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A REVIEW ON DIFFERENT APPLICATIONS OF SOLAR CHIMNEY

Arvind Gwatiya[1], Rajneesh Kumar Gedam[2]

PG Scholar[1], Associate Professor[2]

Department of Mechanical Engineering, RKDF College of Engineering, Bhopal

Abstract: Most recent couple of decades the vitality interest is ascending for space warming and cooling, in private and business building distinctive sorts of hardware, techniques, trial setup are utilized to lessen vitality request and for diminishing utilization of vitality numerous sorts of renewable wellsprings of vitality are likewise used to decrease vitality request and spare environment by various sorts of poison. Most normal renewable wellsprings of vitality is sunlight based vitality which is utilized as a part of this exploratory as Solar Chimney. In this proposal we utilize solar chimney for Natural Room Ventilation framework amid summer season. Solar Chimney is utilized for its incorporated Design, Low cost of upkeep, Easy to utilize. This is recipient for carbon dioxide outflow necessity of vitality and interest of vitality, starting expense of operation. In this paper we discuss about different solar chimney application in previous years.

Keywords: Solar Chimney, Temperature Variation, Natural Room Ventilation, Atmospheric Temperature, Solar Panel, Thermo Couple.

I. INTRODUCTION

The types of gear, materials or human movement expand the toxin focus inside the building, which influences to the indoor air quality. Toxin focus can influence human well being and efficiency, which makes essential their evacuation. Generally the ventilation replaces the indoor air for open air, which has better quality. The distinctive methods of advancing air trade are mechanical ventilation, which permits controlling the stream rate all the occasion, their quality and temperature; and characteristic ventilation, which has less upkeep, makes less commotion and does not utilize electric vitality to move the air.

The solar chimney is a framework that uses the sun oriented radiation to move the air, enhancing the normal ventilation and now and again giving outside air to the building. Numerous works were completed the most recent two decades showing the upsides of solar chimney, for instance the distinction of a customary stack and a solar chimney [1], the temperature effect of a sun oriented stack [2] or their advantage in mixture ventilation frameworks [3]. Different works center in the configuration of the sun based stack as the stature, width or point of tilt, utilizing as a part of the greater part of the cases CFD devices to complete the reproductions or examinations and advancements physical and numerical models for a solar chimney [1, 4-7]. Likewise different works focuses in the investigation of a working with a sunlight based stack and other ventilation frameworks as a cooling hole [8], Trombe dividers [9] or heat recuperation [4]. All these studies demonstrates the suitability of the this framework and these days one can see that new structures begin to introduce solar chimneys, similar to the Tånga School in Falkenberg Sweden [10].

1.1.FLUID DYNAMICS

The Navier-Stokes equations describe the motion of a fluid substance:

- Continuity

$$\frac{\partial \rho}{\partial t} + \nabla(\rho \bar{u}) = 0$$

- Momentum

$$\rho\frac{\partial\vec{u}}{\partial t}+\rho\vec{u}\nabla(\vec{u})=-\nabla p+\frac{\mu}{\rho}\nabla^2\vec{u}+\rho\bar{f}_m$$

- Energy

$$\rho\frac{\partial c_p T}{\partial t}+\rho\vec{u}\nabla(c_p T)=-p\nabla\vec{u}+\bar{\tau}:\nabla\vec{u}+\nabla(k\nabla T)$$

These equations do not have an analytic solution; therefore usually it used simplification of these ones to achieve an approximate solution. The dimensionless number is used to carry out these simplifications, as the Reynolds number or the Rayleigh number.

The Reynolds number gives a measure of the ratio of inertial forces to viscous forces and consequently quantifies the relative importance of these two types of forces for given flow conditions.

$$Re=\frac{\rho UD}{\mu}$$

When this number is high (Re>>1) the viscous forces can be neglected. Also when Re<2300 in ducts a laminar flow occurs and for Re>4000 the flow is turbulent.

The Rayleigh measures the importance of buoyancy driven flow). When the Rayleigh number is below the critical value for that fluid, heat transfer is primarily in the form of conduction; when it exceeds the critical value, heat transfer is primarily in the form of convection.

$$Ra=\frac{g\beta\Delta T c_p \rho^2 L^3}{\mu k}$$

Besides, in a pure natural convection the Rayleigh number measures the strength of the buoyancy-induced flow. When $R_a<10^8$ indicates an induced laminar flow and a transition to turbulent flow among $10^8<R_a<10^{10}$.

