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Research Article

The effect of radiation and height of solar air chimney to improve performance of green buildings

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ABSTRACT
Nowadays, energy due to the complexity and increasing evolution of the global society , played a major role in the economy and politic. forecasts the prospects for the energy sector and adopt the right strategy is the main factor for sustainable development of each country due to various factors affecting consumption Heating energy of building has great impact in saving solutions in buildings, reduce consuming energy in the household sector. Climate and weather, architecture, materials, using efficient heating systems and equipment with capacity requirements are mainly effective in heating load of building also control of the heating system is mainly effective in amount of consuming heating energy. Use of solar receptors is considerable debate that install often on the roof and south side of the building which has the most potential to absorb solar energy, furthermore it has considerable influence on heating load of building. Case study is a simple physical model of the solar chimney is similar to the Trombe wall. One side of the chimney is provided with a glass cover which with the other three solid walls of the chimney form a channel through which the heated air could rises and flow by natural convection. This article, from the viewpoint of purpose is applied- developmental that has been done with analytic methods. Study conditions are for Kermanshah with outside winter design temperature -10.56 °C. These equations are solved by matrix inversion. Thermal efficiency of solar air chimney which is calculated due to temperature of glass, wall and air mass flow rate and heat momentary, will be presented. By study of researches, significant relationship was observed between experimental data so empirical research in this area is continuing.

Keywords: solar chimneys, energy, building, heating.

INTRODUCTION
These days, the water crisis, soil pollution, noise pollution and multiple environmental problems are serious crises in Iran which engineers have an important role in the development of the situation. To take a step in way of sustainable development should catch contracting industry professionals' attention to be made better future environmental situation. Importance would be clear since in some developed countries, the contracting industry use about 40% of the extracted resources, 17% of electricity and 12% of the drinking water and produce 45% to 60% waste. In developed countries close to 50% cost of energy is used in the construction sector and after manufacturing processes. The contracting industry is in the first place of greenhouse gas emissions. In recent years in Iran, some efforts are done which include the compilation topic of 19 National Building Regulations, but there are more challenges that should be studied.

Green buildings are champion of steady development and create a balance between environmental health issues, economic and social. Recently the concepts such as sustainable building and alive buildings have been discussed that in all of them regarding to three pillars of people, planet and social-economical prosperity are central. Sustainable development supply needs of the present without endanger the ability of future generations to meet their needs.

The three basic principles of sustainable design are people, planet and economical prosperity, which the general framework sustainable development is based on of, proper site selection, project planning, project development, resources and energy consumption, environmental quality of indoor and arrangement, economic, social, cultural and environmental goals.

Traditional thinking should be developed to implementation strategy of sustainable development. Fundamental reflection change energy consumption and building design operations are carried out in accordance with the following:

- Recognition climate, culture and location of project
- Determine the type of building
- Reducing the need to use resources
- Use of local-free resources and natural systems
- Use known efficient systems
- The use of renewable energy systems and non-fossil (Ravanshadnia, Ghanbari.M, 2015)

Management of optimization of energy in the building sector organized at the beginning of 2000, due to the high share of this sector in energy consumption. Surveys conducted in 1379 explained that household sector by taking over 40% of total energy consumption, has highest share among the other economical sectors, which the highest consumption is natural gas. (Saba, 2013)

Nowadays intensity of consuming energy in Iran is 9 times of Japan and Norway, 7 times of the developed countries of Europe, 3 times of Saudi Arabia and 4 times of Turkey and of average the world. Iran with 1% population of the world consumes more than 4% gas of the world which nearly 40% of total gas consumes in houses and the annually about 6.1% adds to consumption of energy. If the consumption of energy increases with this rate, definitely Iran would become a major energy importer in 1404.

The energy crisis in recent years causes countries have a different approach with energy issues, between replacement of fossil fuel with renewable energy such as solar energy to reduce consuming energy and control demand - supply energy and reduce emissions of greenhouse gases was met great welcome. Sun emits every second 1020 * 1.1 kWh of energy on average. From total energy emitted by the Sun, only about 47% of it reaches to the surface. This means that the Earth will receive about 60 million Btu per hour radiation.

