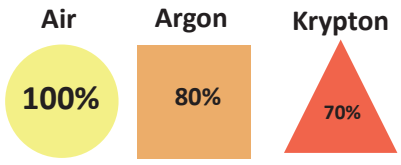


Changing the air for Argon improve the conditions in a 13,89%.
Changing the air for Krypton improve the conditions in a 22,23%.

Study case adding an extra panel



1,00 W/m².k _____100%
0,80 W/m².k _____ 80%
0,70 W/m².k _____ 70%



Adding a extra panel in the case of Argon, respect to a triple panel fill with air, would improve the conditions in a 20%.
Adding a extra panel in the case of Krypton, respect to a triple panel fill with air, would improve the conditions in a 30%.

Task 2. Consider the house that we analysed 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 aluminium ?

Heating case A (fixed 14,40 m2 on the west)

From the class example: ΔT heating= 24,8°C

$U_{windows_{west}}$ = 2,84 W/m². K

HF= $U_{windows_{west}}$ x ΔT heating
2,84 W/m² x 24,8°C
70,43 W/m²

$Q_{windows_{west}}$ = $HF_{windows_{west}}$ x $A_{windows_{west}}$
70,43 W/m² x 14,40 m2
1014,19W

Answer:
The heating value for the fixed window of 14,40m2, on the west is 1014,19W

Heating case B (fixed 3,60 m2 on the south)

$Q_{windows_{south}}$ = $HF_{windows_{south}}$ x $A_{windows_{south}}$
70,43 W/m² x 3,60 m2
1014,19W

Answer:
The heating value for the fixed window of 3,60m2, on the south is 1014,19W

Heating case C (operable 3.6 m2 on the south)

$Q_{windows_{south}}$ = $HF_{windows_{south}}$ x $A_{windows_{south}}$
70,43 W/m² x 3,60 m2
1014,19W

Answer:
The heating value for the operable window of 3,60m2, on the south is 1014,19W

Cooling case A (fixed 14,40 m2 on the west)

From the class example: ΔT cooling= 7,9°C

$U_{windows_{west}}$ = 2,84 W/m². K

HF= $U_{windows_{west}}$ x ΔT cooling
2,84 W/m² x 7,9°C
22,43 W/m²

$Q_{windows_{west}}$ = $HF_{windows_{west}}$ x $A_{windows_{west}}$
22,43 W/m² x 14,40 m2
322,99W

$CF_{windows_{west}}$ = ($U_{windows_{west}}$ x (ΔT - (0,46DR))) + (PXI x SHGC x IAC x FFs)
2,84 W/m². C x (7,9°C - 0,46 x 11,90°C)
2,84 W/m². C x (7,9°C - 5,47°C)
2,84 W/m². C x 2,43°C
6,90 W/ m²

(PXI x SHGC x IAC x FFs)=
747 x 0,54 x 1 x 0,56=
225,89 W/m²

PXIwindows$_{west}$= ED + Ed = 559 + 188= 747
SHGC= 0,54
IAC (we assume there are no shading)= 1
FFs= 0,56

Total CF= 6,90 W/m² + 225,89 W/m²=
232,79 W/m²

TOTAL Q= CFwindows$_{west}$ x Awindows$_{west}$
232,79 W/m² x 14,40 m2 = 3352,17W

Answer:
The cooling value for the fixed window of 14,40m2, on the west is 3352,17W

Cooling case B (fixed 3,60 m2 on the south)

CFwindows$_{south}$ = (Uwindows$_{south}$ x (ΔT - (0,46DR))) + (PXI x SHGC x IAC x FFs)
2,84 W/m². C x (7,9°C - 0,46 x 11,90°C)
2,84 W/m². C x (7,9°C - 5,47°C)
2,84 W/m². C x 2,43°C
6,90 W/ m²

PXIwindows$_{south}$= ED + Ed = 348 + 209= 557
SHGC= 0,54
IAC (we assume there are no shading)= 1
FFs= 0,47

(PXI x SHGC x IAC x FFs)=
557 x 0,46 x 1 x 0,47=
120,20 W/m²

Total CF= 6,90 W/m² + 120,20 W/m²=
127,10 W/m²

TOTAL Q= CFwindows$_{south}$ x Awindows$_{south}$
127,10 W/m² x 3,60 m2 = 457,56W

Answer:
The cooling value for the fixed window of 3,60m2, on the south is 457,56W

Cooling case C (operable 3.6 m2 on the south)

Uwindows$_{west}$ = 2,87 W/m². K

HF= Uwindows$_{west}$ x ΔT cooling
2,87 W/m² x 7,9°C
22,67 W/m²

Qwindows$_{south}$ = HFwindows$_{south}$ x Awindows$_{south}$
22,67 W/m² x 14,40 m2
326,44W

CFwindows$_{south}$ = (Uwindows$_{south}$ x (ΔT - (0,46DR))) + (PXI x SHGC x IAC x FFs)
2,87 W/m². C x (7,9°C - 0,46 x 11,90°C)
2,87 W/m². C x (7,9°C - 5,47°C)
2,87 W/m². C x 2,43°C
6,97 W/ m²

PXIwindows$_{south}$= ED + Ed = 348 + 208 = 556
SHGC= 0,46
IAC (we assume there are no shading)= 1
FFs= 0,47

(PXI x SHGC x IAC x FFs)=
556 x 0,46 x 1 x 0,47=
120,20 W/m²

Total CF= 6,97 W/m² + 120,20W/m²= 127,17 W/m²

TOTAL Q= CFwindows$_{south}$ x Awindows$_{south}$
127,17 W/m² x 3,60 m2 = 457,81W

Answer:
The cooling value for the operable window of 3,60m2, on the south is 457,81W

Heating case A (fixed 14,40 m2 on the west) in aluminium.

