SIMULATION TEMPERATURE DISTRIBUTION OF SOLAR AIR HEATER

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ABSTRACT

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A mathematical model for a single-pass solar collector developed to determine the temperature distribution is presented. A flat-plate air collector design was considered. The collector divided into N sub cell of collector. The temperature of each sub cell of collector will be determined individually. By considering a steady state heat transfer using the thermal network analysis procedure, a set of heat balance equations are identified for the temperature distribution. There are three sets of each section. Because heat transfer coefficients were temperature dependent, a set of temperatures distribution was approximated which allowed the heat transfer coefficients to be evaluated as a first guess. Instead of solving the heat balance equations, a matrix inversion method was employed for each section using a standard sub-routine program. An iterative process was then used that enabled the calculated temperatures distribution for the collector closed to the guess value. The newly-calculated temperatures distributions were then compared with the initially-guessed temperatures. The iterative procedure was repeated until following temperature distribution values differed by greater than 0.1°C. By this procedure, predictions of plate, glass and fluid temperatures for a collector of any length could be obtained. Although only single-pass type of flat-plate solar collector is considered here, the solution procedure could be extended to encompass most other collector designs.

CHAPTER 1

INTRODUCTION

1.1 Background and problem statement

A solar air heater system consists of an array of interconnected solar heat collectors. Most systems incorporate a once-through or single-pass type of forced air circulation with cold ambient air intake and solar-heated hot air discharge to the working space. The collectors may be connected in series, parallel, or a series-parallel combination. A series-only connection would result in a long but higher temperature system whereas a parallel-only connection would result in a short but lower temperature system. Apart from the length effect, the performance of the system would also depend upon the air circulation rate, physical design of the collectors, and prevailing ambient conditions. Therefore, knowledge of the operating characteristics of the collectors would enable the system performance to be optimized. There are numerous works on both experimental and theoretical performance of solar air heaters. Recent works by Parker (1981), Vijeysundera *et d.* (1982), Than and Ong (1984), Biondi *et al.* (1988), Duffie and Beckman (1991), Verma *et al.* (1992), and Parker et *al.* (1993) considered the steady state heat balance equations and involved linking plate efficiency and heat removal factors with air flow rates, surface wind heat transfer coefficients, and heat transfer coefficients between the moving air streams and the surfaces forming the flow channels. The derivation of these factors are quite complex and require considerable