



**THE COMPARISON OF EFFICIENCY OF SOME OF GLASSES IN REDUCTION
OF HEAT FROM WINDOW****TAYEBE YAZERLOU¹**

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The windows in Iranian buildings are the weaknesses of external shell of building due to high heat transfer coefficient. On the other hand, the windows as clear levels of building with less thickness to the rest of external shell walls require special attention in reduction of heat transfer coefficient. Although the number of light passing surfaces are effective in terms of light and ventilation in building, due to little thermal resistance of these surfaces to other external shell components, thermal loss of building is increased. Reduction of health transfer coefficient of windows can turn them into good components in terms of heat exchange. One of the solutions to achieve this issue is using good glasses with the aim of improving thermal performance of these building elements as the lower the surface thermal transfer coefficient of glass, the higher the resistance against thermal transfer. This study applied windows 6.3 of LBNL in Berkley University [1] and it is an important software in heat transfer through windows and climatic data, wind speed, sky temperature, material of glasses, number of walls, type of filled gas between walls, thickness and emission of glasses are considered.

The common glasses in the windows of our country are single or double as considered as clear or with Low-Emissivity Coating in internal and external surface and type of filling gas. By the analysis of simulation results, the different effects of number of walls, thickness and type of gas are determined in reduction of heat transfer of glasses and they reduce energy consumption in building and an optimal model is selected among them.

Keywords: Low-Emissivity Coating, Double glass, Heat transfer coefficient, Windows software, Energy consumption

INTRODUCTION

The applied windows in Iranian buildings have single clear glasses and with high heat transfer coefficient is the weakness of external shell of buildings [2]. Heat loss in windows is via frame and glass and this study only investigates the effect of glasses on heat transfer coefficient. The reduction of heat transfer coefficient in windows can turn them to good components of heat transfer. One of the ways of achieving this goal is using suitable glasses with the aim of improving thermal performance of these building components as the lower the heat transfer coefficient, the higher the resistance against heat transfer. This study investigates the heat transfer of single and double glasses with different thicknesses with the effect of different gases between walls (by using) 6.3 windows and an optimal state is introduced to reduce heat transfer coefficient of glass and reducing heat transfer from window.

Before, a few studies have been conducted on efficiency of new glasses in reduction of energy consumption and orientation of windows. A research only regarding glasses, number of walls, Low-Emissivity Coating and gas among the walls is not presented.

The features of investigated glasses

All the glasses are selected based on access in domestic market and each has different thermal features. These glasses include:

- Single clear glass (thicknesses 3,6 mm)
 - Clear single glass with inside Low-Emissivity Coating
 - Clear single glass with outside Low-Emissivity Coating
 - Clear double window (thickness 6mm, filled with different gases)
 - Clear double window (thickness 3mm, filled with different gases)
 - Clear double window (inner glass with thickness 3 and exterior with thickness 6mm, filled with different gases)
 - Clear double window (inner glass with thickness 6 and exterior with thickness 3mm, filled with different gases)
 - Double glass with Low-Emissivity Coating on second surface (with thickness 3mm filled with different gases)
 - Double glass with Low-Emissivity Coating on third surface (with thickness 3mm filled with different gases)
 - Clear glasses more than double
- Surface heat transfer coefficient

Heat transfer coefficient is a quantity to measure transferred heat from wall, ceiling, floor or window. The lower the coefficient, the better the suitability of thermal performance and the higher the value, the

lower the suitability of thermal performance of building.

Surface heat transfer coefficient is a part of external shell of building as equal to: Transferred thermal power from its surface with area one square meter if the difference of temperature of inside and outside is one degree [4]. In other words, Surface heat transfer coefficient is equal to the inverse total resistance of wall.

$$1- R = d/\lambda \quad (\text{m}^2.\text{k}/\text{W})$$

$$(1)$$

$$2- R_T = R + 1/h_i + 1/h_o$$

$$(2)$$

3-

$$U = \frac{1}{R + \frac{1}{h_i} + \frac{1}{h_o}}$$

$$(3)$$

(W.K)

$$4- U = 1/R_T$$

$$(4)$$

Based on this formula, the lower the value of surface heat transfer coefficient, the higher the resistance of wall against heat transfer. Thus, to achieve saving in health transfer via wall exterior shell, we can achieve minimum heat transfer coefficients. In this study, windows software is used to compute heat transfer coefficient.

Windows software

This software is provided from Laurence national lab of Berkley University performing some researches of ministry of energy of USA (DOE) and it is in LBNL

with specialized software in window and is dedicated to window calculations.

To provide this study, version 6.3 is used as published in July 2013 [1].

