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Trombe Wall and Its Application for Disinfection of Indoor Air

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ABSTRACT

Fossil energy is an essential component of daily life. Solar energy plays an important role for numerous people in different walks of life. Solar energy can be used in remote and undeveloped areas to meet the requirements of schools, clinics and other buildings. Building accounts for 33% of the world's total greenhouse-gas emissions, green buildings and sustainable architecture are new techniques for addressing the environmental and energy crises. Trombe wall are regarded as a sustainable architecture for heating and ventilation. In this study south wall of the two rooms, located on the building"s second floor of the industry and renewable resources research center in Bojnoord has become a Trombe wall. Treatments included the time of radiation, power of the lamps and air flow. Time of exposure to the ultraviolet lamp was turned on and off for half an hour alternatively. The parabolic mirror has three lamps in the focus with the power of 40 watt per lamp and airflow through a fan. In this conditions total count of molds and yeasts of the rooms were examined to determine the effect of disinfection by-hybrid system. The results show that when the ultraviolet light is on, it has a great impact on the removal of microorganisms in the room.
KEY WORDS: trombe wall configuration, trombe wall efficiency, ultraviolet disinfection.

1. INTRODUCTION

Fossil energy is an essential component of daily life (1), whose environmental impact and, fast increasing price and sharp depletion of this natural resources generated interest in renewable energy sources, such as the sun, wind, biomass, waves, and rain. (2, 3, 4). Solar energy plays an important role for numerous people in different walks of life. Solar energy can be used in remote and undeveloped areas to meet the requirements of schools, clinics and other buildings (5). Building accounts for 33% of the world's total greenhouse-gas emissions (6). In the building industry, the significance of solar energy is more obvious when the role of architecture, the use of renewable energy, and climatic design are taken into account. These factors are the main guidelines for energy conservation in the building sector (7, 8).

Passive solar techniques can reduce annual heating demand up to 25% (9). Various architectural devices, such as solar chimneys, solar roofs, Trombe walls, etc. , are used in construction. These devices diminish environmental degradation and reduce green house gas emissions (10, 11). Trombe walls, which are also known as storage walls and solar heating walls (SHW), reduce a building's energy consumption up to 30% (12). A Trombe wall is an important green architectural feature that aides the ventilation, heating, and surprisingly, cooling of buildings (13).

This study investigated the performance of Trombe wall and its application in sterilization and energy saving of the buildings.

Configuration of trombe wall

The idea that underlies Trombe walls is using solar energy to heat, ventilate and provide thermal comfort in buildings in various climatic regions (14). Different configurations are used to adapt Trombe walls to various climates, purposes and seasons such as a zigzag Trombe wall; a solar water wall, a solar trans wall, a solar hybrid wall, a composite Trombe wall and ... (13).

A classic Trombe wall is a simple Trombe wall in which glass and an air space separate the wall from the outdoor environment the inventor of this type of Trombe wall was Edward Morse, an American engineer who patented his design in 1881. However, the classic Trombe wall has been popularized by Felix Trombe and French. Therefore, this wall is known as a Trombewall (15, 16).

Some Iranian scientists believe that the idea of Trombe walls is the same as that of the gangway in the vernacular architecture of the Persian Gulf. This gangway is a corridor that separates the main entry of the rooms

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from the main hall and has windows on the sides. The Trombe wall absorbs solar energy and releases it to provide thermal comfort. For optimal performance, this wall is usually positioned facing south (see Fig1.A).

The design of a classic Trombe wall is based on using materials with high heat storage capacity. These materials include bricks, concrete, stone and adobe. The external surface of the wall is coloured black to increase the absorption rate Moreover; the surface of the Trombe wall is glazed. An air gap is left between the glass and wall (17, 18) (Fig 1.B) Depending on the application, the materials used and the construction tere are various types of Trombe wall as it can be seen in (Fig2)

