Week 8_Prize Kabahinda

Task 1

1. Heat transfer through a window is determined by adding the heat transfer through each region

Q window = Q center + Q edge + Q frame

= U window A window (T indoors - T outdoors)

U window = (U center A center + U edge A edge + U frame A frame)/ A window

Since we cannot reduce the heat transfer through the window, we can reduce it by introducing another window pane and using gases like krypton or argon instead of air to fill the gap between windows

This can be determined using;

1/U double-pane (center region)= $1/h_i + 1/ h_{space} + 1/ h_o$;

Where h_i - R_{inside} , h_{space} = R_{airgap}, h_o;- $R_{outdoors}$

Therefore the U-factor and the h_{space} change with the type of gas and number of window panes

With an extra window pane; a double pane window

Argon gas

From the drawings;

U-factor for air = 2.8Wm2/K

U-factor for argon = 2.65Wm2/K

We take the U-factor for air as our coefficient

(2.8-2.65)/2.8 * 100% = 5.35% less of heat transfer

Krypton gas

From the drawings;

U-factor for air = 2.8Wm2/K

U-factor for krypton = 2.55Wm2/K

We take the U-factor for air as our coefficient

(2.8-2.55)/2.8 * 100% = 8.93% less of heat transfer

Therefore Krypton is a better gas to use compared to argon since less heat transferred through it.

With an extra window pane; a double pane window with a coating of emissivity of 0.1

Argon gas

From the drawings;

U-factor for air = 1.8Wm2/K

U-factor for argon =1.52Wm2/K

We take the U-factor for air as our coefficient

(1.8-1.52)/1.8 * 100% = 15.56% less of heat transfer

Krypton gas

From the drawings;

U-factor for air = 1.8Wm2/K

U-factor for krypton = 1.4Wm2/K

We take the U-factor for air as our coefficient

(1.8-1.4)/1.8 * 100% = 22.2% less of heat transfer

With an extra window pane; a triple pane window
Argon gas
From the drawings;
U-factor for air = 1.53Wm2/K
U-factor for argon = 1.516Wm2/K
We take the U-factor for air as our coefficient
(1.53-1.516)/1.53 * 100% = 0.92% less of heat transfer

Krypton gas
From the drawings;
U-factor for air = 1.53Wm2/K
U-factor for krypton = 1.504Wm2/K
We take the U-factor for air as our coefficient
(1.53-1.504)/1.53 * 100% = 1.69% less of heat transfer

With an extra window pane; a triple pane window with a coating of emissivity of 0.1
Argon gas
From the drawings;
U-factor for air = 1Wm2/K
U-factor for argon = 0.75Wm2/K
We take the U-factor for air as our coefficient
(1-0.75)/1 * 100% = 25% less of heat transfer

Krypton gas
From the drawings;
U-factor for air = 1Wm2/K
U-factor for krypton = 0.5Wm2/K
We take the U-factor for air as our coefficient
(1-0.5)/1* 100% = 50% less of heat transfer

Task 2
1.For the fixed window on the West
A=14.4m2
From the tables;
Delta T cooling = 31.8- 24 = 7.9
Delta T heating = 20 - - 4.8 =24.8
U factor= 2.84
SHGC = 0.54
Heating (winter)
HF window west = U window west (Delta T heating)
Qwindow west =HF window west * Awindow west
=2.84(24.8) * 14.4 = 1014.22W
Cooling (summer)
CF window west heat transfer = U window west (Delta T cooling - 0.46DR)
= 2.84 (7.9 -(0.46*11.9))
=6.89W/m2

PXI window west = $E_D + E_d$ = 559 + 188 = 747
Since there is no internal shading, IAC is 1
FFs = 0.56
CFwindow west _ Irradiation part = PXI * SHGC * IAC * FFs
= 747 * 0.54 * 1* 0.56 =225.89W/m2
CFwindowwest = CF window west heat transfer part + CF window west irradiation part
=6.89 +225.89 = 232.79 W/m2
Q window west = CFwindow west * A windowwest
=232.79 *14.4
= 3352.18W

