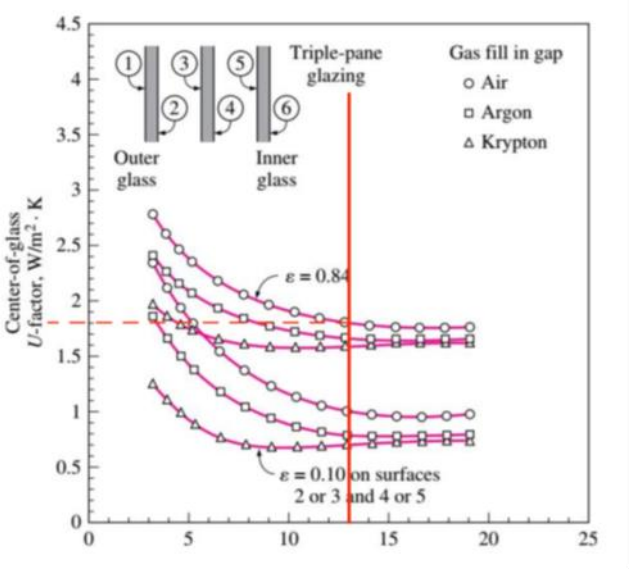
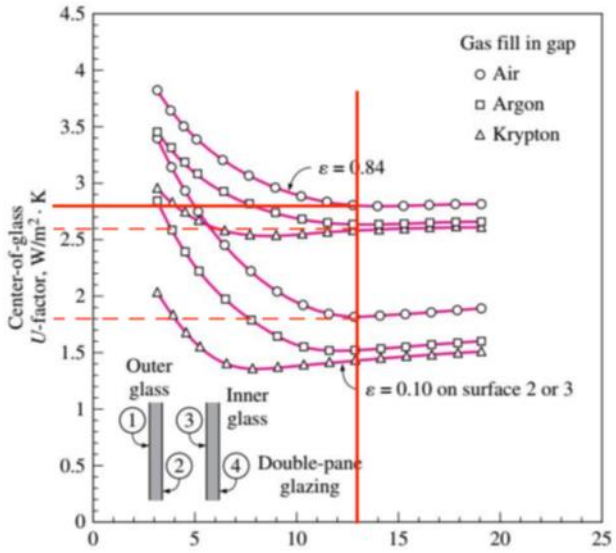
Amirhossein Roustaei 10689304 26/1/2019

1.

Based on the graph, we can find out by comparing the benchmark with the first case where the gas (krypton) has been changed, the U FACTOR value
decreases by 7%, so the thermal transmittance of the window has increased.
in the second comparison, using a low emissivity coating, the U FACTOR value
decreases by 36%, greatly improving the thermal transmittance compared to
the benchmark.
in the last comparison, adding an extra pane, the U FACTOR value, still decreases
by 36%, proving a great improvement in the thermal efficiency of the
window.





	Bench mark	1	2	3
Gap (mm)	13	13	13	13
ϵ	0.84	0.84	0.1	0.84
N PANE	2	2	2	3
Gas	Air	Krypton	Air	Air
U_{factor} w/m²k	2.8	2.6	1.8	1.8
percentage	100%	93%	64%	64%

2.

PIACENZA, Italy WMO#: **160840**

Lat: **44.92N** Long: **9.73E** Elev: **138** StdP: **99.68** Time Zone: **1.00 (EUW)** Period: **89-10** WBAN: **99999**

Annual Heating and Humidification Design Conditions

Coldest Month	Heating DB		Humidification DP/MCDB and HR						Coldest month WS/MCDB				MCWS/PCWD to 99.6% DB	
			99.6%			99%			0.4%		1%			
	99.6%	99%	DP	HR	MCDB	DP	HR	MCDB	WS	MCDB	WS	MCDB	MCWS	PCWD
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)
1	-6.2	-4.8	-11.6	1.4	3.1	-8.8	1.8	1.8	8.8	5.6	7.7	6.2	2.1	250

(1)