Three days recieved solar energy is equal to energy of all fossil fuels combustion. Therefore it can be concluded with solar radiation in a period of 40 days, required energy can be stored for a century. So solar collectors can be used somewhat an endless energy source, clean and free and save consumption of fossil fuels. Industrialized countries have found with optimization of consuming energy in building and industries, it can be reduced 30 to 40 percent. (Saba, 2013)

Latitudes of Iran is 25 and 45 north that is suitable area for collecting solar energy which is located in a region of the world with the highest category of solar energy. The amount of solar radiation in Iran is between 1800 and 2200 kWh per square meter per year is estimated, but it’s higher than average radiation of world. In Iran in annually average there are more than 280 sunny days that is very impressive. (Sabmsa, 2014)

Solar air chimney is a device that absorbs thermal energy from the sun also heats the fresh air entering to the building. This case uses clean energy and has not restrictions on supply fresh air. These systems also are able to supply all or part of the building load. Solar air chimneys are in two categories: active and passive (normal). Active type has mechanical devices such a fan to move warm air or electricity production, but in passive type there is no mechanical device.

Fig.1. passive solar air chimney

The other applications of solar air chimney:
The main feature of the solar air chimney is providing unlimited amount of fresh and warm air of entering the building. Hot air produced can be used in residential and industrial requirements. Accordingly, major applications of these devices include: residential and dwelling units, warehouses, industrial workshops, repair shops and military units, trade centers, supermarkets, centers of animal husbandry, storage and drying of agricultural products, educational and cultural centers such as schools, sports halls.

As goal in study of passive solar chimney in this paper for determined conditions and simple mathematical model, it must be predicted air flow rate of normal circulation and temperature distribution of walls, glass, air. (K.S.Ong, 2002)

To absorb more solar radiation, a black metal sheet is placed on the inner surface of the channel. Each air heater worked normally as a thermosyphon and the buoyancy force makes air flow. Heated air could rise and flow by natural convection because of decreasing specific gravity. The air flows into upper end of the channel to the horizontal channel on the wall to flow through the ceiling diffuser. To continue this process cold air that has more density enters to the heater from hatch of cornice. If the air temperature in the channel was lower than room temperature, hatch will be closed and stops flow in channel to prevent cooling air in the room. As long as the air temperature in the air heater is higher than room temperature, the natural flow of air will be established. At night, the temperature of the walls, floor, ceiling and other objects were transferred to room and keeps air warm in the room. To prevent air flow to be reversed in the evening and did not cool the room, a thin curtain is installed behind the air inlets near the floor. This curtain allows air enter to heater near the floor and prevent reverse air flow by binding to the hatch. Glass has radiation between earth sky and convection whit environment. Black absorber absorbs portion of the solar radiation that passes through the glass. The air in the channel has convection with the black absorber plate. (Safarzadeh, 2004)

Table1

Nomenclature

A_o, A_i	cross sectional areas of outlet and inlet to air flow channel [m^2]
A_r	ratio of A_o/A_i
C_d	coefficient of discharge of air channel [=0.6]
c_f	specific heat of air [J kg^{-1} K^{-1}]
d	distance between wall and glass [m]
g	gravitational constant [=9.81 m s^{-2}]
H	incident solar radiation on vertical surface [W m^{-2}]
h_g	convective heat transfer coefficient between glass cover and air channel [W m^{-2} K^{-1}]
h_w	convective heat transfer coefficient between vertical wall and air channel [W m^{-2} K^{-1}]
h_i	convective heat transfer coefficient between vertical wall and interior of room [=10 W m^{-2} K^{-1}]
h_{rs}	radiative heat transfer coefficient between glass cover and sky [W m^{-2} K^{-1}]
h_{rwg}	radiative heat transfer coefficient between vertical wall and glass cover [W m^{-2} K^{-1}]
h_{wind}	convective wind heat loss coefficient [W m^{-2} K^{-1}]
k_f	thermal conductivity of air [W m^{-1} K^{-1}]
k_w	thermal conductivity of wall [=0.0275 W m^{-1} K^{-1}]
L	length of wall [m]
$\dot{m}$	mass flow rate [kg s^{-1}]
q''	heat transfer to air stream [W m^{-2}]
S_1	solar radiation heat flux absorbed by glass cover [W m^{-2}]
S_2	solar radiation heat flux absorbed by vertical wall [W m^{-2}]
T_a	ambient temperature [=305 K]
T_r	room temperature [=$T_{f,i}$, K]
T_f	mean temperature of air in channel [K]
$T_{f,i}$	inlet temperature of air in channel [=T_a K]
$T_{f,o}$	outlet temperature of air in channel [K]
T_g	mean glass cover temperature [K]
T_s	sky temperature [K]
T_w	mean vertical wall temperature [K]
U_b	Overall convective heat transfer coefficient between vertical wall and room [W m^{-2} K^{-1}]
U_t	Overall convective heat transfer coefficient from top of glass cover [W m^{-2} K^{-1}]
V	wind velocity [=1.0 m s^{-1}]
$\dot{V}_0$	Volumetric air flow rate [m^3 s^{-1}]
W	width of air channel [m]