1.1.1. BERNOULLI EQUATION

The Bernoulli equation is the result of thee simplification of the Navier-Stokes equations assuming and in viscid fluid (Re>>1).

$$\frac{1}{2}\rho v^2+P_s=cte=P_t$$

This means, if the velocity increases, the static pressure has to decrease.

This equation can be completed summing the effects of gravity and a turbo machine.

$$\frac{1}{2}\rho v^2+P_s+\rho gh+\Delta P_{fan}=P_t$$

1.2.CHIMNEY

A chimney is device usually used to remove the hot flue gas or smoke to the atmosphere. It uses the stack effect to induce the movement. In buildings, the chimney also is used in natural ventilation, taking advantage of the differences of temperature between in-outside the building.

Expressed questions for chimney effect:

$$\rho gH\frac{\Delta T}{T_i}=\frac{1}{2}\rho v^2\sum K_{drop}$$

$$v=\sqrt{\frac{2gH\frac{\Delta T}{T_i}}{\sum K_{drop}}}\rightarrow Cd=\frac{1}{\sqrt{\sum K_{drop}}}$$

$$q=Cd\cdot A\sqrt{2gH\frac{T_i-T_e}{T_i}}$$

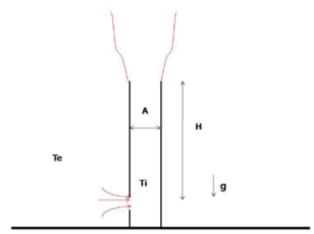

Figure 1: Chimney effect

1.2.1. SOLAR CHIMNEY

Solar chimneys disagree from typical chimneys in this their southern wall (for the north hemisphere) is replaced by a clear sheet, i.e. glazing, that permits the gathering and use of star irradiation. Many works, particularly the last twenty years, have illustrated the benefits in victimization star chimneys accounting additionally for his or her low maintenance value and excellent sturdiness. Solar chimneys are historically utilized in agriculture for air renewal in barns, silos, greenhouses, etc. likewise as in drying of crops, grains, fruits or wood.

Another well-liked application is for natural ventilation in buildings so as to boost the standard of inside air and increase the comfort index for inhabitants.

Having in mind climatization and energy conservation in buildings, efforts have additionally been created to gauge the performance of special chimney configurations, like star roof collectors and Trombe walls likewise as different hybrid constructions involving inclined, vertical or horizontal heated walls with cooling cavities.

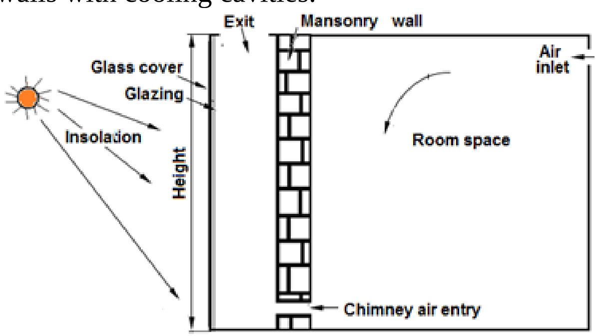

Figure 2: Solar Chimney

II. LITERATURE REVIEW

A few researchers have concentrated on the diverse parameters that influence the execution of solar chimney (SC).

Computational Fluid Dynamics (CFD) examination done by Chung et al. [3] indicates ideal estimations of parameters which influences execution of SC. Specialist found that ideal air width hole ranges from 0.6m to 1.0m, length of stack shifts from 1.5m to 2m and instigated velocity from .04m/s to 0.22m/s. Past exploratory study demonstrates that Ventilation rate increments by 24% and it additionally demonstrates that at air hole 10cm when the edge increments from 15 to 45° [4].

Alzaed et al. [5] appears by trial think about that air hole 5cm accomplishes better ventilation contrasted and 10cm air crevice.

Tongbai et al. appears by CFD model that at 6° channel extension, stream ventilation increments by 90% [4]. Sunlight based stack gives better cooling execution when incorporated with evaporative cooling hole which keeps up the air temperature of 27.31°C to 31.1°C and ideal evaporative cooling pit length discovered 2m [6].

Mahdavinejad et al. [8] foresee by recreation that at 45° tilt point takes after most elevated wind stream in sunlight based fireplace.

