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Update on the Design and Development of a TEG Cogenerator Device Integrated into Self-Standing Gas Heaters

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Heating by gas combustion is widespread in residential and industrial environments, through the use of different types of systems and plants. A relevant case is that of gas stoves, where the heat-radiating unit operates autonomously with local gas feeding. A thermoelectric generator (TEG) can be integrated within this type of autonomous gas heater, for local production of electric power, so that devices requiring electric power can be added, where desired, without the need for any connection to the electrical grid. This approach can also lead to easier installation and operation, and eventually increases the overall efficiency. Following the development plan presented in a previous report, a new prototype of an autonomous gas heater for outdoor use has been implemented through the integration of an improved TEG device with a simple and robust design, which can be easily operated by the end-user. A small amount of heat is withdrawn and converted into electricity by the TEG, providing self-sustaining operation and, moreover, powering additional functions such as high-efficiency light-emitting diode lighting.

Key words: Thermoelectric converter, TEG, gas stove, off-grid operation, waste heat recovery

INTRODUCTION

A wide range of technical solutions based on gas combustion are available for heating of residential and industrial environments. Among traditional solutions, gas stoves are a relevant case where each heat-radiating unit includes a gas combustor and operates autonomously with a local feed of gas and, optionally, electricity. The use of such type of stoves is effective when flexibility of design and operation of the heating plant[1] is critical, e.g., when heat distribution by water circulating through pipes is not feasible. For such autonomous gas heaters, the integration of a cogeneration device could power up accessory functions (control and safety device, internal fan or pump) or new features to be implemented (e.g., illumination) without the need for any external electrical connection, thus further improving functionality and flexibility and eventually increasing the overall efficiency through reduction or elimination of electricity consumption from the grid.[2]

The power requirements for the mentioned functions may vary significantly with the specific application: safety, monitoring, and control devices usually have peak consumptions below 1 W while also needing a small amount of energy storage, for which a backup battery is necessary in most cases; internal fan power requirements, estimated from specifications of existing products, are approximately in the range of 30 W to 60 W for a 6-kW to 9-kW heater module; finally, interesting ancillary functions can be activated with power requirements in the range of 5 W to 20 W.

A cogenerator based on direct conversion of heat into electricity through a thermoelectric converter using the Seebeck effect is especially suitable for these purposes and power ranges, because it can be

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