Greek symbols

α_1	absorptivity of glass [=0.06]
α_2	absorptivity of wall [=0.95]
β_f	coefficient of expansion of air [K^{-1}]
ϵ_g	emissivity of top of glass surface [=0.90]
ϵ_w	emissivity of black wall surface [=0.94]
γ	constant in mean temperature approximation
μ_f	dynamic viscosity of air [kg m^{-1} s^{-1}]
ν_f	kinematic viscosity of air [m^2 s^{-1}]
τ	transmissivity of glass [=0.84]
ρ_f	density of air [kg m^{-3}]
η	instantaneous efficiency of solar chimney [%]
σ	Stefan–Boltzmann constant [=5.67×10^{-8} W m^{-2} K^{-4}]
Δ_w	wall thickness [=0.022 m]

Dimensionless terms

Nu	Nusselts number [$h_f L/\mu_f$]
Pr	Prandtl number [$c_{f}\mu_f/k_f$]
Gr	Grashof number [$g\beta_f(T_w - T_f)L^3/\nu^2$]
Ra	Rayleigh number [GrPr]

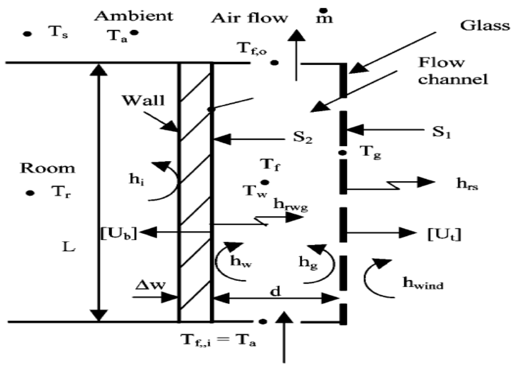


Fig.3.physical model of solar chimney

Figure 3 shows the physical model postulated for the solar chimney. Air enters the chimney at the inlet temperature (Tfo) which is assumed equal to the room air temperature (Tr) and assumed constant. Warm air exits at the outlet temperature (Tfo) from the top of the chimney. Temperatures at the surfaces of the glass (Tg) and wall (Tw) and mean air temperature in the flow channel (Tf) are all assumed to be uniform. Resistance to flow due to friction along the surfaces are assumed negligible. The thermal network for the physical model considered is shown in Fig. 4.

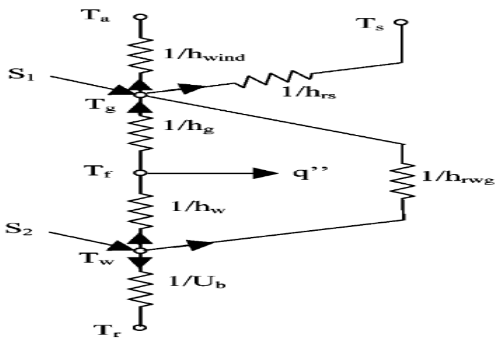


Fig.4. Thermal network for solar chimney

The heat balance equations from the thermal network at the points.