Amori et al. [23] stablish CFD investigation and demonstrates that sun based fireplace with safeguard at center of air crevices has the best warm execution. Air temperature changes directly with the sun oriented irradiance.

Hassanein et al. [9] demonstrates bye tentatively a few smokestack builds wind current rate to 13 to 33%.

Bansal et al. [10] stablish scientific condition and found that 2.25m2 range of sun powered gatherer could produce wind stream rate between 140 to 330m3/hr at hot and dry condition. Sun oriented fireplace gives most extreme execution at greatest irradiance 604W/m2 [11].

Tyagi et al. appears by tentatively that allegorical sun oriented authority improves the framework effectiveness as option vitality [12, 13]. Coating and safeguard temperature increments as the edge of slant of sun powered smokestack diminishes from 90 to 30° and stream rate of air achieves most extreme for point of slant 60° to 70° [14]. Performance investigation of sun powered fireplace appears by tentatively that electrical utilization of an AC lessens by 10 to 20% [15].

Table 2.1: Comparative study

S. No.	Name of the author	Title	Year	Methodology	Parameter Studied	Conclusion	Climate Condition
1	Chung	Effective solar chimney cross section ventilation performance in Malaysia terraced house	2014	Solar chimney optimization carried out by CFD.	1.Air width gap 2. Chimney Length 3. Air Velocity	1.Optimum dimension gap ranges from 0.6m to 1.0m 2. Length from 1.5 to 2m 3. induced air speed from .04m/s to 0.223m/s	Tropical climate with high temp. and humidity
2	Alzaed et	Experimental	2014	Experimentall	Air Gap	Air gap 5cm achieves	Hot and dry

	al.	study of solar chimney for ventilation in hot arid region		y studied		higher ventilation compared with 10cm air gap.	condition
3	Ahmad et al.	Modeling and simulation of natural ventilation of building using solar chimney	2014	CFD software	1.Air width gap 2.Chimney Height	1. Optimum gap dimension is zero.4m. 2. Height 2m in majority of cases for various angles except ninety deg.	Hot and dry condition
4	Tongbai et al.	Enhancement of roof solar chimney performance for building ventilation	2014	Study using CFD model	1. Angle of channel expansion 2. Air gap 3. Angle of Inclination 4. Height of Chimney	1. At 6°channel growth rate of flow will increase by pure gold. 2. Air rate of flow will increase up to 250% once air gap augmented from 10 to 60 cm. 3. At air gap 10 cm once the angle will increase from 15 to 45 deg . The ventilation will increase by 90th. 4. rate of flow will increase as height of the vertical	Tropical climate with high temp. and humidity
5	Tan et al.	Parameterization studies of solar chimneys in the tropics	2013	Experimental Study	1. Stack Height 2. Chimney Depth 3. Chimney width	1. Stack height will increase the solar chimney outlet air temperature, 2.Optimum solar chimney depth is 0.05 m, 3. Outlet air temperature decreases with increase breadth.	Tropical climate with high temp. and humidity
6	Mahdavin ejad et al.	The study on optimum tilt angle in solar chimney as a mechanical eco concept	2013	Simulation based study	Tilt Angle	45 degree tilt angle follow highest air flow.	Hot and dry condition
7	Amori et al.	Numerical study of solar chimney with absorber at different location	2013	CFD Analysis	Different position of absorber	1. Solar chimney with absorbent at middle of air gaps shows optimum performance. 2. The best thermal potency with absorbent at the rear facet throughout day hour.	Hot and dry condition

