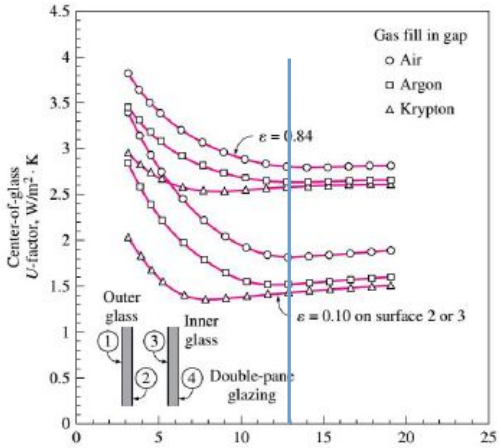
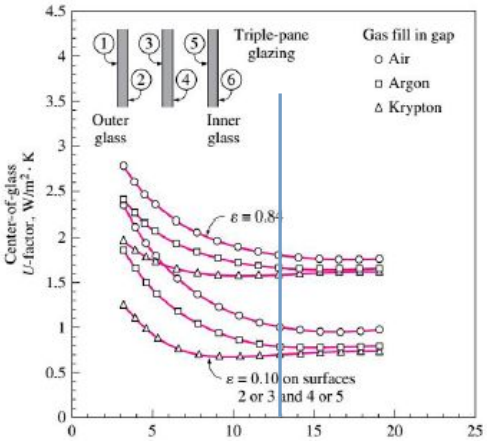
WEEK 8 :

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)





The U_value of a window :

$U_{window} = (U_{center} * A_{center} + U_{edge} * A_{edge} + U_{frame} * A_{frame}) / A_{window}$

$1/U_{double\ pane\ center} = 1/hi + 1/h_{space} + 1/ho$; $h_{space} = h_{radiation\ space}$

<u>U and h change according to the type of gas</u>

- Gap thickness is 13 mm
- Type of gas:ARGON
- In this case, the U_{value} of the center of the glass decreases from 2,8 to 2,65 w/m² k
- percentage : 5,3 %

- Gap thickness is 13 mm
- Type of gas:KRYPTON
- In this case, the U_{value} of the center of the glass decreases from 2,8to 2,6 w/m² k
- percentage : 7,1 %

<u>U and h change when we add an extra pane</u>

- In case of 13mm of thickness, gas--air , an extra pane :
- the U_value decreases from 2,8 to 1,8
- percentage : 35,7 %

- In case of 13mm of thickness, gas--air , an extra pane + a coating film that has an emissivity of 0,1:
- the U_value decreases from 2,8 to 1,8
- percentage : 35,7 %

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 aluminum ?

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	
	99.6%	99%	99.6% DP	99.6% HR	99.6% MCDB	99% DP	99% HR	99% MCDB	0.4% WS	0.4% MCDB	1% WS	1% MCDB	to 99.6% DB MCWS	to 99.6% DB 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 0.4% DB	0.4% MCWB	1% DB	1% MCWB	2% DB	2% MCWB	Evaporation WB/MCDB 0.4% WB	0.4% MCDB	1% WB	1% MCDB	2% WB	2% MCDB	MCWS/PCWD to 0.4% DB 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)

CASE 1 : FIXED WINDOW ON WEST :

•Cooling load:

Frame : wood

$Q_{window\ w} = A*CF_{window\ w}$; A= 14,4 m^2

$Cf_{window\ wheat\ transfer} = U_{window\ w}(\Delta T_{cooling}-0,46\ DR) = 2,84*(7,9-0,46*11,9)$

$Cf_{window\ wheat\ transfer} = 6,89\ w/m^2$

$PXI_{window\ w}$= ED+Ed = 559+188=747 ; SHGC =0,54 ; IAC = 1 ; Ffs = 0,56

$Cf_{window\ wirradiation} = PXI*SHGC*IAC*FFs = 747*0,54*1*0,56$

$Cf_{window\ wirradiation} = 225,9$

$Q_{window\ w} = A*CF_{window\ w} = A*(CF_{window\ wheat\ transfer} + CF_{window\ wirradiation})$

$= 14,4 * (6,89+225,9)$

$Q_{window\ w} = 3352,17\ W$

•Heating load :

