School of Mechanical and Manufacturing Engineering

Waste Heat Recovery from Reciprocating Piston Engines

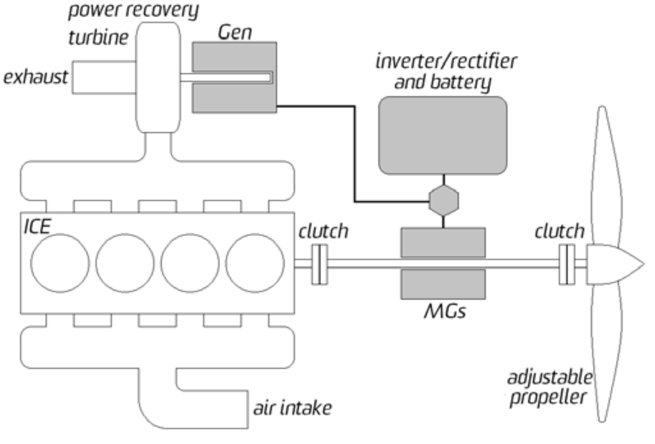
INTRODUCTION

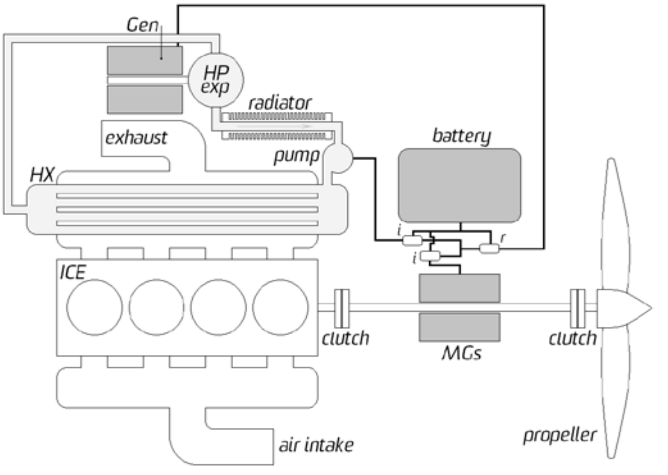
In recent years, we have looked at a number of methods of harvesting the waste heat transferred by the exhaust gases from downsized internal combustion engines. These include the use of power recovery turbines (compound turbocharging) and the use of organic Rankine cycles. This work has come out of work to reduce the fuel consumption and emissions of *light aircraft*.

POWER RECOVERY TURBINES

The idea of employing power recovery turbines comes from the fact that the Lockheed L-1049 Super-Constellation propeller driven aircraft was propelled by four Wright Turbo-Compound Engines (see Wiegand & Eichberg, 1954). In this engine, the power harvested from the exhaust gases was transferred to the propeller shaft by means of gears and a fluid coupling.

Today, high-speed, permanent magnet electrical generators can transfer the power harvested by the power recovery turbine directly to an electrical motor arranged in a parallel topology with the powertrains internal combustion engine (see the figure below). This improves the efficiency and flexibility of the system.





ORGANIC RANKINE BOTTOMING CYCLE

Another means of harvesting waste heat transferred by the exhaust gases from light aircraft internal combustion engines is to employ an organic Rankine bottoming cycle as shown in the figure above.

In evaluating the potential of the organic Rankine bottoming cycle and the power recovery turbine for aircraft, it is important to not only evaluate the thermal efficiency of the overall powertrain, but to evaluate the weight of the overall powertrain. If the weight of the overall powertrain is heavier than the conventional powertrain it is intended to replace, this may lead to an increase in fuel consumption.

TRAINS AND SHIPS

These same technologies could be easily adapted to both long distance trains and ships. In both cases, the power required over long periods of time is steady, enabling the internal combustion engine to operate at a high-efficiency design point while the waste heat recovery system's efficiency can be optimised for this condition.

Another advantage for trains and ships is that the weight of the powertrain is not as important for reducing fuel consumption as it is for aircraft.

References

- Wiegand, FJ. & Eichberg, WR., Development of the Turbo Compound Engine, *SAE AM Detroit*, 62, 1954.
- Olsen, J., Energy harvesting in light aircraft using an organic Rankine bottoming cycle, *AIAC17*, Melbourne, 2017.

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