The environmental conditions in computations

The environmental conditions to compute heat transfer coefficient at the center of window in NFRC calculations are considered as: The exterior air temperature -18°C , inside temperature 21°C , wind speed 5.5m/s , sky temperature -18 and Sky Emissivity 1.

The clear glasses with low Emissivity coating

low Emissivity coatings with insulating glass control heat transfer from windows. The windows with low Emissivity coating are costly 10 to 15% than ordinary ones but they have 30 to 50% higher than reduction of energy loss.

A low Emissivity coating is a thin microscopic layer, invisible, metal or metal oxide as installed indirectly on window glass.

These coatings reduce window heat transfer coefficient and have various types for passing high, average and low light. They can also reduce visible light, unless its visible type is selected.

low Emissivity coating are installed during the production process. Another feature of these films is cheap price compared to

changing windows, 10 to 15 years without defect, energy saving, reduction of fabric color and increase of comfort [5].

Simulation results of surface heat transfer coefficient in glasses

The simulation results are shown in charts 1-9.

The charts are as followings:

- Chart 1 regarding clear single glasses
- Chart 2-7 of double glasses
- Chart 8 regarding the effect of number of layers
- Chart 9 of the effect of increasing gas layer thickness on heat transfer coefficient

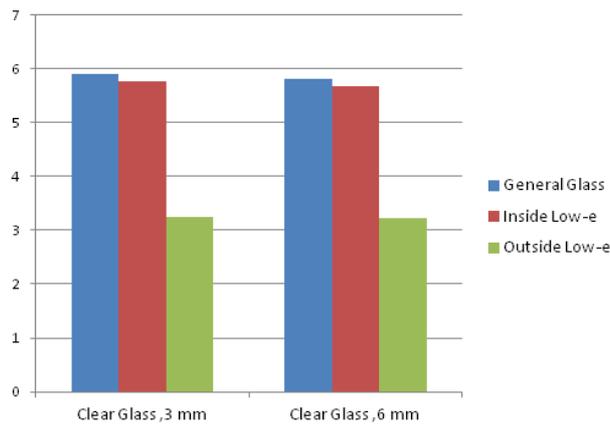


Chart 1-Heat transfer coefficients of single window

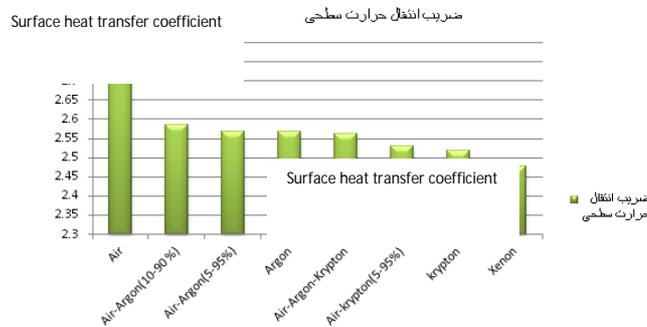


Chart 2-Double glasses with thickness 3mm filled with different gases

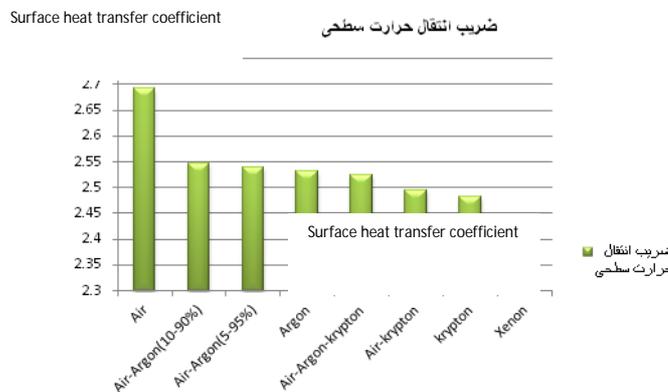


Chart 3-Double glasses with thickness 6mm filled with different gases

Surface heat transfer coefficient

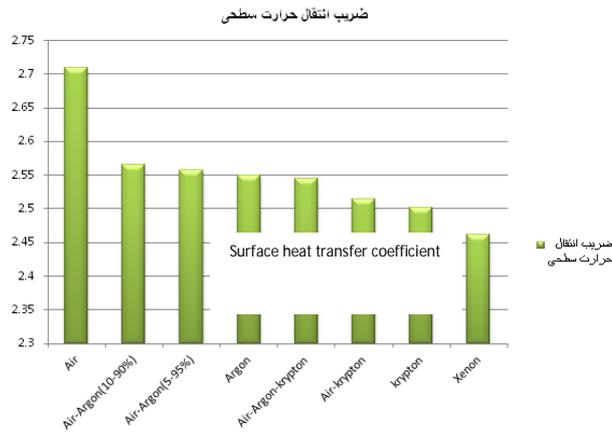


Chart 4-Double glasses with thickness 3mm and exterior 6mm filled with different gases

