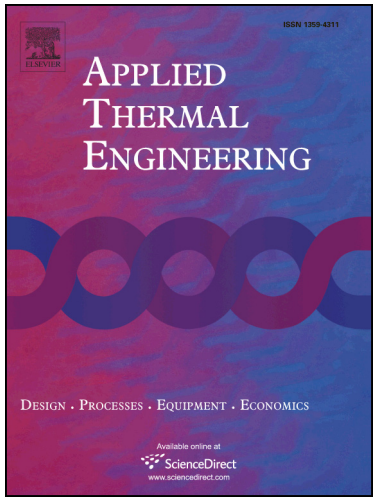

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PII: S1359-4311(16)33009-5
DOI: http://dx.doi.org/10.1016/j.applthermaleng.2016.11.019
Reference: ATE 9429

To appear in: *Applied Thermal Engineering*

Received Date: 1 September 2016
Revised Date: 19 October 2016
Accepted Date: 3 November 2016

Please cite this article as: B. Orr, A. Akbarzadeh, P. Lappas, An exhaust heat recovery system utilising thermoelectric generators and heat pipes, *Applied Thermal Engineering* (2016), doi: http://dx.doi.org/10.1016/j.applthermaleng.2016.11.019

An exhaust heat recovery system utilising thermoelectric generators and heat pipes

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Abstract

Exhaust heat recovery systems are used to make use of otherwise wasted heat from a car engine. The purpose of exhaust heat recovery systems is to potentially reduce the fuel consumption of the car and consequently reduce CO_2 emissions and running costs. The system design described herein utilises thermoelectric generators (TEGs) and heat pipes with its key advantage being it is a passive solid state design. The use of heat pipes allows for more flexible designs as the TEG location is not limited to the exhaust pipe surface. Testing was undertaken on a car with a 3.0 L V6 engine. In all test conditions the power loss due to pressure drop in the exhaust duct was always lower than the electrical power output. Repeat tests were conducted and the results were found to be consistent. When testing the system at different orientations, the bottom heat mode was found to be the best option. After all testing, the maximum power output of the system was 38 W from the eight 62 mm X 62 mm TEGs used. The rate of heat transfer in this case was 1541 W with the resultant TEG efficiency being 2.46%. The calculated potential reduction in CO_2 emissions, fuel consumption and fuel costs was 1.57%.

Keywords: Automotive; power generation; thermoelectric generator; heat pipes

1. Introduction

The reciprocating internal combustion engine, used in a majority of automobiles, does not convert all of the energy in the fuel into mechanical work. Over a standard driving cycle (i.e.: European driving cycle), approximately 40% of the energy used is transferred as heat to the exhaust gases [1] which is wasted as the exhaust gases are expelled to the atmosphere. An exhaust heat recovery system can extract some of this heat and convert it into electricity. This electricity will be used to charge a car battery therefore reducing the load on the car alternator and potentially saving fuel. CO_2 emissions are directly proportional to hydrocarbon fuel consumption therefore CO_2 emissions could potentially be reduced.

This project will make use of two particular technologies, heat pipes and thermoelectric generators as seen in Fig. 1 and Fig. 2 respectively. Heat pipes are passive heat transfer devices which can have thermal conductivity values which are orders of magnitude higher than copper. TEGs are heat engines with no moving parts. When there is a temperature difference over the two sides of the TEG, a voltage is created and consequently power can be generated.