A Review on Performance Enhancement of Air Conditioner Using Earth Air Tunnel Heat Exchanger

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Abstract-Power consumption is a major concern in Air Conditioner. The objective of this research paper is to study the performance enhancement of air conditioner using earth air tunnel heat exchanger. The concept of experimentally study of air conditioner using earth air tunnel heat exchanger (EATHE) can be done to evaluate the performance of system. Soil temperature, at a depth of about 10 feet or more, stays fairly constant throughout the year, and is approximately equal to the average annual ambient air temperature. The ground can, therefore, be used as a heat sink for cooling in the summer and as a heat source for heating in the winter. A simple method of using this concept is to pass air through an underground air tunnel. The air thus cooled or heated can be used directly for the conditioned space or indirectly with air conditioners or heat pumps. The EATHE's are considered as one of the most passive system due to its ability to provide both the effects; heating in cold months and cooling during warm months. This paper reviews on the performance enhancement of air conditioner using earth air tunnel heat exchanger system.

Keyword: Earth air tunnel heat exchanger; Earth's undisturbed temperature; Space conditioning

I. INTRODUCTION

Due to the rapid economic development and urbanization in the past two decades world over, energy consumption in buildings, especially electricity use, has risen sharply. In many hot countries, and also in countries with a temperature climate having hot summers, there is growing interest in utilizing passive and low-energy systems for cooling buildings, both residential and commercial. In developed countries this interest is motivated by the desire to conserve energy and to reduce the summer peak demand for electricity caused by air conditioning.

In developing countries, the interest in passive cooling is motivated by the desire to minimize the heat stress experienced in buildings and its deleterious effect on health and productivity, as well as the desire to minimize the pressure for large-scale installation and use of air-conditioning. Fossil fuel depletion along with pollutant emissions and global warming are important factors for sustainable and environmentally energy systems. Increasing emphasis on effective energy saving applications in buildings has led to utilize nonconventional techniques to cover heating and cooling demands. Exploiting geothermal energy so as to achieve reduction on fuel consumption is becoming more and more popular.

To reduce high grade energy consumption of these active cooling systems, numerous alternative techniques are being currently explored. One such proposition is the Earth Air Tunnel Heat Exchanger system. Soil temperature, at a depth of about 10 feet or more, stays fairly constant throughout the year and is approximately equal to the average annual ambient air temperature. The ground can therefore, be used as a heat sink for cooling in summer and as a heat source for heating in winter. A simple method of using this concept is to pass air through an underground air tunnel. In summer, as the air flows through the earth air tunnels, heat is transferred from the air to the earth. As a result, air temperature at the outlet of earth air tunnel heat exchanger is much lower than that of ambient. This relatively cold air can be used directly for the conditioned space or indirectly with air conditioners in various hybrid modes. In addition to energy conservation, this technique also increases the capacity of a conventional active cooling system.

II. LITERATURE REVIEW

M. Zukowski et al. (2011) [1], The cooling energy load is reduced about 595 kWh due to this system. The underground channels reduce the operative temperature inside the tested building by average 1.9°C.

Kumar et al. (2003) [2]**,** He evaluated the conservation potential of an earth–air–pipe system coupled with a building with no air conditioning. The cooling power for the earth pipe with length of 80 m, section area of 0.53 m^2 and air flow velocity of 4.9 m/s was 19 kW, which was adequate to maintain an average temperature of 27.6 ^{0}C for a single room in India.

Ghosal et al. (2004) [3], developed a simplified analytical model to study year around effectiveness of an EATHE coupled greenhouse located in New Delhi, India. At the end the temperature of greenhouse air on average found to be 6–7 °C more in winter and 3–4 °C less in summer than the same greenhouse when operating without EATHE.

D. Goswami et al. (1990) [4], showed that Use of Underground Air Tunnels for Heating and Cooling Agricultural and Residential Buildings. Open loop air tunnel systems or closed loop systems can operate with a coefficient of performance (COP) as high as 12. When compared to the COP of 1 to 4 for a conventional air conditioning system, these underground air tunnel systems can save enough energy to pay for themselves in a period of 4 years or even less. These systems can reduce the ambient air temperature from 90°F to one in the range of 80°F to 83°F. Therefore, these systems are recommended for use in agricultural buildings where a drop in air temperatures of 7°F to 10°F is acceptable.

