Intercooled Core Concept

Intercooled and recuperated cycles have the potential for lower SFC, but intercooling alone still offers benefits and may be more cost effective as it avoids the weight and complexity of a recuperator (Fig. 1).

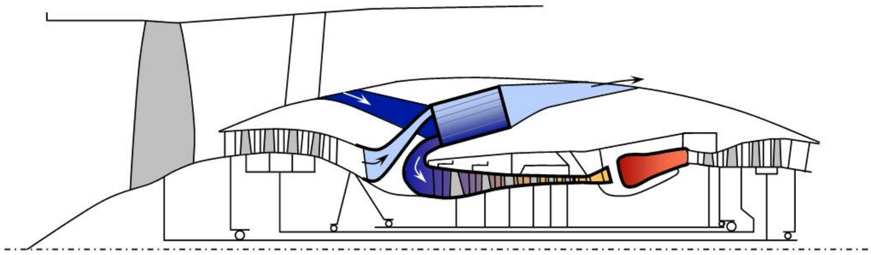

Fig. 1: Schematic of engine with intercooled core

The concept developed in NEWAC is the high OPR intercooled turbofan engine, which uses part of the bypass duct airflow for intercooling. Intercooling reduces the work required to achieve a given OPR, or enables OPR to be increased for the same work. It also reduces HP compressor delivery temperature relative to a simple cycle gas turbine. This means that the combustor temperature rise is bigger for a given TET and the turbine cooling air is cooler so that less cooling air mass flow is required. These effects increase the specific power of the core, so that core size and mass flow are reduced and bypass ratio is increased for an engine of given thrust and fan diameter.

The above effects all improve thermodynamic efficiency, but this improvement is off-set by pressure losses in the heat exchanger and ducting systems. To make inter-cooling viable these pressure losses and the cost, weight and volume of the inter-cooler must be minimised.

Because intercooled engine cycles have lower flame temperatures for a given TET they also have fundamentally reduced NOx emissions.

The cross-section of a typical intercooled turbofan is shown figure 2, and figure 3 shows one way of arranging a number of intercooler modules around the core of such an engine.

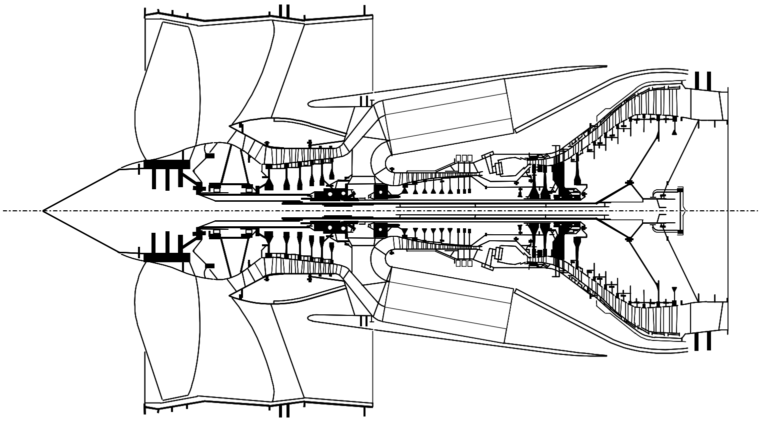

Fig. 2: Typical Intercooled 3-Shaft Engine with Direct Drive Fan

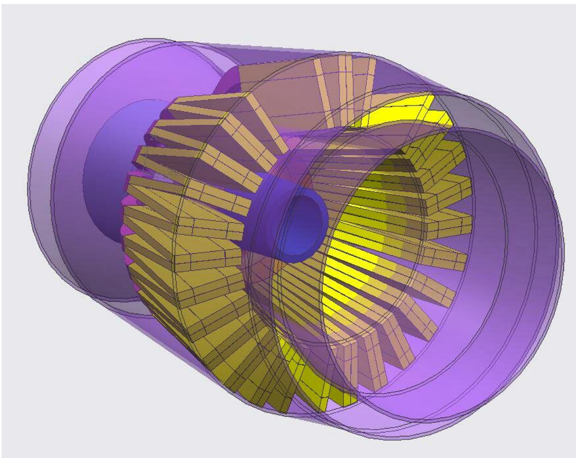

Fig. 3: Intercooler Modules Arranged Around the Core of an Engine

NEWAC will research the technologies required to realize an efficient intercooled aero engine. Activities include the preliminary design of a high OPR intercooled compression system, the aerodynamic design and testing of high pressure and low pressure ducts to take air to and from intercooler modules, the mechanical design and analysis of an advanced intercase structure incorporating the new high pressure ducts, the design optimisation of a very compact and lightweight cross-corrugated heat exchanger module and the manufacture and testing of heat exchanger components.

It also includes the design and rig testing of a high pressure compressor and some associated technologies to enable compressor efficiency to be maintained and improved at the smaller core sizes and higher pressure ratios required for the intercooled aero engine.

The objective is to demonstrate the potential for a 4% SFC improvement and a 16% NO_x reduction from a combination of intercooling, cooler turbine cooling air and compressor efficiency improvements.