From the class example: ΔT heating= 24,8°C

$U_{windows\,west}$ = 4,62 W/m². K

HF= $U_{windows\,west}$ x ΔT heating
4,62 W/m² x 24,8°C
114,57 W/m²

$Q_{windows\,west}$ = $HF_{windows\,west}$ x $A_{windows\,west}$
114,57 W/m² x 14,40 m2
1649,80W

Answer:
The heating value for the fixed window of 14,40m2, on the west is 1649,80W

Heating case B (fixed 3,60 m2 on the south) in aluminium.

$Q_{windows\,south}$ = $HF_{windows\,south}$ x $A_{windows\,south}$
114,57 W/m² x 3,60 m2
412,45W

Answer:
The heating value for the fixed window of 3,60m2, on the south is 412,45W

Heating case C (operable 3.6 m2 on the south) in aluminium.

$Q_{windows\,south}$ = $HF_{windows\,south}$ x $A_{windows\,south}$
114,57 W/m² x 3,60 m2
412,45W

Answer:
The heating value for the operable window of 3,60m2, on the south is 412,45W

Cooling case A (fixed 14,40 m2 on the west) in aluminium.

From the class example: ΔT cooling= 7,9°C
$U_{windows\,west}$ = 3,22 W/m². K

HF= $U_{windows\,west}$ x ΔT cooling
3,22 W/m² x 7,9°C
25,44 W/m²

$Q_{windows\,west}$ = $HF_{windows\,west}$ x $A_{windows\,west}$
25,44 W/m² x 14,40 m2
366,33W

$CF_{windows\,west}$ = ($U_{windows\,west}$ x (ΔT - (0,46DR))) + (PXI x SHGC x IAC x FFs)
3,22 W/m². C x (7,9°C - 0,46 x 11,90°C)
3,22 W/m². C x (7,9°C - 5,47°C)
3,22W/m². C x 2,43°C
7,82W/ m²

(PXI x SHGC x IAC x FFs)=
747 x 0,56 x 1 x 0,56=
234,25 W/m²

$PXI_{windows\,west}$= ED + Ed = 559 + 188= 747
SHGC= 0,56
IAC (we assume there are no shading)= 1
FFs= 0,56

Total CF= 7,82 W/m² + 234,25 W/m²=
242,07 W/m²

TOTAL Q= $CF_{windows\,west}$ x $A_{windows\,west}$
242,07 W/m² x 14,40 m2 = 3485,80W

Answer:
The cooling value for the fixed window of 14,40m2, on the west, in aluminium is 3485,80W

Cooling case B (fixed 3,60 m2 on the south) in aluminium.

$U_{windows\,south}$= 3,22 W/m². K

$CF_{windows\,south}$ = ($U_{windows\,south}$ x (ΔT - (0,46DR))) + (PXI x SHGC x IAC x FFs)
3,22 W/m². C x (7,9°C - 0,46 x 11,90°C)
3,22 W/m². C x (7,9°C - 5,47°C)
3,22 W/m². C x 2,43°C
7,82 W/ m²

(PXI x SHGC x IAC x FFs)=
557 x 0,56 x 1 x 0,47=
146,60 W/m²

$PXI_{windows\,south}$= ED + Ed = 348 + 209= 557
SHGC= 0,56
IAC (we assume there are no shading)= 1
FFs= 0,47

Total CF= 7,82 W/m² + 146,60 W/m²=
154,42 W/m²

TOTAL Q= $CF_{windows\,south}$ x $A_{windows\,south}$
154,42 W/m² x 3,60 m2 = 555,91W

Answer:
The cooling value for the fixed window of 3,60m2, on the south, in aluminium is 555,91W

Cooling case C (operable 3.6 m2 on the south) in aluminium.

$U_{windows\,west}$ = 4,62 W/m². K

HF= $U_{windows\,west}$ x ΔT cooling
4,62 W/m² x 7,9°C
36,49 W/m²

$Q_{windows\,south}$ = $HF_{windows\,south}$ x $A_{windows\,south}$
36,49 W/m² x 3,60 m2
131,36W

$CF_{windows\,south}$ = ($U_{windows\,south}$ x (ΔT - (0,46DR))) + (PXI x SHGC x IAC x FFs)
4,62 W/m². C x (7,9°C - 0,46 x 11,90°C)
4,62 W/m². C x (7,9°C - 5,47°C)
4,62 W/m². C x 2,43°C
11,22 W/ m²

(PXI x SHGC x IAC x FFs)=
557 x 0,55 x 1 x 0,47=
143,98 W/m²

$PXI_{windows\,south}$= ED + Ed = 348 + 209 = 557
SHGC= 0,55
IAC (we assume there are no shading)= 1
FFs= 0,47

Total CF= 11,22 W/m² + 143,98W/m²=
155,20 W/m²

TOTAL Q= $CF_{windows\,south}$ x $A_{windows\,south}$
155,20 W/m² x 3,60 m2 = 558,72W

Answer:
The cooling value for the operable window of 3,60m2, on the south is 558,72W