Thermal energy balance equations in network nodes as follows: (KSOng.2002)

$$T_g{:}\, S_1 + h_{rwg}(T_w - T_g) + h_g(T_f - T_g) = U_t(T_g - T_a) \qquad (1)$$

$$T_f{:}\, h_w(T_w - T_f) = h_g(T_f - T_g) + \dot{q}'' \qquad (2)$$

$$T_w{:}\, S_2 = h_w(T_w - T_f) + h_{rwg}(T_w - T_g) + U_b(T_w - T_r). \qquad (3)$$

Figure (5) shows the heat transferred to the air stream flowing upwards under natural convection in the air gap between the glass and wall.

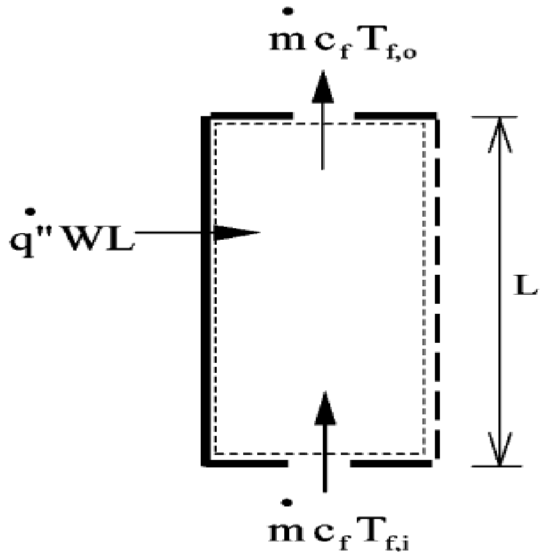


Fig.5. Heat balance to air stream in direction of flow

For a short length of wall (L), the temperature of the glass (Tg) and the wall (Tw) may be assumed constant and the useful heat transferred to the air flowing in the gap is given by

$$\dot{q}'' WL = \dot{m} c_f (T_{f,o} - T_{f,i}). \qquad (4)$$

The mean temperature is calculated by the following equation:

$$T_f = \gamma T_{f,o} + (1-\gamma) T_{f,i}. \qquad (5)$$

From experimental observations, Hirunlabh (Hirunlabh et al,1999) assumed a value of g□0.75.

$$\dot{q}'' = \frac{\dot{m} c_f (T_f - T_{f,i})}{\gamma WL}. \qquad (6)$$

According to the relationship (7) the useful heat transferred may be expressed as:

$$M = \frac{\dot{m} c_f}{\gamma WL} \qquad (7)$$

$$\dot{q}'' = M(T_f - T_{f,i}). \qquad (8)$$

Heat transfer coefficients and air properties can be evaluated at mean fluid temperature. By inserting equation (6) in equation (2) following matrix obtained:

$$T_g{:}(h_g + h_{rwg} + U_t)T_g - h_g T_f - h_{rwg} T_w = S_1 + U_t T_a \quad (9)$$

$$T_f{:}h_g T_g - (h_g + h_w + M)T_f + h_w T_w = -MT_{f,1} \quad (10)$$

$$T_w{:} -h_{rwg} T_g - h_w T_f + (h_w + h_{rwg} + U_b)T_w = S_2 + U_b T_r. \quad (11)$$

In fact, equations (9) to (11) can be written as a matrix:

$$\begin{bmatrix} (h_g + h_{rwg} + U_t) & -h_g & -h_{rwg} \\ h_g & -(h_g + h_w + M) & h_w \\ -h_{rwg} & -h_w & (h_w + h_{rwg} + U_b) \end{bmatrix} \begin{bmatrix} T_g \\ T_f \\ T_w \end{bmatrix} = \begin{bmatrix} U_t T_a + S_1 \\ -MT_{f,i} \\ S_2 + U_b T_r \end{bmatrix}.$$

The matrix can be shown as (12) and the mean temperature vector may be determined by matrix inversion:

$$[A]\,[T] = [B]. \quad (12)$$

$$[T] = [A]^{-1}[B]. \quad (13)$$

The volumetric air flow rate at the outlet opening for uniform room air temperature according to with the Group "Bansal" (Bansal, 1993) and "Andersen" (Andersen, 1995) provided as follows:

$$\dot{V}_o = C_d \frac{A_o}{\sqrt{1 + A_r}} \sqrt{\frac{2gL(T_f - T_r)}{T_r}}. \quad (14)$$

The air mass flow rate will be as follows:

$$\dot{m} = C_d \frac{\rho_{f,o} A_o}{\sqrt{1 + A_r}} \sqrt{\frac{2gL(T_f - T_r)}{T_r}}. \quad (15)$$

Coefficient of discharge air (Cd) by Flourentzou and other researchers (Flourentzou, 1998) is equal to (0.6).

