A Novel Electro Conductive Graphene/Silicon-Dioxide Thermo-Electric Generator

By: Rahman, A (Rahman, Ataur)1; Abdi, Y (Abdi, Yusuf)1

3RD INTERNATIONAL CONFERENCE ON MECHANICAL, AUTOMOTIVE AND AEROSPACE ENGINEERING 2016
Book Group Author(s): IOP
Book Series: IOP Conference Series-Materials Science and Engineering
Volume: 184
Article Number: UNSP 012025
DOI: 10.1088/1757-899X/184/1/012025
Published: 2017
Document Type: Proceedings Paper

Conference
Conference: 3rd International Conference on Mechanical, Automotive and Aerospace Engineering (IC MAAE)
Location: Int Islamic Univ Malaysia, Kulliyyah Engn, Kuala Lumpur, MALAYSIA
Date: JUL 25-27, 2016

Abstract
Thermoelectric generators are all solid-state devices that convert heat energy into electrical energy. The total energy (fuel) supplied to the engine, approximately 30 to 40% is converted into useful mechanical work; whereas the remaining is expelled to the environment as heat through exhaust gases and cooling systems, resulting in serious green house gas (GHG) emission. By converting waste energy into electrical energy is the aim of this manuscript. The technologies reported on waste heat recovery from an exhaust gas of internal combustion engines (ICE) are thermoelectric generators (TEG) with finned type, Rankine cycle (RC) and Turbocharger. This paper has presented an electro-conductive graphene oxide/silicon-dioxide (GO-SiO2) composite sandwiched by phosphorus (P) and boron (B) doped silicon (Si) TEG to generate electricity from the IC engine exhaust heat. Air-cooling and liquid cooling techniques adopted conventional TEG module has been tested individually for the electricity generation from IC engine exhausts heat at the engine speed of 1000-3000 rpm. For the engine speed of 7000 rpm, the maximum voltage was recorded as 1.12V and 4.00V for the air cooling and liquid cooling respectively. The GO/50(92) simulated result shows that its electrical energy generation is about 89% more than conventional TEG for the exhaust temperature of 500 degrees C. The GO-SiO2 composite TEG develops 524W to 1600W at engine speed 1000 to 5000 rpm, which could contribute to reduce the 10-12% of engine total fuel consumption and improve emission level by 20%.

Keywords
Key Words Plus: RECOVERY, WASTE, HEAT, MOBILITY

Author Information
Reprint Address: Rahman, A (reprint author)
Addresses: Int Islamic Univ Malaysia, Kulliyyah Engn, Dept Mech Engn, KI50728, Malaysia

Publisher
IOP PUBLISHING LTD, DIRAC HOUSE, TEMPLE BACK, BRISTOL BS1 6BE, ENGLAND

Categories / Classification
Research Areas: Engineering; Materials Science
Web of Science Categories: Engineering, Aerospace, Engineering, Mechanical, Materials Science, Multidisciplinary

See more data fields
### Cited References: 24

Showing 24 of 24  View All in Cited References page (from Web of Science Core Collection)

| # | Title | Times Cited |
|---|---|---|
| 1. | Instantaneous Heat Transfer Rates to the Cylinder Head Surface of a Small Compression-Ignition Engine | 61 |
| 2. | A special thermocouple for measuring transient temperatures | 55 |
| 3. | Ultra high electron mobility in suspended graphene | 4,462 |
| 4. | Recovery of exhaust and coolant heat with R245fa organic Rankine cycles in a hybrid passenger car with a naturally aspirated gasoline engine | 73 |
| 5. | HD Diesel engine equipped with a bottoming Rankine cycle as a waste heat recovery system. Part 1: Study and analysis of the waste heat energy | 120 |
| 6. | Extraordinary mobility in semiconducting carbon nanotubes | 960 |
| 7. | Theoretical and experimental investigation of an organic Rankine cycle for a waste heat recovery system | 47 |
| 8. | Performance of a thermoacoustic sound wave generator driven with waste heat of automobile gasoline engine | 25 |
| 9. | Nonlinear modeling and simulation of waste energy harvesting system for hybrid engine: Fuzzy logic approach | 4 |
| ID | Title                                                                 | Authors                                                                 | Journal                                                                                           | Pages/Publication Details                                                                 |
|----|----------------------------------------------------------------------|-------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------|---------------------------------------------------------------------------------------------|
| 13 | Power generation from waste of IC engines                            | Rahman, A.; Ataur, R.; Razzak, Fadiliah; Afroz, R.; et al.                | RENEWABLE & SUSTAINABLE ENERGY REVIEWS Volume: 51 Pages: 382-395 Published: NOV 2015               |
| 14 | Reciprocating internal combustion engines                             | Reitz, RD.                                                              | Engine Research Center, University of Wisconsin-Madison                                         |
| 15 | A review on compressed-air energy use and energy savings             | Saidur, R.; Rahim, N.A.; Hasanzaman, M.                                 | RENEWABLE & SUSTAINABLE ENERGY REVIEWS Volume: 14 Issue: 4 Pages: 1135-1153 Published: MAY 2010   |
| 16 | Thermoelectric power generation: efficiency and compatibility        | Snyder, G.                                                              | Thermoelectrics Handbook: Macro to Nano Published: 2006                                        |
| 17 | Automotive applications of high efficiency thermoelectrics           | Stabler, F.                                                             | DARPA ONR PROGRAM RE Published: 2002                                                             |
| 18 | The potential for thermo-electric devices in passenger vehicle applications | Stobart, P.K.                                                | SAE Paper nso 2010-01-0833 Published: 2010 Part 2 of 3 Presented at Detroit, MI, USA, Session     |
| 19 | An availability approach to thermal energy recovery in vehicles      | Stobart, R.K.                                                           | Proceedings of the Institution of Mechanical Engineers, Part D Journal of Automobile Engineering Volume: 221 Issue: 1 Pages: 70-79 Published: 2007 P.K |
| 20 | Experimental investigation of two-dimensional wall thermal loads in the near-injector region of a film-cooled combustion chamber | Wang, T.; Sun, B.; Liu, D.; et al.                                      | Applied Thermal Engineering available from: accessed on 24 April 2018 URL: https://www.sciencedirect.com/science/article/pii/S1359431117381188 |
| 21 | Electrical and thermal conductivities of reduced graphene oxide/polystyrene composites. | Wanjun, P.                                                              | Applied Physics Letter Volume: 104 Issue: 11 Pages: 1-13 Published: 2014                           |
| 22 | A universally applicable equation for the instantaneous heat transfer coefficient in the internal combustion engine           | Woschni, G.                                                            | SAE Technical Paper 670931 Published: 1967                                                        |
| 23 | Potential applications of thermoelectric waste heat recovery in the automotive industry                                     | Yang, J.                                                               | ICT: 2005 24TH INTERNATIONAL CONFERENCE ON THERMOELECTRICS Pages: 155-159 Published: 2005        |
| 24 | Thermoelectric automotive waste heat energy recovery using maximum power point tracking                                      | Yu, Chuang; Chau, K.T.                                                 | ENERGY CONVERSION AND MANAGEMENT Volume: 50 Issue: 6 Pages: 1506-1512 Published: JUN 2009          |
