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CONSTRUCTION AND PERFORMANCE TEST OF A SOLAR POWERED ATTIC VENTILATION SYSTEM

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Abstract*- Bangladesh especially the southern territory is in the climatic region of tropical rainforest and is in hot and humid throughout the month of February to September. It is a very challenging matter to obtain a cooling system that is available in market with low value of economic cost. Hence the auxiliary or passive system are employed extensively. To reduce the small room like attic space temperature cooling cost, solar powered attic ventilation fan plays a vital role. An ordinary ventilation fan available in market required a strong wind to operate it. So whenever wind is slow this fan is also slow. For overcoming this type of obstacle in slow wind area, in this project solar fan utilize the abundant sun energy to reduce upward air flow due to buoyancy forces and hopefully to resolve the hot attic space issue. For intake low temperature of fresh air a new technique is employed which is accomplished by placing the water reservoir beside the attic room. This water reservoir also acts as a heat exchanger. In this project the effect of this heat exchanger shows the decrease of the temperature by 2.5-3 degrees in Celsius of the attic space. This ventilation system that proposed is a passive and it requires low economic value of cost, minimum maintenance, and obviously decrease the usage of air conditioner and save the environment.*

Keywords: Solar Panel, Exhaust fan, Attic space, Water reservoir

1. INTRODUCTION

It is the common interest of people to reduce the temperature of attic space or top floor space. Subsequently they are trying to reduce the cooling cost. Generally attic spaces are ventilated by exhaust fan. These fan has some basic principle. Prominent one is that to create partial vacuum within the space as they expel air outside. Due to the vacuum fresh air to be drawn into the space. The difference between inside and outside pressure of the space is static pressure. It is the measure of the resistance that fans must overcome to move air through the space and circulate as well. Sometimes outdoor air enters and leaves in association of infiltration, natural ventilation. The movement of air is associated with infiltration and natural ventilation is generally caused due to the temperature difference between indoors and outdoors. In mechanical ventilation air moves through ventilator with an exhaust fan. Thus it is obvious that typical exhaust fan will stop to operate at slow wind blowing area. The rate of replacing the indoor air to outdoor air is increased. And attic space temperature is increased.

The region of slow wind blowing and arid climates excessive heat generation in buildings is a big problem. Reduction of cooling cost is then requirements of building occupants. Several passive cooling method uses insulator over the roof of building [1]. These are helpful to maintain the little space temperature within a certain limit. But for a large building these are not capable of completely. In many studies and experiments, 50% of the roof heat gain is the total heat gain of the building. For this reason various types of investigation were performed too and gave some novel roof pond configuration [2]. Most of these cooling systems do not bring the fresh air into the occupied space and attic space as well. This is because of either the nature or the system itself that does not really make perfectly. In general a mechanical ventilation system remove pollutants and hot air that generated in the attic space and provide outdoor air in a controlled manner.

Solar power attic ventilation fan provides great benefit for that instances, cool the home because a hot attic often heats the home too. If the attic is cooled then it will prevent from this type of problem. In fact it will be appreciated to the remote area where the electrical power is not available at all. Solar power attic ventilation fan utilize the abandon source of solar energy. In summer attic space gets too hot that it can be stifling as a dry sauna. That same heat trapped inside the attic space could damage the roofing material and make it harder to cool the room. So the usage of attic ventilation fan with fresh air suction system equalize the temperature indoors.

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2. CONSTRUCTION AND EXPERIMENTAL PROCEDURE

Solar power attic ventilation system consisting of a water reservoir and an exhaust fan which operated by solar energy. This system was constructed and tested in the laboratory of Khulna University of Engineering & Technology (KUET). The schematic and photographic views are shown in figure 2 to figure 4.

