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Thermal History Paint case study

Rotary engine for Unmanned Aerial Vehicles

The novel technology, Thermal History Paint, was successfully demonstrated on a rotor from a compact rotary engine. Temperature measurements were recorded at over 70 locations with an estimated precision of ±4°C. The measurements confirmed predictions that could not be tested using any alternative technique, hence, provided invaluable data for the development of engine designs.

Key facts	*Industrial sector*	Aerospace	*Temperature range*	150-300°C
	Component	Rotor with cooling fins	*Rotational speed*	4000-7500 RPM
	Component material	Steel	*Test duration*	~40 minutes

Quote from AIE

"In the past we have unsuccessfully tried traditional colour changing thermal paints. However, the novel Thermal History Paint remained adherent and I was blown away by the vast amount of high quality temperature data. Further, AIE was very pleased with the detailed reporting and guidance provided by SCS which has given us a critical insight into the thermal characteristics of our engine and hence provided us with a major competitive advantage. " **Nathan Bailey, Managing Director, AIE**

Introduction

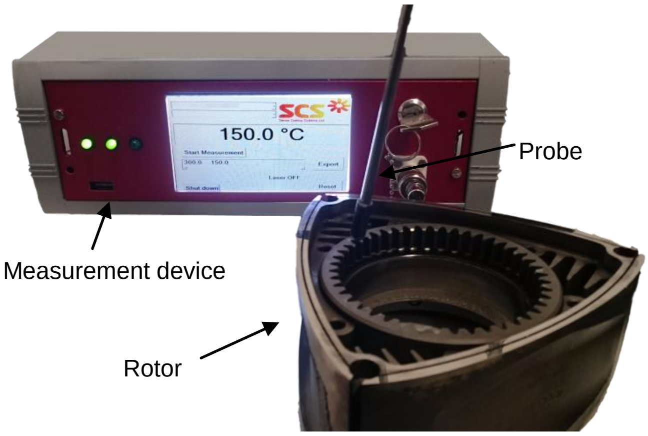
Advanced Innovative Engineering (AIE) have developed a range of compact rotary engines providing lightweight power for Unmanned Aerial Vehicles (UAVs) and high performance vehicles. The engines use their patented SPARCS cooling system to improve performance[1]. AIE required accurate temperature measurements on the rotor to validate the cooling design and feedback into the further development of new engine designs. Previous attempts to measure temperatures inside the engine were unsatisfactory due to the limitation of available measurement technologies. AIE recognised that the novel Thermal History Paint (THP) technology[2] offered by Sensor Coating Systems (SCS) provided the ideal solution. It enables measurements to be recorded over the entire component without requiring access during operation.

Major benefits of THP

No access during operation	*Non-toxic paint*	*Objective interpretation*
3D temperature profiles	*Durable coating*	*Automated read-out*

Results on the rotor

THP was applied to the internal surfaces of the rotor by SCS. It was then installed and operated by AIE in their test engine. The engine speed was gradually increased to reach wide open throttle where it was held for 10 minutes at a rotation speed of 7500 RPM. After operation, there was no damage to the THP and some typical oil and soot deposits were on the painted surfaces. SCS cleaned the rotor and measurements were possible at almost all locations, measurements could not be recorded only in the areas of very heavy deposits where the appearance was pitch black.



A measurement in action on the rotor

SCS generated specific calibration data for the test which indicated a precision of ±4°C. The data was used to convert the measurements into temperature at 74 locations. The results quantified the thermal gradient along the cooling fins (2-5°C/mm) and the temperature differential from the drive side to non-drive side. The measurements confirmed simulations that would otherwise be untested due to lack of viable techniques. A follow-on project is being planned. For further information about THP, please contact SCS (details in the header).

1. Further details at: http://www.aieuk.com
2. Journal publication on THP available at: http://turbomachinery.asmedigitalcollection.asme.org/article.aspx?articleID=2237963