Frame : aluminum

$Q_{window\ w} = A*HF_{window\ w} = A*U_{window\ w}\ \Delta T_{heating} = 14,4*2,84*24,8$

$Q_{window\ w} = 1014,22\ W$

$U_{window\ w} = 3,61$; HSGC=0,56

$CF'_{window\ wheat\ transfer} = U'_{window\ w}*((\Delta T_{cooling}-0,46\ DR) =3,61*(7,9-0,46*11,9)$ $CF'_{window\ wheat\ transfer} = 8,76$

Cooling load :

$q'_{window\ w} = A*CF'_{window\ w} = A*(CF'_{window\ wheat\ transfer} + CF'_{window\ wirradiation})$

$=14,4* (8,76+234,26)$

$q'_{window\ w} = 3499,49\ W$

Heating load :
q'windowW = A*HF'windowW = A*U'windowW* Δ Theating = 14,4*3,61*24,8
q'windowW = 1289,2 W

CASE 2: FIXED WINDOW ON SOUTH:

•Cooling load :
Frame : wood
qwindowS = A*CFwindowS ; A= 3,6 m²
CfwindowSheattransfer = UwindowS (Δ Tcooling-0,46 DR) = 2,84*(7,9-0,46*11,9)
CfwindowSheattransfer =6,89 w/m²
PXIwindowS = ED+Ed = 348+209=557 ; SHGC =0,56 ; IAC = 1 ; Ffs = 0,47
CfwindowSirradiation = PXI*SHGC*IAC*FFs = 557*0,56*1*0,47
CfwindowSirradiation = 146,60
qwindowS = A*CFwindowS = A*(CFwindowSheattransfer + CFwindowSirradiation)= 3,6 * (6,89+146,60) qwindowW = 552,56 W

•Heating load :
Frame : aluminium
qwindowS = A*HFwindowS= A*UwindowS Δ Theating = 3,6*2,84*24,8
qwindowW = 253,56 W
UwindowS = 3,61 ; HSGC=0,56
CF'windowSheattransfer = U'windowS *((Δ Tcooling-0,46 DR) =3,61*(7,9-0,46*11,9)
CF'windowWheattransfer = 8,76 W/m²
Cooling load :
q'windowS = A*CF'windowS = A*(CF'windowSheattransfer + CF'windowSirradiation) =3,6* (8,76+146,60) q'windowS=559,3 W
Heating load :
q'windowS = A*HF'windowS = A*U'windowS* Δ Theating = 3,6*3,61*24,8
q'windowW = 322,3 W

CASE 3: OPERABLE WINDOW ON SOUTH:

COOLING LOAD FOR THE OPERABLE:
qwindowS = A*CFwindowS ; A= 3.6
CfwindowSheattransfer = UwindowS (Δ Tcooling-0,46 DR) = 2,87*(7,9-0,46*11,9)
CfwindowSheattransfer =6,96 w/m²
PXIwindowS = ED+Ed = 348+209=557 ; SHGC =0,46 ; IAC = 1 ; Ffs = 0,47
CfwindowSirradiation = PXI*SHGC*IAC*FFs = 557*0,46*1*0,47
CfwindowSirradiation = 120,42
qwindowS = A*CFwindowS = A*(CFwindowSheattransfer + CFwindowSirradiation)= 3,6 * (6,96+141,36) qwindowS = 533,97 W
HEATING LOAD (fixed window):
qwindowS = A*HFwindowS= A*UwindowS Δ Theating = 3,6*2,87*24,8
qwindowW = 256,23 W

with aluminium frame :
UwindowS = 3,61 ; HSGC=0,56
CF'windowSheattransfer = U'windowS *((Δ Tcooling-0,46 DR) =4,62*(7,9-0,46*11,9)
CF'windowWheattransfer = 11,21 W/m²
Cooling load :
q'windowS = A*CF'windowS = A*(CF'windowSheattransfer + CF'windowSirradiation) =3,6* (11,21+143,98) q'windowS=558,7 W
Heating load :
q'windowS = A*HF'windowS = A*U'windowS* Δ Theating = 3,6*4,62*24,8
q'windowS= 412,47 W