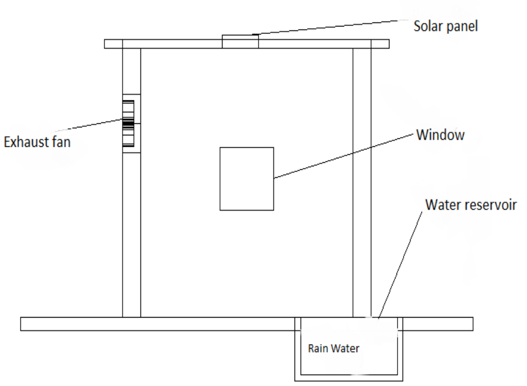

Fig. 1: A schematic diagram of model design

The attic room was made of flat roof type. A solar panel of 21 watt and 21.7 volt was placed over the roof of experimental room. This panel dimension was (22x18) inch. A water reservoir was placed in a manner so that part of it placed inside the experimental room and part of this outside the room. Water reservoir dimension was (18x20) inch. The fresh air is drawn over this water reservoir, so the air temperature is reduced and gets enter the attic room. The exhaust fan diameter is 10 inch. It consists of six blades. This fan blade was made of thermosetting plastic. Because steel blades too much hot in summer which damage the motor. A 12 volt DC motor was used to make this exhaust fan. And this motor was operated by the solar power from solar panel. Exhaust fan creates vacuum inside the experimental room and water reservoir contains rain water to supply fresh air over it and reduce the temperature as well. Solar power attic ventilation system was made in an experimental room and compared with a normal room. The experimental and normal rooms were made of brick with concrete roof and one window in each rooms. These two rooms were separated by cork sheet. For both experimental and normal room, the thickness of the wall was 5 inch and thickness of the roof was 5 cm. The floors and water reservoir are also made by concrete. The south side wall of experimental room was covered with cork sheet. Because the normal room had only one face to the sun and experimental room had two face. For this reason to balance the face of booth room cork sheet was used.

The performance of solar powered attic ventilation fan and this system was investigated for a typical summer day of February and March 2013 for Khulna in Bangladesh. The temperature and solar radiation data were recorded in every 30 minute during 4 hour in day time. Ambient air temperature outside the room were measured by using a thermometer near the experimental room. The temperature of the experimental and normal room were measured by thermometer. These thermometer were placed in the rooms in middle position. The solar intensity was taken by solarimeter. This intensity measurement indicates the day condition.

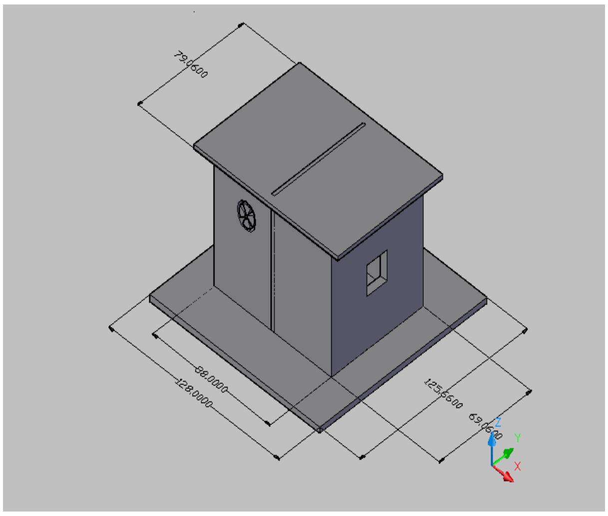

Fig. 2: Schematic diagram of prototype experimental room (a)

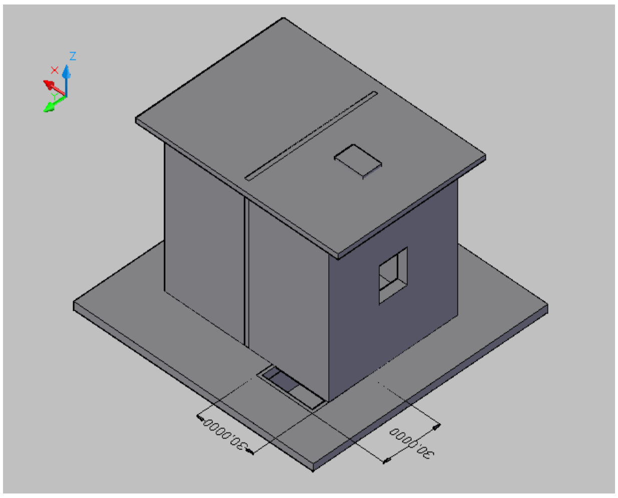

Fig. 3: Schematic diagram of prototype experimental room (b)

Fig. 4: Photographic view of exhaust fan

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Fig. 5: Photographic view of water reservoir

3. RESULTS AND DISCUSSION

The constructed solar powered attic ventilation fan was installed on a room of size 51x47x67 inch. The system was run and the required data were collected.