Radiation heat transfer coefficient from glass cover to sky. It is related to the ambient temperature can be obtained from the following equation:

$$h_{rs} = \sigma\varepsilon_g (T_g + T_s)(T_g^2 + T_s^2)(T_g - T_s)/(T_g - T_a). \quad (16)$$

The sky temperature is presented at by Swinbank (Swinbank, 1963):

$$T_s = 0.0552 T_a^{\,1.5} \quad (17)$$

The radiation heat transfer coefficient between the wind and the glass cover can be obtained from the following equation:

$$h_{wind} = 5.7 + 3.8\ V. \quad (18)$$

The radiation heat transfer coefficient between wall and glass cover could be obtained from:

$$h_{rwg} = \sigma(T_g^2 + T_w^2)(T_g + T_w)/(1/\varepsilon_g + 1/\varepsilon_w - 1). \quad (19)$$

The average natural convection coeficient for air between wall and glass cover is and the glass cover is obtained by DeWitt according to the Rayleigh number and the Nusselt number: (Incropera, DeWitt, 1996)

For laminar flow $(\mathrm{Ra} < 10^9)$:

$$\mathrm{Nu} = 0.68 + (0.67\mathrm{Ra}^{1/4})/[1 + (0.492/\mathrm{Pr})^{9/16}]^{4/9} \quad (20)$$

For turbulent flow $(10^9 < \mathrm{Ra})$:

$$\mathrm{Nu} = \{0.825 + (0.387\mathrm{Ra}^{1/6})/[1 + (0.492/\mathrm{Pr})^{9/16}]^{8/27}\}^2. \quad (21)$$

The overall top heat loss coefficient across the glass cover is:

$$U_t = h_{wind} + h_{rs}. \quad (22)$$

The solar radiation heat flux absorbed by the glass cover can be obtained:

$$S_1 = \alpha_1 H \quad (23)$$

As well as radiation flux absorbed by the absorbent black wall is obtained as follows:
The solar radiation heat flux absorbed by the absorber wall will be:

$$S_2 = \tau\alpha_2 H. \quad (24)$$

The overall heat transfer coefficient from the vertical wall to the room:

$$U_b = 1/(1/h_i + \Delta w/k_w). \quad (25)$$

Physical properties of air:
The physical properties of air are assumed to vary linearly with air temperature because of the low temperature range encountered. The following empirical relationships are proposed, based on tabulated data from handbooks for air properties between 300–350 K.
Dynamic viscosity:

$$\mu_f = [1.846 + 0.00472\,(T_f - 300)] \times 10^{-5}; \quad (26)$$

Air density:

$$\rho_f = 1.1614 - 0.00353\,(T_f - 300); \quad (27)$$

Thermal conductivity:

$$k_f = 0.0263 + 0.000074\,(T_f - 300); \quad (28)$$

The specific heat of air:

$$c_f = [1.007 + 0.00004\,(T_f - 300)] \times 10^3; \quad (29)$$

Volumetric coefficient of expansion:

$$\beta = 1/T_f. \quad (30)$$

The instantaneous efficiency of heat collection by the solar chimney:

$$\eta = \frac{\dot{m}c_f(T_{f,o} - T_{f,i})}{WLH} \times 100. \quad (31)$$

Future prospects and practical application of active solar chimney:
Active solar chimney is used mainly to generate electricity and three basic principles of that are: roof cover glass cover, duct and wind turbines which have traditionally been used. In Figure (6) is shown a simple active solar chimney which is made by combining the components in new method.

