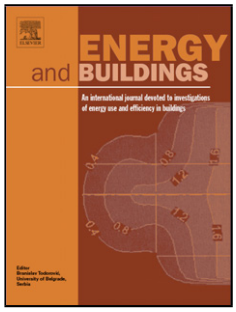

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Exergetic Optimization of Basic System Components for Maximizing Exergetic Efficiency of Solar Combisystems by Using Response Surface Methodology

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Abstract:

In this study "*design parameters*" and efficiency effect of basic system components on exergetic efficiency of "Solar Combisystems (SCS)" which can be named as a new generation space heating systems are investigated in order to determine the optimum operating values of system components. The effects of four variables, instantaneous exergetic efficiency of solar collector ($\eta_{\mathbf{Excoll}}$), heat exchanger-1 ($\eta_{\mathbf{Exhe-1}}$), heat exchanger-2 ($\eta_{\mathbf{Exhe-2}}$) and heating system ($\eta_{\mathbf{ExHS}}$) on the overall exergetic efficiency of SCS are investigated based on central composite design (CCD) and quadratic models are developed to correlate the variables to overall system net and gross exergetic efficiency. From the analysis of variance (ANOVA), the most influential factor on each experimental design response is identified. It is found that, ($\eta_{\mathbf{Excoll}}$), ($\eta_{\mathbf{Exhe-1}}$), ($\eta_{\mathbf{Exhe-2}}$) and ($\eta_{\mathbf{ExHS}}$) are statistically significant for net and ($\eta_{\mathbf{Excoll}}$), ($\eta_{\mathbf{Exhe-1}}$) and ($\eta_{\mathbf{ExHS}}$) are statistically significant for gross exergetic efficiency of overall system. Binary interaction effect of independent variables are investigated and it is found that ($\eta_{\mathbf{Excoll}}$) & ($\eta_{\mathbf{Exhe-1}}$) is the most important couple that effects the net exergetic efficiency of the system. Net and gross exergetic efficiency of overall system reach to 12% and14.6 % individually, within the optimum values of the variables.

Keywords: Central Composite Design (CCD), design parameters, exergy analysis, response surface methodology (RSM), Solar Combisystem, Solar heating

1. INTRODUCTION

Total energy consumption is highly related with industrial development and population growth. The annual mean energy consumption value reached to 40000kWh/capita and 90000kWh/capita in developed countries and USA respectively. However in the rest of the world, annual energy consumption is just one fifth of USA and half of EU (between 15000-20000 kWh/capita) according to the International Energy Agency (IEA) reports which are related with the regional energy consumption. [1].

Table 1 shows that total energy consumption is increasing by the time but the same inference is not valid for the value of energy consumption per capita [2]. This value is decreasing in USA by the time and staying nearly as it was in 1990 in EU. However in the rest of the world, value of energy consumption per capita is increasing exponentially with population growth and industrial development. The trend in Middle East and China should be bold underlined. Irretrievable energy consumption caused by population growth and increment in the energy consumption per capita should be expected in the future projections of these regions.

The basic reason for decline in the values of energy consumption per capita is having high energy efficiency awareness and broad-comprehensive energy efficiency regulations in aforementioned developed countries.

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