Table 1. Experimental data for 15.02.2013

Time	Experimental room temperature in °c	Normal room temperature in °c	Ambient temperature in °c	Solar intensity KW/m^2
10.00	22	22	23	318
10.30	21.5	23	24	421
11.00	22	24	26	477
11.30	22	24.5	28	498
12.00	22	25	28	503
12.30	22.5	25	28.5	574
12.55	23	25.5	29	584

Table 2. Experimental data for 01.03.2013

Time	Experimental room temperature in °c	Normal room temperature in °c	Ambient temperature in °c	Solar intensity KW/m^2
10.00	21	21	26	368
10.30	20.5	22	26.5	416
11.00	21	23	27.5	468
11.30	21	24	28	500
12.00	22	24.5	28	530
12.30	22.5	25.5	28	540
12.55	23	26	30	536

Table 3. Experimental data for 02.03.2013

Time	Experiment al room temperature in °c	Normal room temperature in °c	Ambient temperature in °c	Solar intensity KW/m^2
10.00	22	22	23	360
10.30	21.5	23	24.5	407
11.00	21	24	25	454
11.30	21.5	25	27	500
12.00	22	25.5	28	528
12.30	22.5	26.5	28	542
12.55	24	27	29	539

Table 4. Experimental data for 15.03.2013

Time	Experimental room temperature in °c	Normal room temperature in °c	Ambient temperature in °c	Solar intensity KW/m^2
10.00	28	28	28	205
10.30	27.5	29	30.5	360
11.00	28	30	31	392
11.30	28	31	32	427
12.00	29	32	33	413
12.30	29.5	33	35	518
12.55	30	33	35	387

Table 5. Experimental data for 16.03.2013

Time	Experimental room temperature in °c	Normal room temperature in °c	Ambient temperature in °c	Solar intensity W/m^2
10.00	28	28	32	295
10.30	27.5	29	34	362
11.00	28	30	35	378
11.30	28.5	32	35	393
12.00	29	32	35	336
12.30	30.5	33	36	403
12.55	31.5	34	36	385

Table 6. Experimental data for 22.03.2013

Time	Experimental room temperature in °c	Normal room temperature in °c	Ambient temperature in °c	Solar intensity KW/m^2
10.00	26	28	29.5	350
10.30	26.5	28.5	31	418
11.00	27	29	31	432
11.30	28	30.5	32	460
12.00	28	31	33	518
12.30	28	31.5	34	496
12.55	28.5	32	34.5	313

Table 7. Experimental data for 23.03.2013

Time	Experimental room temperature in °c	Normal room temperature in °c	Ambient temperature in °c	Solar intensity KW/m^2
10.00	27	28	33	402
10.30	27.5	29	34	430
11.00	28	31	35	387
11.30	28.5	31	35	380
12.00	29	32	35.5	507
12.30	30	33	35.5	458
12.55	30.5	33.5	36	387

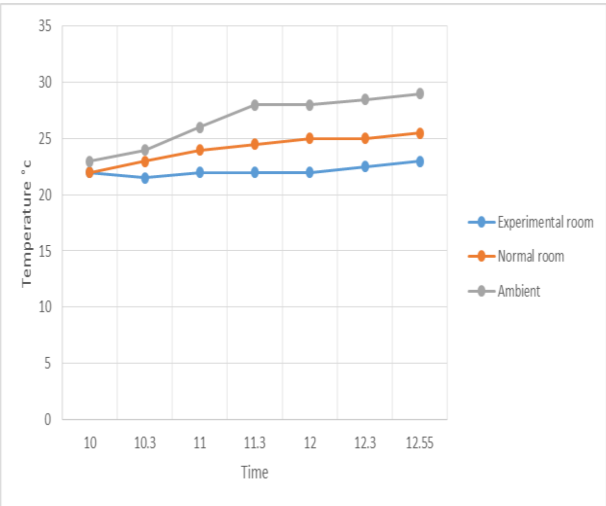

Fig.6: Shows the change of temperature with the change of time (Date-15.02.2013)

