Assignment 8. F.TorresPérez

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Task 1:

The orignal air gap thickness of our 2 panel glass window is 13 mm.

By changing the gas that fills the gap from air to argon the U(value) decreases from 2.8 W/(m2k) to 2.65 (W/m2k), so about 5.38%

By changing the gas from air to krypton the U(value) decreases from 2.8 (W/m2k) to 2.6 (W/m2k), so about 7.14%

By coating the glass surfaces by adding a film with a low emissivity we can also change the U(value). In the case of air with coating the U(value) decreases from 2.8 W(m2k) to 1.82 W(m2k), so about 35%.

In the case of Argon and coating the U value changes from 2.8 W(m2k) to 1.52 W(m2k), so about 46%.

In the case of Krypton and coating the U(value) decreases from 2.8 W(m2k) to 1.45 W(m2k), so about 48.21%.

We can also change the U (value) by adding an extra pane of glass, in this case the U(value) decreases from 2.8 (W/m2k) to 1.8 (W/m2k), so about 35.74%

In the case of 3 panels of glass with Argon the u(value) decreases from 2.8 W(m2k) to 1.68 W(m2k), so about 40%

In the case of 3 panels of glass with krypton the u(value) decreases from 2.8 W(m2k) to 1.6 W(m2k), so about 42.85%.

Last, we can also add an extra layer of coating to the three glass panels, in the case of air the u(value) changes from 2.8 w/(m2k) to 1 w/(m2k), so about 64.29%

In the case of 3 panels of glass with coating and filled with Argon the u(value) decreases from 2.8 W(m2k) to 0.8 W(m2k), so about 71.42%

In the case of 3 panels of glass with coating and filled with Krypton the u(value) decreases from 2.8 W(m2k) to 0.7 W(m2k), so about 75%

Task 2:

Temperature difference calculation

$\Delta T_{cooling} = 31.9 - 24 = 7.9\ °C$

$\Delta T_{heating} = 20 - (-4.8) = 24.8\ °C$

DR = 11.9 °C

WEST WINDOW (FIXED)

Cooling Load: Wooden Frame

$\dot{q}_{windowwest} = A \times CF_{windowwest}$
$A = 14.4\ m^2$
$CF_{windowwest} = CF_{windowwest,heattransfer} + CF_{windowwest,irridiation}$
$CF_{windowwest} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowwest,heattransfer} = U(\Delta T - 0.46DR)$
$U = 2.84$
$CF_{windowwest,\downarrow heattransfer} = 2.84\ (7.9 - (0.46)(11.9)) = 6.89\ \frac{W}{m^2}$
$CF_{windowwest,irridiation} = PXI \times SHGC \times IAC \times FF_s$
$PXI = E_D - E_d = 559 + 188 = 747$
$SHGC = 0.54$
$IAC = 1$
$FF_s = 0.56$
$CF_{windowwest,\downarrow irridiation} = 747 \times 0.54 \times 1 \times 0.56 = 225.89\ \frac{W}{m^2}$
$CF_{windowwest} = CF_{windowwest,heattransfer} + CF_{windowwest,irridiation}$
$CF_{windowwest} = 6.89 + 225.89 = 232.78\ \frac{W}{m^2}$
$\dot{q}_{windowwest} = A \times CF_{windowwest} = 14.4 \times 232.78 = 3352.07\ W$

Cooling Load: Aluminum Frame

$\dot{q}_{windowwest} = A \times CF_{windowwest}$
$A = 14.4\ m^2$
$CF_{windowwest} = CF_{windowwest,heattransfer} + CF_{windowwest,irridiation}$
$CF_{windowwest} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowwest,heattransfer} = U(\Delta T - 0.46DR)$
$U = 3.61$
$CF_{windowwest,\downarrow heattransfer} = 3.61\ (7.9 - (0.46)(11.9)) = 8.76\ \frac{W}{m^2}$
$CF_{windowwest,irridiation} = PXI \times SHGC \times IAC \times FF_s$
$PXI = E_D - E_d = 559 + 188 = 747$
$SHGC = 0.56$
$IAC = 1$
$FF_s = 0.56$
$CF_{windowwest,\downarrow irridiation} = 747 \times 0.56 \times 1 \times 0.56 = 234.26\ \frac{W}{m^2}$
$CF_{windowwest} = 8.76 + 234.26 = 243.02\ \frac{W}{m^2}$
$\dot{q}_{windowwest} = A \times CF_{windowwest} = 14.4 \times 243.02 = 3499.47\ W$

