RECYCLE

theRmal Energy reCoverY eleCtricaL systEms

State of the art – Background

The trends in rotorcraft engine technologies aims at improved fuel economy, reduced emissions, improved flight safety and increased passenger comfort. Such trends require accurately controlled auxiliary pumping, heating, cooling and active condition monitoring systems with an associated higher demand for electrical power. Technological advances in generators, alternators and batteries along with optimised electrical power networks support such increase in electrical power demand.

There are two main ways of electricity generation through which waste heat are converted to electrical energy, namely dynamic conversion and static conversion. In the process of dynamic conversion, mechanical energy is first generated in terms of shaft energy, usually through a heat expander or turbine, and then this mechanical energy is converted into electrical energy through an electromagnetic generator. For gas turbine engines used in land or marine applications, there is another way to utilise waste heat and this is through regeneration where the exhaust heat is recuperated through a heat exchanger and used to preheat compressor exit air before flow enters the combustor.

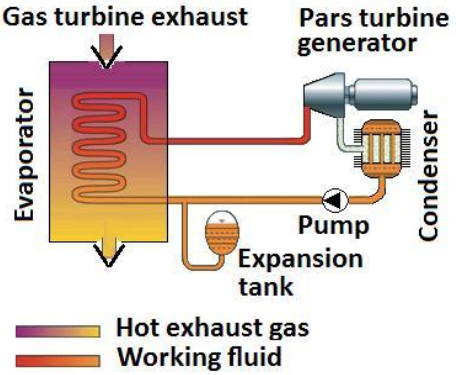
Waste heat is recovered in gas turbines by using steam or air bottoming cycles coupled to the exhaust of a turbo shaft engine. Although air bottoming cycles are rare, steam bottoming cycle configuration is commercially feasible when combined with stationary gas turbines. For land or marine applications where weight and size are not primary considerations, waste heat recovery has found a worldwide spread use.

Objectives

RECYCLE will advance technologies devoted to the development of waste heat recovery electrical generation systems dedicated to rotorcrafts, with specific objectives like weight optimization and proof of feasibility in the helicopter thermal environment.

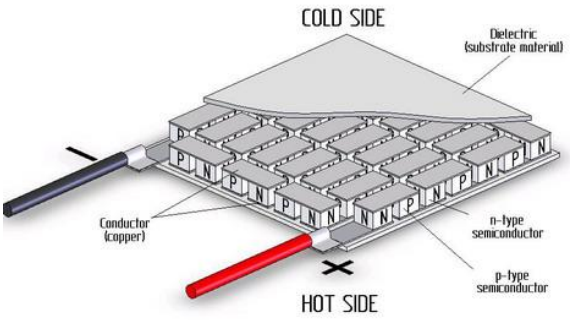
Description of work

Present project is a systematic progressive study of thermal heat recovery systems which aims at generating electrical power from rotorcraft heat losses. After an extensive review and assessment of existing heat recovery systems, the well-known Rankine cycle was chosen and will be weight-optimized by choosing the most appropriate turbine / expander technology and assessing the integration issues in the Helicopter, in particular the optimization of pressure drops in the nozzle due to the evaporator and the compliance with the helicopter environmental constraints. This innovative dynamic waste heat recovery system design will allow providing extra 30kW thus decreasing the electrical load input drawn from the engine and achieving an overall increase in thermal efficiency of the propulsion system.



Dynamic Waste Heat Recovery Rankine cycle

The other solution to generate electrical power from waste heat, the static waste heat recovery system, will be optimized in terms of configuration and power level using existing market cells – a total 500W recovery is expected from thermal losses in the engine area. The performance of this solution will be finally assessed in order to foresee the power level that can be recovered in the next years using future technologies.



Static thermoelectric converter (TEC) module

Expected results

a) Timeline & main milestones

M1.1 July 2010, RECYCLE Kick Off Meeting

M1.2 Oct. 2010 Rotorcraft waste heat specification
M2 Dec. 2010, Global WHR system specification
M3 Nov. 2011, Behavioural model of WHR system simulation concept studies validation
M4 Dec. 2011, CSTM choice of optimized solution: Heat recovery system integrated power network simulation concept studies validation
M5.1 June 2012, System design review
M5.2 June 2012 Mechanical and control system design review
M6.1 May 2013, Test matrix defined.
M6.2 June 2013, Test of optimised design completed

b) Environmental benefits

More electrical aircraft, less engine power requirement, less fuel burn, less emission, less pollution, more aircraft reliable operation, longer MTBO's.

c) Maturity of works performed

RECYCLE has performed initial laboratory scale dynamic wate heat recovery experiments using 4 boiler configurations and 3 different expanders. Also the project has undergone static waste heat recovery from a cluster of 24 thermoelectric modules.

Project Summary

Acronym :	RECYCLE
Name of proposal:	"theRmalEnergy reCoverYeleCtricaLsystEms"
Technical domain:	Greening of rotorcraft power networks
Involved ITD	Green Rotorcraft
Grant Agreement:	267643
Instrument:	Clean Sky
Total Cost:	250 000€
Clean Sky contribution:	187 500€
Call:	SP1-JTI-CS-2009-02
Starting date:	July 2010
Ending date:	June 2013
Duration:	36 months
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