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Numerical Investigation of the Integration of a Micro-Combustor with a Free Piston Stirling Engine in an Energy Recovery System

Authors : Ayodeji Sowale, Athanasios Kolios, Beatriz Fidalgo, Tosin Somorin, Aikaterini Anastasopoulou, Alison Parker, Leon Williams, Ewan McAdam, Sean Tyrrel

Abstract : Recently, energy recovery systems are thriving and raising attention in the power generation sector, due to the request for cleaner forms of energy that are friendly and safe for the environment. This has created an avenue for cogeneration, where Combined Heat and Power (CHP) technologies have been recognised for their feasibility, and use in homes and small-scale businesses. The efficiency of combustors and the advantages of the free piston Stirling engines over other conventional engines in terms of output power and efficiency, have been observed and considered. This study presents the numerical analysis of a micro-combustor with a free piston Stirling engine in an integrated model of a Nano Membrane Toilet (NMT) unit. The NMT unit will use the micro-combustor to produce waste heat of high energy content from the combustion of human waste and the heat generated will power the free piston Stirling engine which will be connected to a linear alternator for electricity production. The thermodynamic influence of the combustor on the free piston Stirling engine was observed, based on the heat transfer from the flue gas to working gas of the free piston Stirling engine. The results showed that with an input of 25 MJ/kg of faecal matter, and flue gas temperature of 773 K from the micro-combustor, the free piston Stirling engine generates a daily output power of 428 W, at thermal efficiency of 10.7% with engine speed of 1800 rpm. An experimental investigation into the integration of the micro-combustor and free piston Stirling engine with the NMT unit is currently underway.

Keywords : free piston stirling engine, micro-combustor, nano membrane toilet, thermodynamics
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