If the window has an aluminum frame
U window west =3.61 W/m2
SHGC for aluminum = 0.56
Heating (winter)
HF window west = U window west (Delta T heating)
Qwindow west =HF window west * Awindow west
=3.61(24.8) * 14.4 = 1289.2W
Cooling (summer)
CF window west heat transfer = U window west (Delta T cooling - 0.46DR)
= 3.61 (7.9 -(0.46*11.9))
=8.76W/m2
CFwindow west _ Irradiation part = PXI * SHGC * IAC * FFs
= 747 * 0.56 * 1* 0.56 =234.26W/m2
CFwindow west = CF window west heat transfer part + CF window west irradiation part
=8.76 +234.26 = 243.02W/m2
Q window west = CFwindow west * A windowwest
=243.02 *14.4
= 3499.488W

2. For a fixed window in the south
A=3.6m2
From the tables;
Delta T cooling = 31.8- 24 = 7.9
Delta T heating = 20 - - 4.8 =24.8
U factor= 2.84
SHGC = 0.54
Heating (winter)
HF window south = U window south(Delta T heating)
Qwindow south =HF window south * Awindow south
=2.84(24.8) * 3.6= 253.56W
Cooling (summer)
CF window south heat transfer = U windowsouth (Delta T cooling - 0.46DR)
= 2.84 (7.9 -(0.46*11.9))
=6.89W/m2
PXI window south = $E_D + E_d$ = 348 + 209 =557

Since there is no internal shading, IAC is 1
FFs = 0.47
CFwindow south _ Irradiation part = PXI * SHGC * IAC * FFs
= 557 * 0.54 * 1* 0.47 =141.37W/m2
CFwindow south = CF window south heat transfer part + CF window south irradiation part
=6.89 +141.37 = 148.29W/m2
Q window south = CFwindow south * Awindow south
=148.29 *3.6
= 533.7W

If the window has an aluminum frame
U window south for aluminum =3.61 W/m2
SHGC for aluminum = 0.56
Heating (winter)
HF window south = U window south(Delta T heating - 0.46 DR)
Qwindow south =HF window south * Awindow south
=3.61(24.8) * 3.6 = 322.3W
Cooling (summer)
CF window south heat transfer = U window south (Delta T cooling - 0.46DR)
= 3.61 (7.9 -(0.46*11.9))
=8.76W/m2
CFwindow south _ Irradiation part = PXI * SHGC * IAC * FFs
= 557 * 0.56 * 1* 0.47 =146.6W/m2
CFwindow south = CF window south heat transfer part + CF window south irradiation part
=8.76 +146.6 = 155.39W/m2
Q window south = CFwindow south * Awindow south
=155.39 *3.6
=559.4W

3. For an operable window in the south
A=3.6m2
From the tables;
Delta T cooling = 31.8- 24 = 7.9
Delta T heating = 20 - - 4.8 =24.8
U factor= 2.84
SHGC = 0.46
Heating (winter)
HF window south = U window south(Delta T heating)
Qwindow south =HF window south * A window south
=2.84(24.8) * 3.6= 253.56W
Cooling (summer)
CF window south heat transfer = U windowsouth (Delta T cooling - 0.46DR)
= 2.84 (7.9 -(0.46*11.9))
=6.89W/m2
PXI window south = E_D + E_d = 348 + 209 =557
Since there is no internal shading, IAC is 1

FFs = 0.47

CFwindow south _ Irradiation part = PXI * SHGC * IAC * FFs

= 557 * 0.46 * 1* 0.47 =120.42W/m2

CFwindow south = CF window south heat transfer part + CF window south irradiation part

=6.89 +120.42 = 127.31W/m2

Q window south = CFwindow south * Awindow south

=127.31 *3.6

= 458.3W

If the window has an aluminum frame

U window south for aluminum =4.62 W/m2

SHGC for aluminum = 0.55

Heating (winter)

HF window south = U window south(Delta T heating - 0.46 DR)

Qwindow south =HF window south * Awindow south

=4.62(24.8) * 3.6 = 412.47W

Cooling (summer)

CF window south heat transfer = U window south (Delta T cooling - 0.46DR)

= 4.62 (7.9 -(0.46*11.9))

=11.21W/m2

CFwindow south _ Irradiation part = PXI * SHGC * IAC * FFs

= 557 * 0.55 * 1* 0.47 =143.98W/m2

CFwindow south= CF window south heat transfer part + CF windowsouth irradiation part

=11.21 +143.98 = 155.19W/m2

Q window south = CFwindow south * Awindow south

=155.19*3.6

=558.68W