Convective heat transfer happens within gas state substances, such as air, whenever a difference in temperature occur. Since cold air is heavier, it tends to move downwards and substitute the warmer air which goes up as a consequence. In its turn, if the underneath cold air will be heated again, it will move up and replace colder air layers repeating the cycle. The rate of convective heat transfer depends on the characteristics of the gas, the speed of its motion (f.i. in case of wind), the amount of fluid that is heated/cooled (surface of the object such as a wall) and the temperature difference. In the case of the wall of a heated building, the outside air just nearby the wall gets hotter, so it starts to move upwards along the surface of the wall. This is because the temperature of the surface is not equal to the outside or inside actual temperature, which means that part of the heat is exchanged through the inner and outer air layers which move due to convection. The more the wall resists to conductive heat transfer, the more the surface temperatures are close to the real outside/inside temperatures and the less heat is exchanged through convection. A big rate of heat transferred by convection is not a good situation when it comes to efficiency in architecture since it means a big amount of energy dispersed throughout the walls and a greater amount of energy needed to preserve the inside temperature.

If the material of the wall has a very low resistance to heat transfer, it needs to have the thickness be increased. However, that might not be convenient because of the cost of the material itself. This is the case of glass: its high cost in relation to the transmittance is the reason that makes no sense to put thicker single glass panes on windows for efficiency purposes. The best way is to use more panes alternated with layers of air that need to have the right thickness to do not allow the creation of other convective movements in between.

Exercise:

Q = $\frac{\Delta \boldsymbol{T}}{\boldsymbol{Rc1+Rg+Ra+Rg+Rc2}}$

R*tot* = $\frac{1}{10 \text{ x } 1{,}2} + \frac{0{,}006}{0{,}078 \text{ x } 1{,}2} + \frac{0{,}013}{0{,}026 \text{ x } 1{,}2} + \frac{0{,}006}{0{,}078 \text{ x } 1{,}2} + \frac{1}{40 \text{ x } 1{,}2} =$

= 0,083 + 0,064 + 0,4166 + 0,064 + 0,021 = 0,6486 °(C/W)

Q = $\frac{30}{0{,}6486}$ = 46,253 (J)

As we can see, the *Ra = 0,4166 °C/W* is the highest of the rates of resistance and it is much higher than the two resistances of convection. That means that a gap of 13mm between the two glasses is a good option and it’s even more impactful than the two glass panes of 6mm alone. Moreover, it has been experimentally proved that around 13 mm is the maximum allowed thickness beyond which other convective movement would occur and that would negatively affect the total resistance. In order to increase even more the resistance of the window, is necessary to add a third glass pane.