Surface heat transfer coefficient

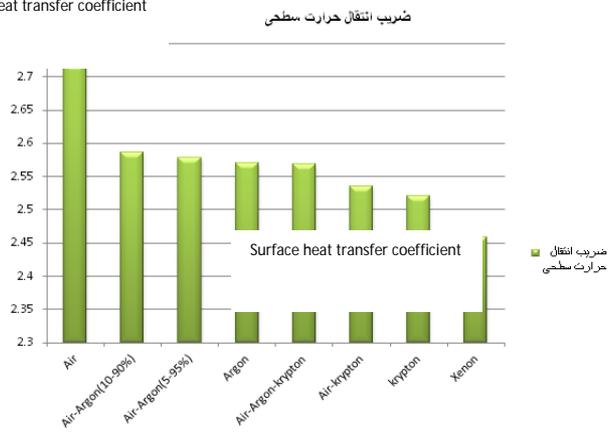


Chart 5-Double glasses with inside thickness 6mm and external 3mm filled with different gases

Surface heat transfer coefficient

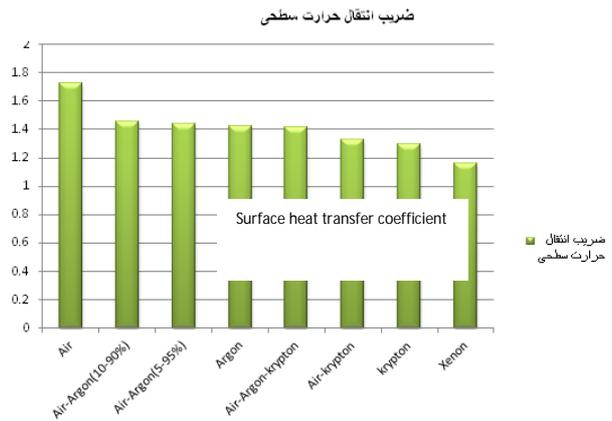


Chart 6-Clear Double glasses with thickness 3mm with Low-Emissivity Coating on second surface filled with different gases

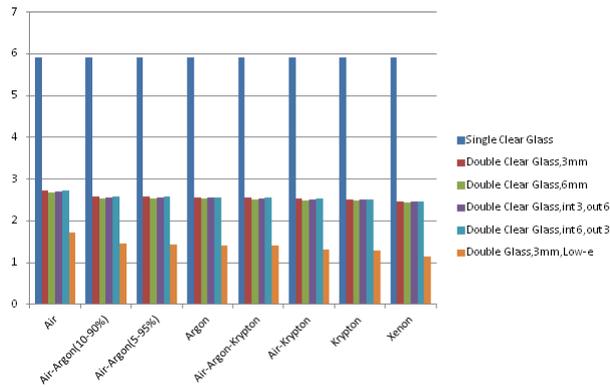


Chart 7- The comparison of all single and double cases

Surface heat transfer coefficient

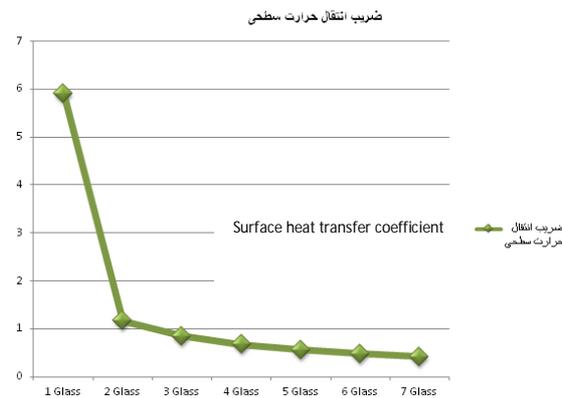


Chart 8- The effect of increase of layers on surface heat transfer coefficient

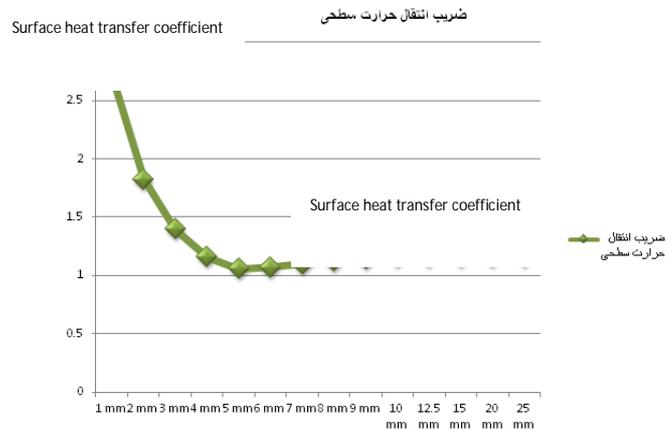


Chart 9- The effect of increasing the thickness of Xenon gas layer on surface heat transfer coefficient

