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Integration of Thermoelectric Generators and Wood Stove to Produce Heat, Hot Water, and Electrical Power

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Traditional fire stoves are characterized by low efficiency. In this experimental study, the combustion chamber of the stove is augmented by two devices. An electric fan can increase the air-to-fuel ratio in order to increase the system's efficiency and decrease air pollution by providing complete combustion of wood. In addition, thermoelectric generators (TEGs) produce power that can be used to satisfy all basic needs. In this study, a water-based cooling system is designed to increase the efficiency of the TEGs and also produce hot water for residential use. Through a range of tests, an average of 7.9 W was achieved by a commercial TEG with substrate area of 56 mm × 56 mm, which can produce 14.7 W output power at the maximum matched load. The total power generated by the stove is 166 W. Also, in this study a reasonable ratio of fuel to time is described for residential use. The presented prototype is designed to fulfill the basic needs of domestic electricity, hot water, and essential heat for warming the room and cooking.

Key words: Thermoelectric generators, wood stove, experimental investigation

INTRODUCTION

There are about 2.7 billion people in the world living in rural areas; 1.3 billion of them do not have access to electricity, representing 20% of the world's total population.[1] As it is hard to establish energy supplies in such areas, new energies and practical renewable energies are considered. Traditional or rudimentary stoves, which are widely used as heat generators in developing countries (representing 41% of the total population of the world[1]), are potential sources to access reliable energy, but they have low efficiency (about 20% to 40%),[2] which results in wastage of precious fuel supplies in these areas. Also, these stoves cause air pollution due to incompletely combusted output gases and cause damage to human health. Traditional stoves produce heat by burning fuel, usually solid fuel such as wood or coal. To generate electrical power, one can attach thermoelectric generators (TEGs) to such stoves. We designed a multifunction device that is able to produce a considerable amount of electricity as well as hot water, besides essential heat for cooking and warming a house. Generated electricity can be used to satisfy basic needs such as light, radio, phone, and other electronic devices. This prototype is equipped with a water-based cooling system which also produces hot water. Using TEGs has a lot of advantages compared with other generators, such as:

- The stove is designed to reduce the amount of CO_2 output, by full combustion of fuel. In fact, there is no pollution while using TEGs, as opposed to traditional stoves.
- TEGs are not dependent on sunlight or wind, so unlike solar panels or wind turbines, they can be used at any time of day and any place.
- TEGs do not need an auxiliary source of energy. They can use energy exhausted as waste heat.
- There is no need to move TEGs. They are silent and work very smoothly.

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