Heating Load: Wooden Frame

$\dot{q}_{windowwest} = A \times HF_{windowwest}$
$A = 14.4\ m^2$
$HF_{windowwest} = U_{windowwest} \times \Delta T_{heating}$
$U = 2.84$
$HF_{windowwest} = 2.84 \times 24.8 = 70.43\ \frac{W}{m^2}$
$\dot{q}_{windowwest} = A \times HF_{windowwest} = 14.4 \times 70.43 = 1014.22\ W$

Heating Load: Aluminum Frame

$\dot{q}_{windowwest} = A \times HF_{windowwest}$
$A = 14.4\ m^2$
$HF_{windowwest} = U_{windowwest} \times \Delta T_{heating}$
$U = 3.61$
$HF_{windowwest} = 3.61 \times 24.8 = 89.53\ \frac{W}{m^2}$

$\dot{q}_{windowwest} = A \times HF_{windowwest} = 14.4 \times 89.53 = 1289.20\ W$

Difference:
Cooling Load = 147.4 W
Heating Load = 274.98 W

SOUTH WINDOW (FIXED)
Cooling Load: Wooden Frame
$\dot{q}_{windowsouth} = A \times CF_{windowsouth}$
$A = 3.6\ m^2$
$CF_{windowsouth} = CF_{windowsouth,heattransfer} + CF_{windowsouth,irridiation}$
$CF_{windowsouth} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowsouth,heattransfer} = U(\Delta T - 0.46DR)$
$U = 2.84$
$CF_{windowsouth\downarrow heattransfer} = 2.84\ (7.9 - (0.46)(11.9)) = 6.89\ \frac{W}{m^2}$
$CF_{windowsouth,irridiation} = PXI \times SHGC \times IAC \times FF_s$
$PXI = E_D - E_d = 348 + 209 = 557$
$SHGC = 0.54$
$IAC = 1$
$FF_s = 0.47$
$CF_{windowsouth\downarrow irridiation} = 557 \times 0.54 \times 1 \times 0.47 = 141.37\ \frac{W}{m^2}$
$CF_{windowsouth} = CF_{windowsouth,heattransfer} + CF_{windowsouth,irridiation}$
$CF_{windowsouth} = 6.89 + 141.37 = 148.26\ \frac{W}{m^2}$
$\dot{q}_{windowsouth} = A \times CF_{windowsouth} = 3.6 \times 148.26 = 533.74\ W$

Cooling Load: Aluminum Frame
$\dot{q}_{windowsouth} = A \times CF_{windowsouth}$
$A = 3.6\ m^2$
$CF_{windowsouth} = CF_{windowsouth,heattransfer} + CF_{windowsouth,irridiation}$
$CF_{windowsouth} = U(\Delta T - 0.46DR) + PXI \times SHGC \times IAC \times FF_s$
$CF_{windowsouth,heattransfer} = U(\Delta T - 0.46DR)$
$U = 3.61$
$CF_{windowsouth\downarrow heattransfer} = 3.61\ (7.9 - (0.46)(11.9)) = 8.76\ \frac{W}{m^2}$
$CF_{windowsouth,irridiation} = PXI \times SHGC \times IAC \times FF_s$
$PXI = E_D - E_d = 348 + 209 = 557$
$SHGC = 0.56$
$IAC = 1$
$FF_s = 0.47$
$CF_{windowsouth\downarrow irridiation} = 557 \times 0.56 \times 1 \times 0.47 = 146.60\ \frac{W}{m^2}$
$CF_{windowsouth} = 8.76 + 146.60 = 155.36\ \frac{W}{m^2}$
$\dot{q}_{windowsouth} = A \times CF_{windowsouth} = 3.6 \times 155.36 = 559.30\ W$

Heating Load: Wooden Frame
$\dot{q}_{windowsouth} = A \times HF_{windowsouth}$
$A = 3.6\ m^2$
$HF_{windowsouth} = U_{windowsouth} \times \Delta T_{heating}$
$U = 2.84$

$HF_{windowsouth} = 2.84 \text{ x } 24.8 = 70.43 \frac{W}{m^2}$
$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth} = 3.6 \text{ x } 70.43 = 253.08 \text{ W}$