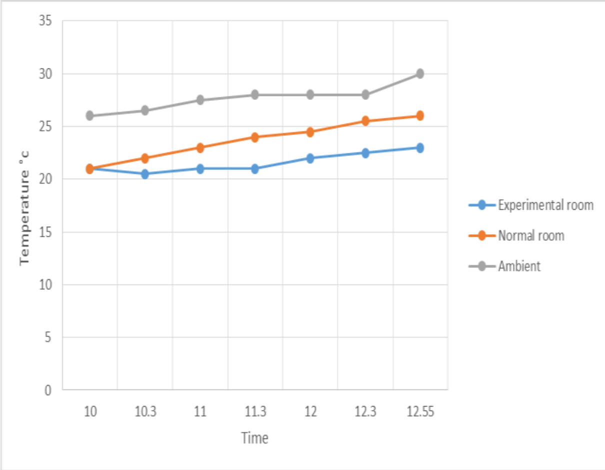

Fig. 7: Shows the change of temperature with the change of time (Date-01.03.2013)

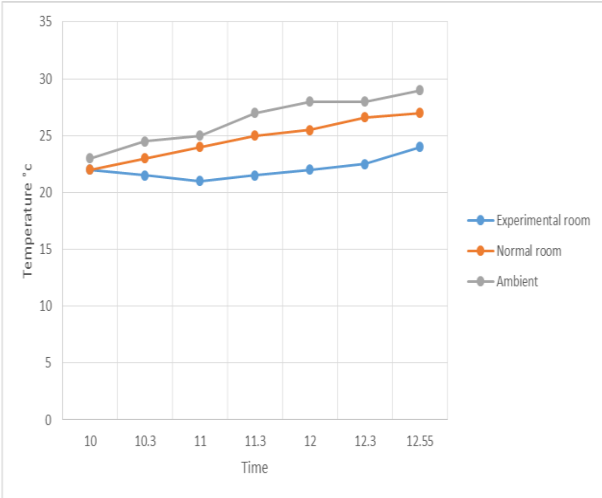

Fig. 8: Shows the change of temperature with the change of time (Date-02.03.2013)

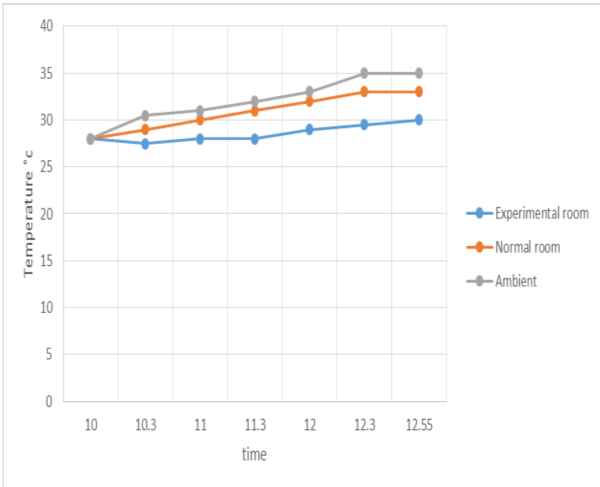

Fig. 9: Shows the change of temperature with the change of time (Date-15.03.2013)

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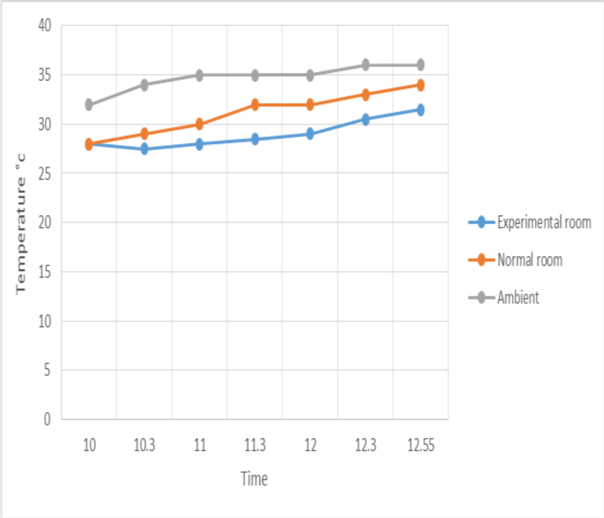