Fig 1.A: A gangway with windows in its sides resembles a solar wall

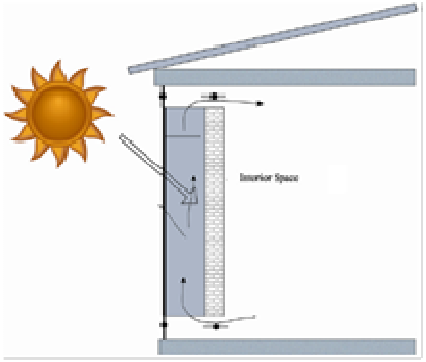
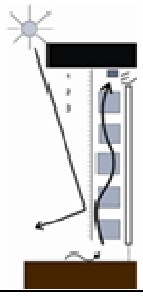
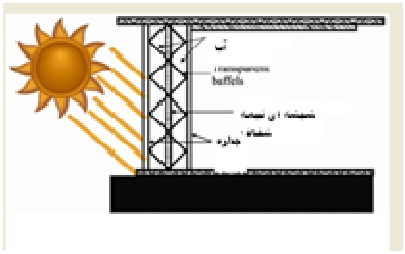
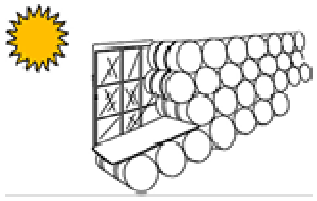
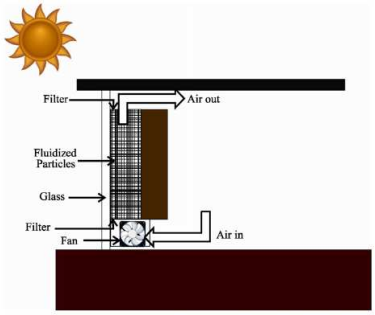
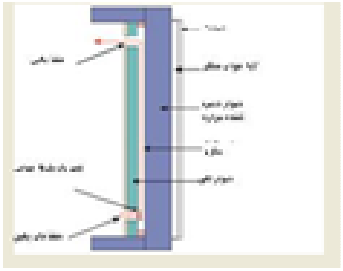
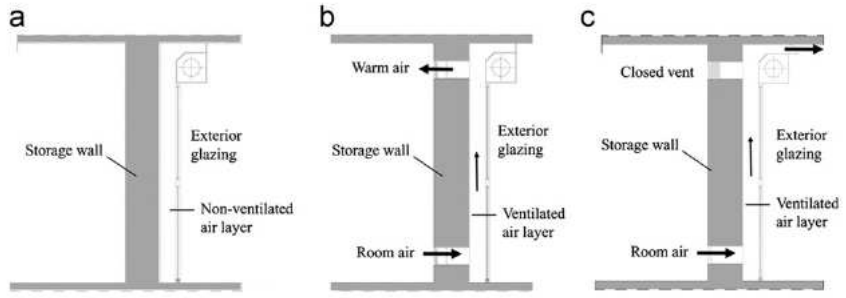


Fig 1.B: A simple diagram of trombe wall

solar ceramic evaporative cooling wall 	A trans wall 
A sketch of water wall 	zigzag solar wall 
Different parts of fluidised wall 	A composite solar wall 

Various configurationsofasolarwall:(a)withoutventilation;(b)wintermodewithairthermo-circulation;(c)summermodewithcrossventilation



Day and night application in trombe wall

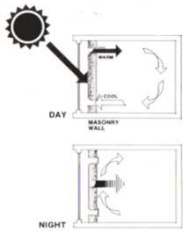


Fig2: Types of trombe wall

2. Methods:

2.1: wall construction method:

South wall of the two rooms, located on the building"s second floor of the industry and renewable resources research Center in bojnoord has become a Trombe wall, material used was the brick and the wall thickness was 25 Cm, a cube-shaped steel structure constructed in a way that South, East and West walls of the cube formed a transparent network such as a window. North side of the cube was an empty frame and a few metal parts were used in order to reach a uniform structure and continuous attachment to the south wall. Although transparent window network with the dimension of 9*3 meter and the eastern and western forms of 60cm in 3meter covered with metal mesh: 4cm*3cm to avoid scathes by throwing stones and other factors. In each of the bottom and top of the transparent frame inserted two valves with the dimension of one meter in 60 centimeters; these valves will be closed in winter and open in summer. In the brick walls of the room's two valves in sizes of 30 cm in 1 meter at a distance of twenty centimeter from the floor and ceiling have been created. The dimensions of these valves are designed for fast moving of air between the chamber and the south wall with thermal siphon. Fig 3 A and B shows the test rooms and transparent cover trombe.