Heating Load: Aluminum Frame
$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth}$
$A = 3.6 \text{ m}^2$
$HF_{windowsouth} = U_{windowsouth} \text{ x } \Delta T_{heating}$
$U = 3.61$
$HF_{windowsouth} = 3.61 \text{ x } 24.8 = 89.53 \frac{W}{m^2}$
$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth} = 3.6 \text{ x } 89.53 = 322.31 \text{ W}$

Difference:
Cooling Load = 25.56 W
Heating Load = 69.23 W

SOUTH WINDOW (OPERABLE)
Cooling Load: Wooden Frame
$\dot{q}_{windowsouth} = A \text{ x } CF_{windowsouth}$
$A = 3.6 \text{ m}^2$
$CF_{windowsouth} = CF_{windowsouth,heattransfer} + CF_{windowsouth,irridiation}$
$CF_{windowsouth} = U(\Delta T - 0.46DR) + PXI \text{ x } SHGC \text{ x } IAC \text{ x } FF_s$
$CF_{windowsouth,heattransfer} = U(\Delta T - 0.46DR)$
$U = 2.87$
$CF_{windowsouth\downarrow heattransfer} = 2.87\ (7.9 - (0.46)(11.9)) = 6.96 \frac{W}{m^2}$
$CF_{windowsouth,irridiation} = PXI \text{ x } SHGC \text{ x } IAC \text{ x } FF_s$
$PXI = E_D - E_d = 348 + 209 = 557$
$SHGC = 0.46$
$IAC = 1$
$FF_s = 0.47$
$CF_{windowsouth\downarrow irridiation} = 557 \text{ x } 0.46 \text{ x } 1 \text{ x } 0.47 = 120.42 \frac{W}{m^2}$
$CF_{windowsouth} = CF_{windowsouth,heattransfer} + CF_{windowsouth,irridiation}$
$CF_{windowsouth} = 6.96 + 120.42 = 127.38 \frac{W}{m^2}$
$\dot{q}_{windowsouth} = A \text{ x } CF_{windowsouth} = 3.6 \text{ x } 127.38 = 458.57 \text{ W}$

Cooling Load: Aluminum Frame
$\dot{q}_{windowsouth} = A \text{ x } CF_{windowsouth}$
$A = 3.6 \text{ m}^2$
$CF_{windowsouth} = CF_{windowsouth,heattransfer} + CF_{windowsouth,irridiation}$
$CF_{windowsouth} = U(\Delta T - 0.46DR) + PXI \text{ x } SHGC \text{ x } IAC \text{ x } FF_s$
$CF_{windowsouth,heattransfer} = U(\Delta T - 0.46DR)$
$U = 4.62$
$CF_{windowsouth\downarrow heattransfer} = 4.62\ (7.9 - (0.46)(11.9)) = 11.21 \frac{W}{m^2}$
$CF_{windowsouth,irridiation} = PXI \text{ x } SHGC \text{ x } IAC \text{ x } FF_s$
$PXI = E_D - E_d = 348 + 209 = 557$
$SHGC = 0.55$
$IAC = 1$
$FF_s = 0.47$

$CF_{windowsouth_{\downarrow}irridiation} = 557 \text{ x } 0.55 \text{ x } 1 \text{ x } 0.47 = 143.98 \frac{W}{m^2}$

$CF_{windowsouth} = 11.21 + 143.98 = 155.19 \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \text{ x } CF_{windowsouth} = 3.6 \text{ x } 155.19 = 558.68 \text{ W}$

Heating Load: Wooden Frame

$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth}$

$A = 3.6 \text{ m}^2$

$HF_{windowsouth} = U_{windowsouth} \text{ x } \Delta T_{heating}$

$U = 2.87$

$HF_{windowsouth} = 2.87 \text{ x } 24.8 = 71.18 \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth} = 3.6 \text{ x } 71.18 = 256.23 \text{ W}$

Heating Load: Aluminum Frame

$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth}$

$A = 3.6 \text{ m}^2$

$HF_{windowsouth} = U_{windowsouth} \text{ x } \Delta T_{heating}$

$U = 4.62$

$HF_{windowsouth} = 4.62 \text{ x } 24.8 = 114.58 \frac{W}{m^2}$

$\dot{q}_{windowsouth} = A \text{ x } HF_{windowsouth} = 3.6 \text{ x } 114.58 = 412.47 \text{ W}$

Difference:

Cooling Load = 100.11 W

Heating Load = 156.24 W