8	Kamal et al.	An overview of passive cooling techniques in buildings: Design concepts and architectural intervensions	2012	Theoretical study	Methods of passive cooling studied	Studies shows the different methods of passive cooling system which reduces the cooling load in buildings.	Different climate condition
9	Hassanein et al	Improvement of natural ventilation in building using multi solar chimneys at different direction	2012	Experimental work	Effect of no of chimney	Using two to three chimney increases air flow rate to 13 to 33%.	Tropical climate with high temp. and humidity
10	Mehani et al.	Passive cooling of building by using solar chimney	2012	Study solar chimney by CFD	Air gap width	Optimum air gap width was 0.2 to 0.3m for maximum ventilation.	Tropical climate with high temp. and humidity
11	Bansal et al.	Solar chimney for enhanced stack ventilation	2010	Mathematical model	Size of opening of solar chimney with varying discharge coefficient.	2.25 m^2 area of solar collector was able to generate air flow rate between 140 to 330 m^3/hr at hot and dry condition	Hot and dry
12	Bassiouny et al.	Effect of solar chimney inclination angle on space flow pattern and ventilation rate	2009	Numerical simulation using ansys	Inclination angle	Maximum air flow rate achieved for chimney inclination angle between 45°C to 70°C	Tropical climate with high temp. and humidity
13	Arce et al.	Experimental study for ventilation on a solar chimney.	2009	Experimental 46study	Performance of solar chimney	Maximum irradiance 604W/m^2 and maximum air temperature increment was 7°C in SC.	Tropical climate with high temp. and humidity
14	Bassiouny et al.	an analytical and numerical study of solar chimney use for room natural ventilation	2008	Experimental study	Effect of chimney width	ACH increases by 25% while increase chimney width 0.1 to 0.3mm	Tropical climate with high temp. and humidity
15	Sakonidou et al.	Modeling of the optimum tilt of a solar chimney for maximum air flow	2008	Simulation modeling	Inclination of chimney	1. Glazing and absorbent temperature s will increase once inclination angle of SC decreases from 90 to 30°C. 2. Air speed reaches most wo rth for inclination vary of 60 to 70°C.	Hot and dry
16	Harris et al.	Solar chimney and building	2007	CFD analysis	Effect of inclination	Maximum flow rate found at inclination angle	Hot and dry

		ventilation			angle	67.5°C.	
17	Chungloo et al.	Application of passive cooling system in the hot and humid climate	2007	Experimental study	Compare the result of solar chimney with water spray.	The room temporary worker 1-3.5 degree lower that region and 1 to 1.3 degree below controlled cell.	Tropical climate with high temp. and humidity
18	Mathur et al	Performance of inclined solar roof chimney for natural ventilation	2006	Experimental study	Inclination of absorber	Absorber inclination varies 40 to 60°C gives optimum result and maximum flow rate found at 45° at noon time.	Hot and dry
19	Mathur et al	Experimental investigation on solar chimney for room ventilation	2006	Experimental investigation	Effect of ratio between height of absorber and air gap.	Study shows the optimum result at 10/1.	High temp. and humidity
20	Liping et al.	A numerical study of trombe wall for enhancing stack ventilation in building	2006	Experimental investigation	1. Mass flow rate, 2. Temperature field and velocity field for tromb wall system.	1.Mass rate is plagued by radiation. 2. There's AN optimum qu antitative relation of air gap breadth and chimney height is 1/10 to obtained most ventilation.	High temp. and humidity

III. CONCLUSION

On account of developing interest of vitality and expanding expense of electrical vitality, it is required to decrease crest load also spare vitality. Sun based smokestack and earth air funnel heat exchanger are the new way to deal with decrease the cooling load by method for detached ventilation and cooling which requires low vitality to run the framework. It was found that coordinated framework alongside EAPHE gives more tasteful results. On the off chance that sunlight based fireplace can be utilized for ideal result, it decreases the electrical utilization by 10-20%. Sun oriented fireplace can be utilized around evening time by introducing turning turbine at the outlet of sunlight based stack to charge the battery. Execution of coordinated SC-ECC framework can be improved by expanding the vanishing rate of water and that can be accomplished by including a few added substances. It was found that EAPHE is the usually utilized techniques for cooling of warming purposes. Writing audit demonstrates that temperature drop up to 12.6°C can be accomplished and vitality utilization gets decreased by 18% when combined with air cooled condenser of 1.5TR window AC. EAPHE outlet can be specifically interface with the AC suction to diminish the cooling load. Proposed future work has been distinguished where exploration is missing as specified underneath:

- Use of CFD model to anticipate the external temperature in winter of EAPHE framework under precarious condition might be concentrated on.
- Geothermal vitality and warm properties of soil might be learned at various area.
- Theoretical model ought to be created to anticipate the temperature of soil and impact of dampness substance in the dirt.
- Humidity control system ought to be consolidated for winter and summer season.
- Work ought to be done to build the warmth exchange rate of covered funnel to expand the cooling impact.

- Mathematical model ought to be created to anticipate no of covered channel required for the sought impact.
- Effect of thickness of air and dampness on cooling impact and warmth exchange rate ought to be considered.
- Counter stream funnel should be utilized for EAPHE to improve the execution.

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