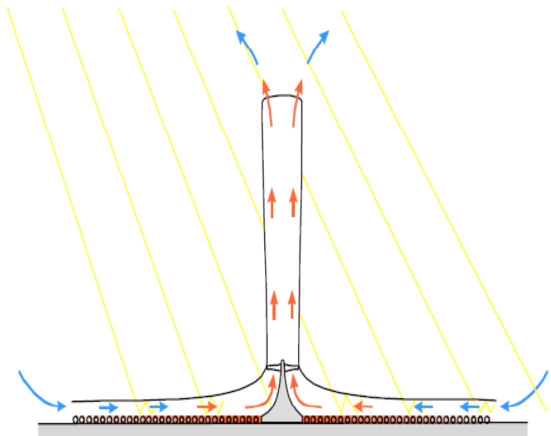


Fig.6. Active solar chimney

Fig (6) shows air heated by solar radiation under a glass short roof cover which is usually circular. Surrounding of cover glass is open and natural environment makes it a hot air collector. A 24-hour operation is guaranteed by put together water tubes on the ground, beneath the glass roof. Water heats during the day and emits during the night. The tubes are filled only once and do not require water. In the middle of glass roof there is a vertical channel with large air inlets on the base. The junction between the roof and the channel is isolated. Warm air rises in vertical channel because it is lighter than cold air. Suction of channel receives more hot air from the collector and cold air comes from surrounding into the collectors.
Solar radiation creates a constant suction from the lower part of the channel. The energy obtained in the lower part of channels by a wind turbine produce mechanical energy into electricity.
A solar chimney is designed to generate electricity for 24 hours continuously with a

large enough glass ceiling and high channel daily. So few proper solar chimney can be replaced by a large number of nuclear power plants. Solar chimneys are easily exploitable.

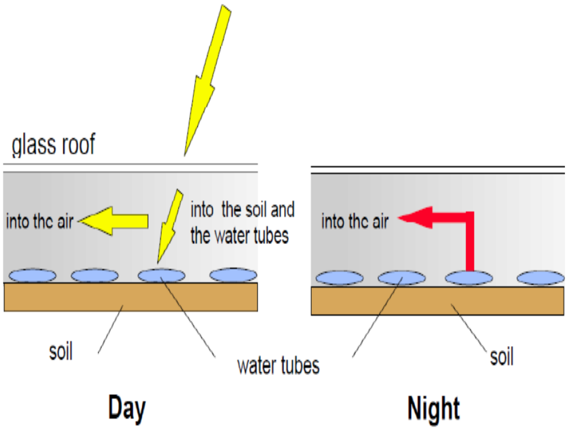


Fig.7.principle of storage underneath the roof using water-filled black tube

Main advantages of solar chimney:

- All solar collectors can be used in two ways: direct and indirect. It is economical for countries with so much radiation such as Iran.

- Thermal storage system for solar chimney can use pure energy of the sun for 24 hours. Water pipes which lied on the ground beneath the glass roof during the night release part of the solar radiation that received during the day to collectors. So the electricity that produced by the solar chimney during the night is as well as produced in day.

- Solar chimneys compared to the other solar generators, are reliable and would not be disabled. Only moving parts of these power plants are turbines, transmission and generator. The simple firm structure guarantees exploitation with minimal need for maintenance without burning fuel.

- The most advantage of this type of solar chimneys for sunny countries with lack of drinkable water is unlike usual power plants don’t need cooling water. Concrete and glass are necessary materials to build a solar chimney are that everywhere there is enough amount. In fact with energy of these solar chimney and stone and sand in the desert, more solar chimney could be built.

- Recently the solar chimneys could be constructed even in less-developed countries and in some countries there is almost as much as their needs. No huge investment is required for this type of advanced power plant. It is possible Even in poor countries to build a large solar power plant with using its own resources and labour, without spending huge finance. This will create lots of jobs and also reduce vital investment and cost of electricity generation.

- Solar chimneys can only collect a small part of energy of sun into electricity, so they have low efficiency, but they compensate the loss by their low cost of firm structure and maintenance. (Sana, 2013)

Solar- hydro power plant:

Solar chimneys are very similar to hydroelectric power plant in terms of technology. Roof of collector is equivalent of the water tank and vertical channel is equivalent of the water flow. Both power systems work with pressure-class turbines and both spend a little cost for power generation, because of long range of useful life and low maintenance costs. Roof of collectors and water tanks are comparable in size for the same electricity output but the roof of collectors could be built in deserts and is removable and useful without any problems.

