Summary:

Transfer of heat from one place to another by the movement of fluids is named convection. Convection is usually the dominant form of heat transfer in liquids and gases. In natural convection, an increase in temperature produces a reduction in density. For example, when air is getting warm, hot air from the bottom of the floor rises, displacing the colder denser air, which falls.

In addition to natural convection, there is another convection which is named 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.

It is notable that natural heat convection happens in spaces with a wider width of 13 mm. thus increasing the thickness of the air between glasses does not increase the total resistance of the pane.

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.

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

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

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

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

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

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

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

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

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

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