1) Summary

Heat convection, which is one form of heat transfer happens between two moving fluids, as an example when cold air touches the surface of a hot solid, the air gets hot and moves up due to the higher density of hot air and this process continues. In a closed room this flow of cold and hot air happens naturally due to the different density of hot and cold air which is called Natural Convection.

There is another kind of convective heat transfer called Forced convection which happens between one solid and one moving fluid or two moving fluid with an external force. For example wind is an external force for the outside air contacting a wall.

2) Question

Why increasing the thickness of a single pane glass does not increase the total resistance?

The thermal resistance of convection between glass and air is much bigger than the thermal resistance of the glass, and the final thermal resistance does not change considerably when the thickness of a single glass plane increases.

$$A_{glass} = 0.8 \times 1.5\text{m} = 1.2 \text{ m}^2$$

$$R_{conv1} = \frac{1}{h_1 A} = \frac{1}{10\frac{w}{m^2 °C} \times 1.2 \text{ m}^2} \approx 0.0833 \frac{°C}{w}$$

$$R_{conv2} = \frac{1}{h_2 A} = \frac{1}{40\frac{w}{m^2 °C} \times 1.2 \text{ m}^2} \approx 0.0208 \frac{°C}{w}$$

$$R_{glass} = \frac{L_g}{k_g A} = \frac{0.006\, m}{0.78\frac{w}{m°C} \times 1.2 \text{ m}^2} \approx 0.0064 \frac{°C}{w}$$

$$R_{air} = \frac{L_a}{k_a A} = \frac{0.006\, m}{0.026\frac{w}{m°C} \times 1.2 \text{ m}^2} \approx 0.4167 \frac{°C}{w}$$

$$R_{total} = R_{conv1} + R_{conv2} + R_{g1} + R_a + R_{g2}$$

$$0.0833 \frac{°C}{w} + 0.0208 \frac{°C}{w} + 0.0064 \frac{°C}{w} + 0.4167 \frac{°C}{w} + 0.0064 \frac{°C}{w} = 0.5333 \frac{°C}{w}$$

$$\dot{Q} = \frac{T_{\infty 1} - T_{\infty 2}}{R_{total}} \approx \frac{20°C - (-10°C)}{0.5333 \frac{°C}{w}} \approx 56.2535\ _w$$

$$\dot{Q} = \frac{T_{\infty 1} - T_1}{R_{conv1}}$$

$$T_1 = T_{\infty 1} - \dot{Q} \times R_{conv1} \approx 20°C - 56.2535_w \times 0.0833 \frac{°C}{w} \approx 15.3\ °C$$