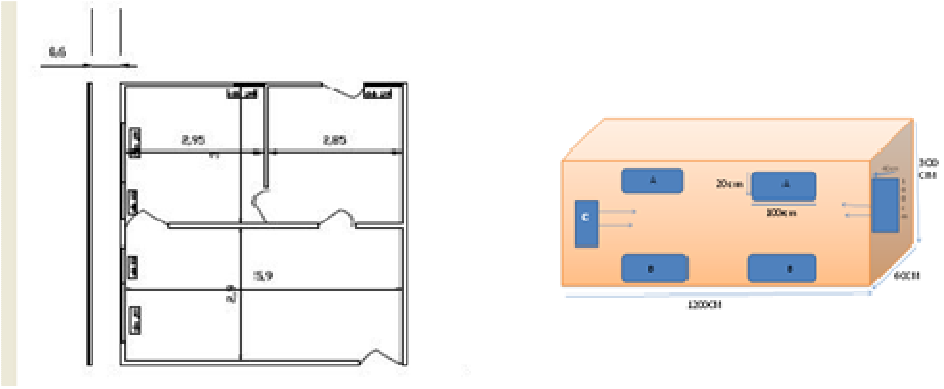


Fig 3 A: Air inlet and exit dimension in trombe wall B: location of Ultraviolet lights and valves in trombe wall
A: inlet air valves from the air chamber to trombe wall B: exit air valves from the trombe wall to air chamber
C: Location of parabolic mirrors on the east and west sides of the air chamber of Trombe wall

Mercury pen light bulbs are located in the focus of parabolic mirrors. Mirrors in the East and West of trombe wall located in a way that ultraviolet radiation from the mirror parallel to the main axis and parallel to the Trombe wall light. Indoor air that enter from the bottom valves of trombe wall after passing through the filter into the path of ultraviolet radiation re-enter the room. In this way ultraviolet radiation caused air disinfection and separation of particles.

Exposure time was evaluated by the following equation:

$$T=X/V$$

In which X is: long of light bulbs in the parabolic mirrors and V is Velocity of air entering or exiting the building, which is measured by a tachometer air.

2.2: microbial Assesment:

Pour plate method was use for microbial testing and the way is as follow: Sixteen plates were placed at different locations in 3 rooms. Plate doors are left open for 15 minutes, then sterile casein-peptone glucose yeast extract agar chilled and poured into the plates. The plates were incubated at 30 ° C for 72 hour. And colony counts were performed to check the total count of rooms, in order to count molds and yeast population of the rooms yeast extract glucose chloramphenicol agar medium was used.

3: RESULTS

Fig4: appearance of the trombe wall

3.1:Figure 4 shows the appearance of the trombe wall in the second floor of the building.

3.2: Microbial analysis:

Fig5 shows the diagrams in the period of one week test, the weather condition at the time of the test was cloudy, a fan discharge an air flow of 400 m^3 per hour from the upper valve of trombe wall. The lamp was turned off and on alternatively every 30 minute. There was a 3 lamp with 4 watt power per lamp in the focus of parabolic mirrors temperature and relative humidity of the rooms was as follow;

Room No1: inside: 21 trombe wall air Layer: 29.4 relative humidity: 20% room No2: inside: 26.36 trombe wall air layer: 29.4, RH: 20.66% room No3: inside: 25.56 out door: 5.43 RH: 39.66%

