Design and Development of a Battery Charging System for Passenger Car using Thermo Electric Generator (TEG) Based Heat Recovery

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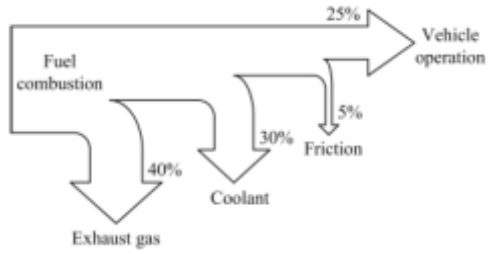
Abstract:

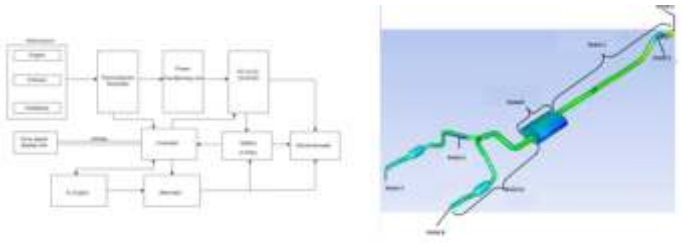
A major part of the energy generated in an internal combustion engine is not realised as work output, but sent into the atmosphere as waste heat. The overall efficiency of an engine can be improved by tapping this waste heat and converting it into usable energy. There is a potential for recovering approximately 30-40% of the energy supplied of the energy, depending on engine load. Thermoelectric Generators (TEGs) have been receiving a lot of attention for their promise in efficient conversion of the waste energy into electrical energy. The efficiency in employing TEGs for battery charging under different drive conditions needs to be analysed before deploying them on the vehicle.

In this project, a waste energy recovery system employing TEGs for charging the battery is modelled, simulated and analysed from a systems point of view. A drive cycle test was carried out on the target vehicle to map and characterize the temperature profile of the exhaust system to identify design characteristics of TEG systems and its co-systems, including their optimal placement. Since the output voltage of the TEG varies under varying operating conditions of the vehicle, as the temperature difference between the surfaces of TEG depends on them, a power conditioning unit incorporating a voltage converter is employed to provide standard voltage to the loads connected to the TEG. A control strategy for optimal use of available energy is developed. The complete system is modelled and simulated in the MATLAB/Simulink environment. The system is analysed for its effectiveness at different electrical load conditions.

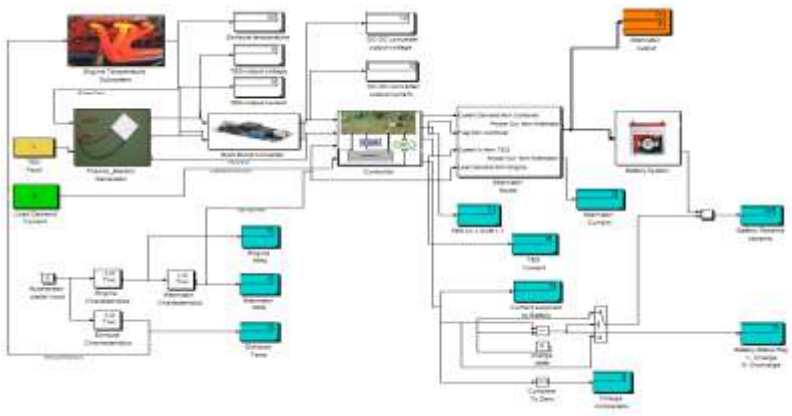
It was observed that the excess amount of energy in the range of 120 W to 360 W available from system in standard driving conditions and approximately 56 W to 170 W of useful energy is available for Mumbai drive cycle. TEGs can displace up to 5 to 15% of the alternator energy with Mumbai driving cycle. From the available results in simulation studies, it is concluded that thermoelectricity based energy recovery is an option for future development.



Waste heat in vehicle



System block diagram and temperature mapping



System modeling