R. Misra et al. (2010) [5], showed that Performance analysis of earth–pipe–air heat exchanger for summer cooling. They concluded from this analysis that the performance of the EATHE system is not affected by the material of the buried pipe, therefore a cheaper material pipe can be used for making the pipe. The hourly cooling obtained through the system is found to be in the range of 1.2–3.1MWh.

Bansal et al. (2009) [6], investigated the performance analysis of EAHE for summer cooling in Jaipur, India. They discussed 23.42 m long EATHE at cooling mode in the range of 8.0–12.7^0 C and 2–5 m/s flow rate for steel and PVC pipes. They showed performance of system is not significantly affected by the material of buried pipe instead it is greatly affected by the velocity of air fluid. They observed COP variation 1.9–2.9 for increasing the velocity 2–5 m/s.

Tiwari et al. (2006) [7], presented an experimental validation of a simple earth tube model using experimental data for a greenhouse located in New Delhi, India. Temperature increases of 4°C in the winter and decreases up to 8°C in the summer are observed. The earth tube system is more efficient in the summer than in the winter. Despite its simplicity, the model seems to be in good agreement with experimental data.

III. WORKING PRINCIPAL OF EARTH AIR TUNNEL HEAT EXCHANGER

In Earth Air Tunnel Heat Exchanger Earth acts a source or sink.High thermal inertia of soil results in air temperature fluctuations being dampened deeper in the ground. It Utilizes Solar Energy accumulated in the soil. Cooling/Heating takes place due to a temperature difference between the soil and the air. Performance of Earth Air Tunnel also impacted by the thermal conductivity of soil. Soil temperature, at a depth of about 10 feet or more, stays fairly constant throughout the year, and is approximately equal to the average annual ambient air temperature. The ground can, therefore, be used as a heat sink for cooling in the summer and as a heat source for heating in the winter. A simple method of using this concept is to pass air through an underground air tunnel. The air thus cooled or heated can be used directly for the conditioned space or indirectly with air conditioners or heat pumps.

Types of Earth Air Tunnel Heat Exchanger:

1) Open System: In open system ambient air passes through tubes buried in the ground for preheating or pre-cooling and then the air is heated or cooled by a conventional air conditioning unit before entering the building.

2) Closed System: In this case heat exchangers are located underground, either in horizontal, vertical or oblique position, and a heat carrier medium is circulated within the heat exchanger, transferring the heat from the ground to a heat pump or vice versa.

Applications of Earth Air Tunnel Heat Exchanger: EATHE can be used in a vast variety of buildings

- Commercial Buildings: Offices, showrooms, cinema halls etc.
- Residential buildings
- University Campus
- Hospitals
- Greenhouses
- Livestock houses

Important Design Parameters: The design parameters that impact the performance of the Earth Air Tunnel Heat Exchanger

- Tube Depth
- Tube Length
- Tube Diameter
- Air Flow rate
- Tube Material
- Tube arrangement
- Efficiency
- Coefficient of Performance (COP)

IV. PROPOSED WORK

The aim of the project is to investigate experimentally the Coefficient of Performance of the air conditioner with and without using earth air tunnel heat exchanger. The temperatures at various locations in earth air tunnel heat exchanger can be measure with the help of calibrated K Type thermocouples. So in general, the coefficient of performance can be improved by lowering the compressor power consumption, increasing the cooling and heat rejection capacity, decreasing the refrigerant pressure loss, or reducing the pressure difference between the condenser and evaporator.

V. CONCLUSION

In this paper the performance of earth air heat exchanger system was reviewed. Earth Air Tunnel Heat Exchanger is a recent technology to improve the quality of life in developing countries like India and to reduce the electricity demand. EATHE can be used as substitute for the conventional air conditioning systems. More the thermal conductivity of soil better is the thermal performance of EATHE. If the length of the pipe is so small and the blower is of high voltage then the system is useless because the temperature difference between inlet and out let is very less.

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