Solar chimneys can work with dry air and without corrosion and cavitation even with polluted air or water tubes submerged in water. Hydroelectric power plants are going to replace with solar power plants soon and successfully. Electricity produced from solar chimney increases with global solar radiation, collector area and height of the chimney. Optimal dimensions can be calculated only by determining cost of special parts (collector, chimney, turbines) for any place. Construction dimensions of various projects vary from place to place but costs are always optimal.

For example, if the glass price is cheap and concrete expensive proportionally it will be larger collector with high ceilings and two layers of glass and short channel, and if the glass price is high and concrete is cheap proportionally it will be smaller collector, with a one layer glass and higher channel. (Saba, 2013)

Way to reduce air pollution in Tehran:

Inversion is one of the causes of air pollution in Tehran and other large cities. Inversion uses for abnormal condition of atmosphere temperature when the temperature drop is negative, it means temperature increases with height of the surface, instead of decrease. In this case, a layer of warm air covers cold air and because cold air is heavier, it can't raises so any pollution would be trapped. Inversion could occur at any temperature. Undoubtedly, nowadays electricity is one of the basic human needs and power plants can't be shut down just because of the adverse environmental impacts. But major efforts are to reduce or even eliminate the effects of pollution caused by power plants. Solar chimney can also be regarded as one of the solutions to generate electricity without pollution of thermal power plants, also it prevent the inversion. Solar chimneys don't make smoke and pollution because they don' consume fuel. In fact, just natural energy is used. When inversion occurs there is no solution other than closure some of the power plants that mentioned are the most important sources of pollution. Tehran faces atmospheric inversion more than two-thirds days of the year and this situation occurs more in autumn and winter. According to the statistics was taken over five years from Mehrabad station, the highest inversion height was 419 m in the autumn, 404 m in winter, 354 m in spring and 384 m in the summer. Basically, by using some average solar chimney in Tehran, power plants can be turned off without any concern when air is polluted. Ghale Morghi could be required land to provide a solar chimney that is large enough, adjacent to some main highways and can easily ventilate air of surrounding areas. In addition this system can be set up in parks and other open areas. Also as a collector, mountainside can be used and chimney can be on the outer side of mountain which has appropriate temperature gradient. Another solution is establishment of this technology in high-rise buildings. (Sadeghian et al, 2010).

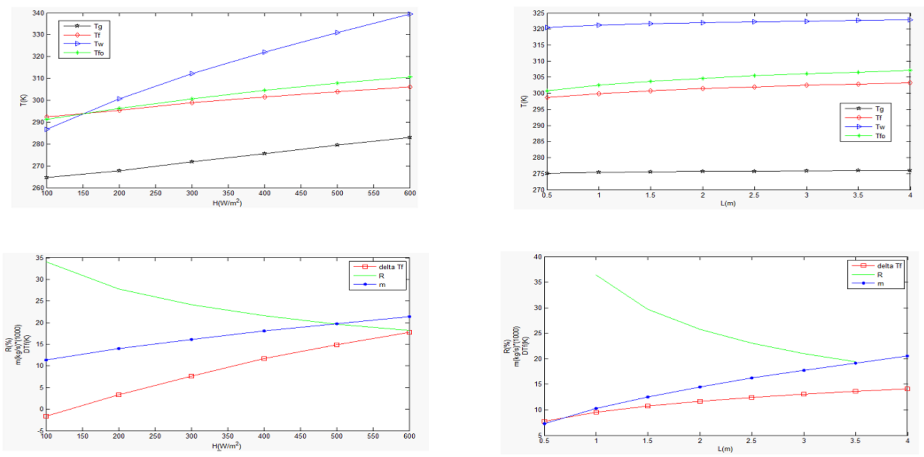
CONCLUSION:

For this type of solar chimney with given conditions MATLAB is used and important parameters is shown in graphs. Typical performance results of wall, glass and air temperatures, air mass flow rate and instantaneous efficiency at a solar radiation intensity of 400 $\mathrm{W\ m^{-2}}$ for walls up to 4m long are shown in graphs. As expected, temperatures increase as wall length increases. It shows that wall temperature is always higher than either glass surface or mean air flow temperature. The glass surface temperature is lower than mean air temperature at the radiation level of 400 $\mathrm{W\ m^{-2}}$. The instantaneous efficiency however is seen to decrease because higher operating temperatures result in lower efficiencies. Glass temperature is lower than the mean and also the outlet air temperature. The temperature distribution pattern across the gap width is thus not uniform and dependent upon solar radiation for a fixed wall length. The air temperature and mass flow rate all increase with solar radiation. Efficiency η or (R) has an inverse relationship, efficiency reduces when H increases for the constant (L) that considered as average value (L = 2 m). Efficiency η or (R) reduces with increasing the length L for average value of H=400. The present simulation for a 2m wall with an air gap and 0.145m with a solar radiation intensity of about 400 $\mathrm{W\ m^{-2}}$ showed temperatures of 49°C for wall, 33°C for air outlet, 28°C for mean air temperature and air mass flow rate around 0.016kg.s-^{1}. The discrepancies are attributed to the different physical values and ambient conditions assumed in the two studies conducted.

Table.2

dimension (SI)	parameter
W/m^2k^4	$\sigma = 5.67 \times 10^{-8}$
m/s^2	$g = 9.81$
$°C$	$T_a = 8$
$°C$	$T_r = 20$
m/s	$V_{wind} = 1$
W/m^2	$H = 100,200,300,400,500,600$
m	$L_w = 0.5,1.0,1.5,2.0,2.5,3.0,3.5,4.0$
cm	$D_w = 22$
m^2	$A_i = A_o = 0.025$
cm	$d = 14.5$
$W/m^2.°C$	$h_i = 10$
$W/m^2.°C$	$k_w = 0.0275$
	$C_d = 0.6$
	$\alpha_g = 0.06$
	$\varepsilon_g = 0.90$
	$\alpha_w = 0.95$
	$\varepsilon_w = 0.94$
	$\tau_g = 0.84$

Fig.8



REFERENCES

1. Andersen.KT, 1995. Theoretical considerations on natural ventilation by thermal buoyancy. Trans. ASHRAE,1995;101(2):1103–17.
2. Flourentzou. F, Van der Maas. J, Roulet C-A,1998. Natural ventilation for passive cooling: measurement of discharge coefficients. Energy and Buildings; 1998;27:283–92.
3. Hirunlabh .J, Kongduang. W, Namprakai .P, Khedari .J, 1999. Study of natural ventilation of houses by a metallic solar wall under tropical climate. Renewable Energy ;1999;18:109–19.
4. Incropera. FP, DeWitt. DP, 1996. Fundamentals of Heat and Mass Transfer. 4th ed. John Wiley, 1996.
5. K.S.Ong, 2002. A mathematical model of a solar chimney,Monash University Malaysia.
6. Ravanshadnia, M, Ghanbari Motlagh, M ,2015, Green BIM,SUSTAINABLE Design with building information modeling, authoring: Krygiel, Eddy, Nice, Brad,c 2008; Publishing sima ye danesh.
7. S.A.B .A. the energy balance of the energy efficiency Iran ,2013, the parent company specialized, Executive Vice Ministry of Energy, to address access www.saba.org, Tehran, Iran.
8. S.A.B.M.S.A, Iranian Fuel Conservation Organization, 2014, Research and Technology, National Iranian Oil Company, Oil Ministry, with an address access www.ifco.ir.

9. S.A.N.A, 2013, Renewable Energy Organization of Iran, the parent company specialized in the management of production, transmission and distribution of electricity (tavanir), executive vice president, Tehran.
10. Safarzadeh, H., Bahador, M., 2005, to evaluate the thermal performance yards, finishing a PhD in Mechanical Engineering Major Energy Conversion, Sharif University of Technology, November 2004, Tehran.
11. sadeghian, M, Mostafaei, A., farahmand, MR, 2010, solar chimneys strategy to reduce air pollution in Tehran, Twenty-Fifth International Conference on Electricity, Tehran.
12. Swinbank .WC, 1963. Long-wave radiation from clear skies. Q. J. R. Meteoro. Soc. 1963;89:339.