

WASTE ENERGY RECOVERY CONCEPTS FOR MILITARY VEHICLES

Grayson Walker, Steve Cooper, Mark Qin, and Richard Dinges
General Dynamics Land Systems

And

Yaomin Dong and Bassem Ramadan
Kettering University

As DOD places greater emphasis on reducing the consumption of fuel throughout the military, vehicle developers will not only have to integrate more efficient components in to their designs, but in cases where efficiency improvements are limited, conversion of waste energy into useful energy will be required. Experience has shown that internal combustion engines, whether diesel or turbine, convert on average 30 % of the heat of combustion into useful energy (e.g., propulsion and system power), while 70 % of the energy produced by combustion is wasted in various forms, such as thermal losses, friction losses, kinetic losses. From a total vehicle efficiency perspective, this “wasted” energy is probably greater than 70 % because it produces secondary effects such as increased vehicle signatures, decreased reliability, greater life cycle costs, and personnel fatigue.

The goals of this work are to review existing technologies for recovering various forms of waste energy and to develop thermoelectric generator concepts (TEG) for converting waste vehicle heat into electrical power. Current bulk thermoelectric materials operate at efficiencies of around 5 % but by considering the various emerging semiconductor technologies, where 15–20 % efficiencies seem likely, TEGs could enable the recovery of meaningful levels of electricity from a variety of heat sources. These solid state devices have no moving parts and produce no vibration or noise, so they will not contribute to the production of additional harmful energy. A mathematical model has been developed in Matlab/Simulink to simulate a thermoelectric device based on typical GDLS vehicle operating conditions. This thermal subsystem module is integrated into GDLS’ system-level Matlab/Simulink model, which is then run on simulated missions to predict overall effects on system performance. Two types of thermal models are considered: a thermal model utilizing engine exhaust heat and a thermal model of a representative Line Replacement Unit (LRU) box with a thermo-electric generator utilizing waste electrical energy.