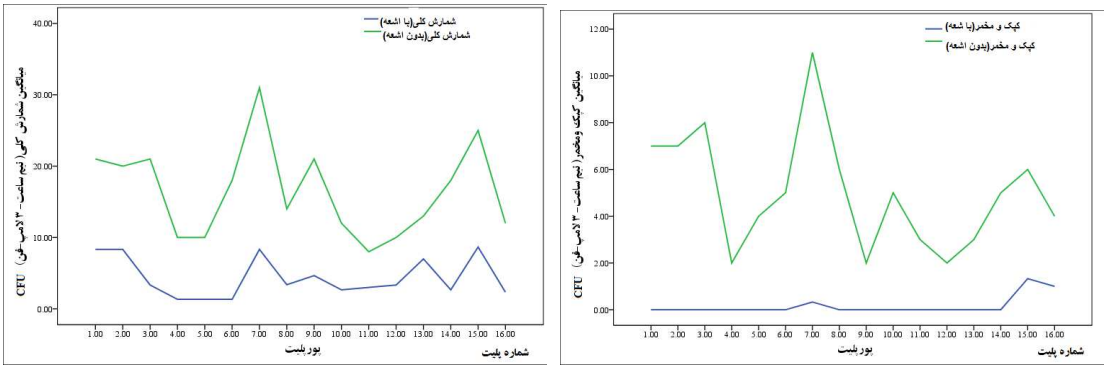


Fig 5: diagrams of microbial analysis

4: DISCUSSION

If the direction of the air passing through trombe wall, we can be ensure that the risk of entry of microorganism will be minimized due to disinfection of all air by passing through filter before entering to the residential area.

Using hybrid system of tromb wall and UV lights is a good way for disinfection and ventilation of the air, because in addition of energy saving this system is safe for building occupants due to the location of ultraviolet light in a separate place. In winter the temperature was measured, it was observed that the temperature of the air in Trombe wall is greater than room temperature, which proves that the Trombe wall is suitable for heating the room in winter.

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REFRENCES

1. Teschner Na, McDonald A, Foxon TJ, Paavola J. Integrated transitions toward sustainability: the case of water and energypolicies in Israel. Technological forecasting andSocial Change 2011; 79:457–68
2. 2-Ruud W. Weighted Average cost of Retail Gas (WACORG) highlight spricin effects in the US gas valuechain: doweneed well head price-floor regulation to bailout the unconventional gas industry? Energy Policy 2011; 39:6291–300.
3. Karakosta C, Doukas H, and JohnP.EU-MEN an energy technology transfers under the CDM: Israel as a front runner, EnergyPolicy2010; 38:2455–62.
4. Saadatian O, Haw LC, Sopian K, Sulaiman MY. Review of wind catcher technologies. Renewable and Sustainable Energy Reviews2012; 16:1477–95.
5. Krivtsov V, Linfoot B. Disruption to benthic habitats by moorings of wave energy installations: a modelling case study a dimplications for overall ecosystem functioning. Ecological Modeling. 2012
6. Wan KKW, Li DHW, Liu D, Lam JC. Future trends of building heating and cooling loads and energy consumption in different climates. Building and Environment 2011; 46:223–34
7. Li DHW, Yang L, Lam JC. Impact of climate change on energy use in the built environment in different climate zone sareview.Energy.2012.
8. Misra M. The elements of architecture: principles of environmental perfor- mance in buildings. International Journal of Environmental Studies 2011; 68:234–6.
9. Liu YW, Feng W .Integrating passive cooling and solar techniques in to the existing building in South China. Advanced Materials Research 2012; 368-373:3717–20
10. Zamora B, Kaiser A. Influence of the variable thermophysical propertieson the turbulent buoyancy-driven air flow inside open square cavities. Heat and Mass Transfer 2012; 48:35–53.
11. Chan H-Y, Riffat SB, Zhu J. Review of passive solar heating and cooling technologies. Renewable and Sustainable Energy Reviews2010; 14:781–9.
12. Hordeski MF. New technologies for energy efficiency NewYork.TheFair-mont Press; 2011
13. Omidreza Saadatian n, K. Sopian, C.H. Lim, Nilofar Asim, M.Y. Sulaiman, Trombe walls: A review of opportunities and challenges in research and development
14. Llovera J, Potau X, Medrano M, Cabeza LF. Design and performance of energy-efficient solar residential house in Andorra. Applied Energy 2011; 88:1343–53.
15. Agrawa lB, Tiwari GN. Building integrated photovoltaic thermal systems: for sustainable developments. Delhi: Royal Society of Chemistry; 2011
16. Birkeland J. Positive development: from vicious circle stovirtuous cycles through built environment design. Earthscan; 2008.
17. ThumannA, Mehta DP. Handbook of energy engineering. Fairmont Press; 2008.
18. AgrawalB, Tiwari GN. Building integrated photovoltaic thermal systems: for sustainable developments .Royal Society of Chemistry2010