Annual Cooling, Dehumidification, and Enthalpy Design Conditions

Hottest Month	Hottest Month DB Range	Cooling DB/MCWB						Evaporation WB/MCDB						MCWS/PCWD to 0.4% DB	
		0.4%		1%		2%		0.4%		1%		2%			
		DB	MCWB	DB	MCWB	DB	MCWB	WB	MCDB	WB	MCDB	WB	MCDB	MCWS	PCWD
(a)	(b)	(c)	(d)	(e)	(f)	(g)	(h)	(i)	(j)	(k)	(l)	(m)	(n)	(o)	(p)
8	11.9	33.1	22.7	31.9	22.4	30.3	21.8	24.6	30.2	23.7	29.2	22.9	28.3	2.4	90

(2)

Wood Frame

WINDOW 1 : East, fixed, wood frame, Area= 14,4 m^2

Heating:

$U_{w1\ east}$= 2,84 W/m^2 K

$HF_{w1\ east}$= $U_{W1\ east}$ * $\Delta T_{cooling}$ = 2.84 *24.8 = 70.44

$Q_{w1\ east}$= $HF_{W1\ east}$ * $A_{W1\ east}$ = 70.44 * 14.4 = 1014.2 W

Cooling:

Heat transfer

$CF_{W1\ east}$ = $UW_{1\ east}$ * ($\Delta T_{cooling}$ – 0.46 DR) = 2,84 (7,9 – (0,46 * 11,9))= 6,9 W/m^2

Irradiation

ED = 559 , Ed= 188

East window of a detached house - FF_S = 0.31

SHGC= 0.54

$PXI_{W1\ east}$ = ED + Ed = 559 + 188 = 747

$CF_{W1\ east}$ = PXI * SHGC * IAC * FF_s= 747*0.54*1*0.31=125.1

$CF_{fen1\ east}$= $U_{w1\ east}$ * ($\Delta T_{cooling}$ – 0.46 DR) +PXI *SHGC *IAC * FFs = 6.9 +125.1 =132 W/m^2

$Q_{w1\ east}$ = $CF_{fen1\ east}$ * $A_{W1\ east}$ = 132*14.4 = 1900.8 W

WINDOW 2 : West, Fixed, Wood frame, Area= 14,4 m^2

Heating

$U_{W2\ west}$ = 2,84 W/m^2 K

$HF_{W2\ west}$= $U_{W2\ west}$ * $\Delta T_{cooling}$ = 2.84 *24.8 = 70.44

$Q_{W2\ west}$= $HF_{W2\ west}$ * $A_{W2\ west}$ = 70.44 * 14.4 = 1014.2 W

Cooling

Heat transfer

$CF_{W2\ west}$ = $U_{W2\ west}$ * ($\Delta T_{cooling}$ – 0.46 DR) = 2,84 (7,9 – (0,46 · 11,9)) = 6,9 W/m^2

ED = 559

Ed= 188

West window of a detached house - FF_S = 0.31

SHGC= 0.54

$PXI_{W2\ west}$ = ED + Ed = 559 + 188 = 747

$CF_{W2\ west}$ = PXI* SHGC * IAC * FF_s=747*0.54*1*0.56=225.9

$CF_{fen\ 2\ west}$= $U_{w2\ west}$ * ($\Delta T_{cooling}$ – 0.46DR) +PXI *SHGC *IAC * FF_s = 6.9+225.9=232.8 $W/^{m2}$

$Q_{W2\ west}$ = $CF_{fen2\ west}$ * $A_{W2\ west}$ = 232.8 * 14.4 = 3352.32 W

WINDOW 3: South, Fixed, Wood Frame, Area= 3.6 m^2

Heating:

$U_{W3\ south=}$ 2,84 $W/m^2 K$

$HF_{W3\ south=}\ U_{W\ 3south} * \Delta T_{cooling} = 2.84 * 24.8 = 70.44\ W/m^2$

$Q_{W3\ south=}\ HF_{W3\ south} * A_{W3\ south} = 70.44 * 3.6 = 253.6\ W$

Cooling:

