A review of various approaches to optimize the solar air heater

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ABSTRACT

A comparative study of various approaches to optimise and increase the performance of solar air heater is carried out in the present work. Various types of artificial roughness geometries in the absorber plate of solar air heater duct and their characteristics have been investigated for the heat transfer improvement or enhance the performance by many researchers. However, exergy data are more practical and realistic in comparison with the respective energy values that have been found in this communication.

Key words: Solar air heater, various approaches.

INTRODUCTION

Renewable energies are going to be a main substitute for fossil fuels in the coming years for their clean and renewable nature. Solar air heaters of many types have been developed in India and their performance studied in detail .today solar energy play a very important role in space heating, food drying and refrigeration. While solar air heater is now become a very integral part of some solar system.

The conventional methods of energy analysis are based on the first law of thermodynamic, which is concerned with the conservation of energy. The first law merely serve as a necessary tool for bookkeeping of energy during a process. Practical devices involving energy conversion law, but the quality of energy degrades i.e. work potential is lost or exergy is consumed or destroyed since according to Gouy - Stodola theorem the loss of available work is directly proportional to the total entropy generation in an observed process¹. Recently, the concept of exergy has received great attention from scientists, researchers and engineers, and exergy concept has been applied to various utility sectors and thermal processes. Energy analyses on their own incorrectly interpret some processes; for example, environmental air, when isothermally compressed and maintains its energy (e.g., enthalpy) equal to zero, whereas the exergy of the compressed air is more than zero⁶⁻⁸.

Performance improvement by using various configurations

Convective heat transfer coefficient between absorber plate and air in a flat- plate solar air heater can be enhanced by providing the absorber plate with artificial roughness. Paper of Gupata and Garg² gives the result of thermal behaviour of artificially roughened solar air heater which is similar to that of usual flat plate conventional air heater. The usual procedures of calculating the absorbed irradiation and the heat losses are used, Also experimentally evaluate the energy and exergy efficiency of four types of double-flow flat plate solar air heater with obstacles and without obstacles on absorber plate. And found that there is not a single roughened geometry which gives best performance for whole range of Re (Reynolds no)





An analysis for a novel type of solar air heater gives the main idea is to minimize heat losses from the front cover of the collector and to maximize heat extraction from the absorber. This can be done by forcing air to flow over the front glass cover (preheat the air) before passing through the absorber. Hence, this design needs an extra cover to form a counter-flow heat exchanger. Naphon⁵ applied the mathematical models for predicting the heat transfer characteristics and performance of the various configurations flat-plate solar air heater. A comparative theoretical parametric analysis of solar air-heating collectors with and without packing in the flow passage above the back plate is carried out. The air heater without packed airflow passage is the conventional type, comprising a glass cover in conjunction with an absorber and a back plate with the air flow beneath the absorber. For comparing the performance, packing of different materials, shapes, and sizes with different void fractions are considered. To estimate the effective energy gain, the energy expended in pumping the air through the air heaters with different duct depths and lengths and with different airflow rates is computed.

Solanki¹⁴ experimentally investigate of optimum thermo hydraulic performance of solar air heaters with metal rib grits roughness. As compared to the smooth duct the presence of ribs at one broad wall of the duct yields up to about two fold and threefold increase in the Stanton number and the friction factor respectively. study is carried out for the range of Reynolds numbers (3000-20000) chamfer angle (-15 to +18) relative roughness height (0.014-0.033) relative roughness pitch (4.6-8.5)and duct aspect ratio (4.65-12)

Omojaro and Aldabbagh⁴ experimentally calculated the thermal efficiency, optimization of mass flow rate ,and other parameter with respect to the day time. This study shows that for a single and double pass solar air heater using wire mesh as absorber plate. Artificial roughness has been found to enhance the heat transfer from the absorber plate to the air in a solar air heater duct. However, this improvement is invariably accompanied by increased pumping power. Choudhary and Garg¹²For shorter duct lengths and lower air mass flow rates, the performance of the two-pass air heater with a single cover is found to be most cost-effective, as compared to the other designs.

Performance evaluation

Omojaro and Aldabbagh⁴ experimentally calculated the thermal efficiency, optimization of mass flow rate ,and other parameter with respect to the day time for single and double pass solar heater. A thermodynamic analysis of the configuration (double-pass solar air heater with longitudinal fins) considered has been carried out by Naphon⁵. Model yields the prediction of heat transfer characteristics, the performance, and entropy generation of the double-pass solar air heater with longitudinal fins. Effect of the height and number of fins on the performance and entropy generation are considered. It was found that the thermal efficiency increases with increasing the height and number of fins. The entropy generation was inversely proportional to the height and number of fins. Unfortunately, this not only assumed a constant overall loss coefficient and other heat transfer coefficients but also the calculation of entropy generation with respect to all optimization parameters.

An exergetic optimization of the solar air heater is developed by Farahat⁸. For this means, an integrated mathematical model of thermal and optical performance of the solar heater is derived. exergy efficiency is compared with the thermal efficiency of the heater, resulting in an extraordinary increase of the exergy efficiency according to the optimized parameters and benefit of this approach for such system. There is a wide difference between energy and exergy efficiency as shown in fig 3-4, also found the exergy basis estimation yields a better optimization. Variation of exergy and energy efficency with respect to variable like wind speed, area of heater surface, incident radiation has been found out. Efficiency graphs are similar for both, but exergy basis observation gives comparatively better optimization.

CONCLUSION

The performance evaluation in terms of ς_{th} and ς_{ex} has been carried out, by various authors. It can be concluded from present review that Exergy analysis is a useful method, to investigate the problem not to replace the energy analysis. Exergy analysis yields useful results because it deals with irreversibility minimization or maximum exergy delivery. Exergy analysis can indicate the process under consideration. The exergy analysis has proven to be a powerful tool in the thermodynamic analyses of energy systems.

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