By investigation of the charts of calculation of heat transfer coefficient in glasses, the following results are achieved:

1- Single glasses

- Based on the results of calculations regarding surface heat transfer

coefficient at the center of single glass, the priority is as followings:

- Glass 6mm, low Emissivity of energy with outside coating
- Glass 3mm, low Emissivity of energy with outside coating

- Glass 6mm, low Emissivity of energy with inside coating
- Glass 3mm, low Emissivity of energy with inside coating
- Clear glass with thickness 6mm
- Clear glass with thickness 3mm
- The glasses with low Emissivity have low heat transfer coefficient compared to single clear glasses and their performance is better and outside low Emissivity coating has good performance in this case.

In clear single glasses, by increasing the thickness of glass as double, the conductivity coefficient change is low as ignored.

Heat transfer coefficient of clear single glass with thickness 3mm with low inside Emissivity compared to clear single glass is improved as 2.5%.

The heat transfer coefficient of clear single glass with thickness 3mm with external low Emissivity compared to clear single glass is improved as 45%.

2-Double glasses

Based on simulation results regarding surface heat transfer coefficient at the center of glasses, the priority is as: double glass with low Emissivity coating of energy.

- Double glass with thickness 6mm
- Double glass with inside 3mm and outside 6mm

- Double glass with inside 6mm and outside 3mm, double glass with thickness 3mm
- Single glass

Based on the improvement of heat transfer coefficient and type of filled gas between double glasses, the priority is as: Xenon, krypton, air-Krypton, air-Argon-Krypton, Argon air-Argon (5-95%), air –Argon (10-90%) and air.

Based on the results, using double glasses with low Emissivity coating of energy on second surface with Xenon gases is optimal.

Optimal case compared to clear single glass is improved as 80%.

Clear double glasses have improvement 58% compared to clear single glasses.

Increasing the thickness as double in clear double glasses is with improvement 1.4% and it is little.

Double glasses with low Emissivity coating have improved 53% compared to clear double glasses.

3-Increase of the number of layers

Based on simulation results, the increase of the number of glass layers from one to two has high effect on reduction of heat transfer coefficient but the increase of number of layers from two to there has little effect and this reduction is high in high layers.

Making glass double reduces 80.4% of heat transfer coefficient compared to single glasses.

4- Increase of gas layer thickness

The investigation of the increase of gas thickness for optimized level with Xenon gas is considered. Based on the results, thickness of gas layer (Xenon at optimal level) from 1 to 10 mm has fluctuation of heat transfer coefficient. In thicknesses more than 10mm have constant coefficient and they don't change. The lowest coefficient is dedicated to thickness 5mm and the highest coefficient is dedicated to thickness 1mm. The increase of thickness from 1mm to 5mm reduces coefficient. The thickness from 5 to 10, increases coefficient and more than 10mm, the coefficient is not changed with thickness change and is fixed.

We should avoid high thickness in gas layer as it creates flow and transfers heat and low thickness is avoided due to heat transfer via radiation.

The discussion of glasses in reduction of heat transfer coefficient

It can be said heat transfer is via window, frame and glass and this study only refers to the effect of glass and gas between walls as generally. The investigation needs other features as window orientation, light passing surface to shell surface and

foundation of the buildings in the region. To reduce energy consumption of buildings from light passing surface, we can estimate some cases as sealing of walls and air leakage.

To estimate energy consumption reduction in a sample building as a case of study, we can use the results of heat transfer of glasses in this study.

CONCLUSION

This study investigates the efficiency of clear single and double glasses based on thickness, type of glass, number of walls and filling gas to reduce heat transfer coefficient of building as reducing energy consumption in buildings. By windows 6.3, the analysis is done. Regarding the other required information as using these results, the discussion is performed.

List of sign

M , layer thickness

R_{hi} Thermal resistance of outside air layer· $m^2.k/w$

R_{hi} Thermal resistance of inside air layer· $m^2.k/w$

R_{T} Thermal resistance of homogenous layers· $m^2.k/w$

R_{T} Thermal resistance of total wall· $m^2.k/w$

α Surface heat transfer coefficient , $w/m^2.k$

Greek signs

λ Heat Conductivity coefficient · $w/m.k$

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