Fig. 10: Shows the change of temperature with the change of time (Date-16.03.2013)

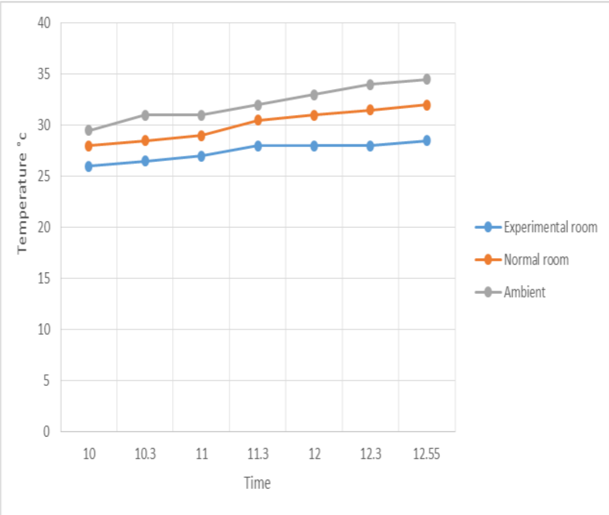

Fig. 11: Shows the change of temperature with the change of time (Date-22.03.2013)

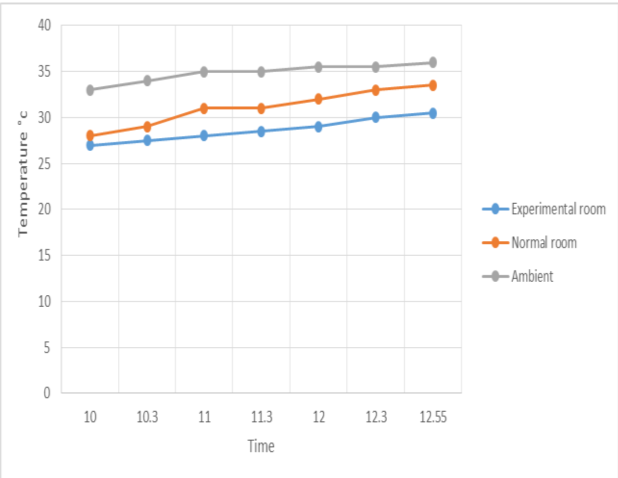

Fig. 12: Shows the change of temperature with the change of time (Date-23.03.2013)

The normal room temperature was lower than the ambient temperature. Before performing the exhaust fan operation both room were in almost same temperature. After a certain period of time experimental room temperature was lower than the normal room temperature. Initially after half an hour the experimental room temperature fell down to 0.5 degree Celsius at each day of investigation. Since the temperature fell down after half an hour, we choose the time interval of 30min. After that room temperature continuously maintained to keep in same temperature, though the normal room temperature was increased with time. The constructed solar powered exhaust ventilation system reduces the internal room temperature by an average of 2.5-3 degree Celsius in comparison of the temperature of normal room. And from ambient temperature experimental room temperature was lower in 4-5 degree Celsius. Solar intensity measurement had given the record of day sunlight condition. In general solar intensity increased with time, but sometime it had fallen down (22.03.2013).

4. CONCLUSION

An innovative concept of solar powered attic ventilation system that could satisfy the domestic cooling demand is presented in slow wind blowing and remote area. Being a totally new concept, it will certainly require additional work and analysis in future.

During the hot arid condition a prototype model for a solar powered attic ventilation system used to improve the attic space cooling has been investigated. The experimental results examined the effectiveness of such a system in comparison to normal room. The results showed that the attic space cooling of building in slow wind blowing and remote area can be improved by the application of such a system.

5. REFERENCE

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