Heat transfer part

$CF_{W3\ south} = U_{W3\ south} * (\Delta T_{cooling} - 0.46 * DR) = 2,84\ (7,9 - (0,46 * 11,9)) = 6,9\ W/m^2$

Part for Irradiation part

$E_D = 348$

$E_d = 209$

South window of a detached house - $FF_S = 0.31$

SHGC= 0.54

$PXI_{W3\ south} = E_D + E_d = 348 + 209 = 557$

$CF_{W3\ south} = PXI * SHGC * IAC * FF_s = 557 * 0.54 * 1 * 0.47 = 141.4$

$CF_{fen3\ south=}\ U_{w3\ south} * (\Delta T_{cooling} - 0.46 * DR) + PXI * SHGC * IAC * FF_s = 6.9 + 141.4 = 148.3\ W/m^2$

$Q_{w3\ south} = CF_{fen3\ south} * A_{W3\ south} = 148.3 * 3.6 = 533.88\ W$

WINDOW 4 : South, Operable, wood frame, Area= 3.6 m^2

Heating:

$U_{W4\ south=}$ 2,87 W/m^2 K

$HF_{W4\ south=}$ $U_{W4\ south}$ * $\Delta T_{cooling}$ = 2.87 *24.8 = 71.17 W/ m^2

$Q_{W4\ south=}$ $HF_{W4\ south}$ * $A_{W4\ south}$ = 71.17 * 3.6 = 256.2 W

Cooling:

Heat transfer part

$CF_{W4\ south}$ = $U_{W4\ south}$ *($\Delta T_{cooling}$ – 0.46 * DR) = 2,87 (7,9 − 0,46 · 11,9) = 6,96 W/m^2

Part for Irradiation part

E_D = 348

E_d= 209

South window of a detached house - FF_S = 0.47

SHGC= 0.46

$PXI_{W4\ south}$ = E_D + E_d = 348 + 209 = 557

$CF_{W4\ south}$ = PXI * SHGC * IAC * FF_s= 557*0.46*1*0.47=120.4

$CF_{fen4\ south=}$ $U_{w3south}$ *($\Delta T_{cooling}$ – 0.46 * DR) +PXI *SHGC *IAC * FF_s = 6.9 +120.4=127.3 W/m^2

$Q_{w4\ south}$ = $CF_{fen4\ south}$ * $A_{W4\ south}$ = 127.3 * 3.6 = 458.28 W

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

$Q_{Total\ windows\ Heating\ wood\ frame}$ = 1014.2 + 1014.2 + 253.6 + 256.2 = 2538.2 W

Aluminium Frame

Window 1: East, Fixed, Aluminium, Area= 14,4 m^2

Heating:

$U_{w1\ east=}$ 3.61 $W/m^2 K$

$HF_{w1\ east=} U_{W1\ east} * \Delta T_{cooling} = 3.61 * 24.8 = 89.52\ W/m^2$

$Q_{w1\ east}= HF_{W1\ east} * A_{W1\ east} = 89.52 * 14.4 = 1289.1\ W$

Cooling:

Part for Heat transfer

$CF_{W1\ east} = U_{W1\ east} *(\Delta T_{cooling} - 0.46 * DR) = 3.61* (7,9 - 0,46 \cdot 11,9) = 8.7\ W/m^2$

Part for Irradiation part

$E_D = 559$

$E_d= 188$

East window of a detached house - $FF_S = 0.31$

SHGC= 0.56

$PXI_{W1\ east} = E_D + E_d = 559 + 188 = 747$

$CF_{W1\ east} = PXI*SHGC*IAC*FF_s= 747*0.56*1*0.31=129.6$

$CF_{fen1\ east}= U_{w1\ east}*(\Delta T_{cooling} - 0.46 * DR) +PXI *SHGC *IAC * FF_s = 8.7 +129.6 =138.3\ W/m^2$

$Q_{w1\ east} = CF_{fen1\ east} * A_{W1\ east} = 138.3*14.4 = 1991.5\ W$

WINDOW 2: West, Fixed, Aluminium, Area= 14,4 m^2

Heating:

$U_{W2\ west=}$ 3.61 W/m^2 K

$HF_{W2\ west=}$ $U_{W2\ west}$ * $\Delta T_{cooling}$ = 3.61 *24.8 = 70.44

$Q_{W2\ west}$= $HF_{W2\ west}$ * $A_{W2\ west}$ = 89.52 * 14.4 = 1289.1 W

Cooling;

Part for Heat transfer

$CF_{W2\ west}$ = $U_{W2\ west}$ *($\Delta T_{cooling}$ – 0.46 * DR) = 3.61 (7,9 − 0,46 · 11,9) = 8.7 W/m^2

E_D = 559

E_d= 188

West window of a detached house - FF_S = 0.56

SHGC= 0.56

$PXI_{W2\ west}$ = E_D + E_d = 559 + 188 = 747

$CF_{W2\ west}$ = PXI*SHGC*IAC*FF_s=747*0.56*1*0.56=234.26

$CF_{fen2\ west}$= $U_{w2\ west}$*($\Delta T_{cooling}$ – 0.46 * DR) +PXI*SHGC*IAC*FF_s = 8.7+234.26=242.96 W/m^2

$Q_{W2\ west}$ = $CF_{fen2\ west}$ * $A_{W2\ west}$ = 242.96 * 14.4 = 3498.6 W

WINDOW 3: South, Fixed, Aluminium, Area= 3.6 m^2

Heating:

$U_{W3\ south=}$ 3.61 W/m^2 K

$HF_{W3\ south=}\ U_{W3\ south}$ * $\Delta T_{cooling}$ = 3.61 *24.8 = 89.52 W/ m^2

$Q_{W3\ south=}\ HF_{W3\ south}$ * $A_{W3\ south}$ = 89.52 * 3.6 = 322.2 W

Cooling:

Heat transfer part

$CF_{W3\ south}$ = $U_{W3\ south}$ *($\Delta T_{cooling}$ – 0.46 * DR) = 3.61 (7,9 − 0,46 · 11,9) = 8.7 W/m^2

Part for Irradiation part

E_D = 348

E_d= 209

South window of a detached house - FF_S = 0.47

SHGC= 0.56

$PXI_{W3\ south}$ = E_D + E_d = 348 + 209 = 557

$CF_{W3\ south}$ = PXI*SHGC*IAC*FF_s= 557*0.56*1*0.47=146.6

$CF_{fen3\ south=}$ $U_{w3\ south}$ *($\Delta T_{cooling}$ – 0.46 * DR) +PXI *SHGC *IAC * FF_s = 8.7 +146.6=155.3 W/m^2

$Q_{w3\ south}$ = $CF_{fen3\ south}$ * $A_{W3\ south}$ = 155.3*3.6 = 559.08 W

WINDOW 4: South, Operable, Aluminium, Area= 3.6 m^2

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 part

$CF_{W4\ south} = U_{W4\ south} *(\Delta T_{cooling} – 0.46 * DR) = 4.62\ (7{,}9 - 0{,}46 \cdot 11{,}9) = 11.2\ W/m^2$

Part for Irradiation part

$E_D = 348$

$E_d = 209$

South window of a detached house - $FF_S = 0.47$

SHGC= 0.55

$PXI_{W4\ south} = E_D + E_d = 348 + 209 = 557$

$CF_{W4\ south} = PXI*SHGC*IAC*FF_s = 557*0.55*1*0.47=143.95$

$CF_{fen4\ south=} U_{w3\ south} *(\Delta T_{cooling} – 0.46 * DR) + PXI *SHGC *IAC * FF_s = 11.2 + 143.98 = 155.18\ W/m^2$

$Q_{w4\ south} = CF_{fen4\ south} * A_{W4\ south} = 155.18*3.6 = 558.65$ W

$Q_{\text{Total windows Cooling Aluminium frame}} = 1991.5 + 3498.6 + 559.08 + 558.65 = 6607.8\ W$

$Q_{\text{Total windows Heating Aluminium frame}} = 1289.1 + 1289.1 + 322.2 + 412.4 = 3312.8\ W$