ACCIDENT

Aircraft Type and Registration:	Avid Speedwing Mk 4 Flyer, G-LORT
No & Type of Engines:	1 Rotax 582 piston engine
Year of Manufacture:	1992
Date & Time (UTC):	10 April 2010 at 1534 hrs
Location:	Field at Holne, Newton Abbot, Devon
Type of Flight:	Private
Persons on Board:	Crew - 1 Passengers - None
Injuries:	Crew - 1 (Serious) Passengers - N/A
Nature of Damage:	Serious damage to forward fuselage structure and landing gear
Commander's Licence:	Private Pilot's Licence
Commander's Age:	59 years
Commander's Flying Experience:	1,182 hours (of which 14 were on type) Last 90 days - 2 hours Last 28 days - 2 hours
Information Source:	AAIB Field Investigation

Synopsis

While cruising at approximately 1,900 feet, the pilot noticed the engine coolant temperature rising rapidly. He reduced the engine speed from 5,100 to 4,000 rpm but about 15 seconds later the engine stopped suddenly, without being preceded by any rough running. The pilot attempted to carry out a forced landing into a field but stalled the aircraft at a height of about 15 feet just short of the field. An examination revealed that the engine had seized in flight due to overheating. The overheating was probably caused by a loss of radiator coolant.

History of the flight

The Avid Speedwing Mk4 is a homebuilt aircraft operated under a Permit to Fly. It has a tailwheel configuration with a high wing and a maximum takeoff weight of 463 kg. The pilot had bought the aircraft in 2009 and had completed a conversion course on to the type in April 2009 under the LAA coaching scheme. In May 2009 he suffered two engine failures and carried out two successful forced landings. The engine was removed and deemed beyond economical repair so a new Rotax 582 engine was fitted in October 2009. The pilot did not fly during the winter and then carried out an uneventful flight on 18 March 2010. On 10 April 2010, after carrying out a pre-flight check which included removing the engine cowling, he departed for a flight to

Eaglescott, which was uneventful. After stopping for a coffee he performed another pre-flight check (this time without removing the engine cowling) and carried out a further flight, to Bodmin. After refilling the fuel tank at Bodmin and carrying out another pre-flight check (also without removing the engine cowling) he departed for Clutton Hill Farm. The weather was CAVOK with a light variable wind from the east and north-east.

While cruising at approximately 1,900 feet, 30 nm east of Bodmin, the pilot noticed the coolant temperature gauge needle rise rapidly to the vertical position (approximately 200°F indicated). He reduced the engine speed from 5,100 to 4,000 rpm, which reduced the coolant temperature over a period of about 15 seconds, but then the engine and propeller stopped suddenly, without being preceded by any rough running. The pilot did not attempt to restart the engine and altered course to the south-east to find a field for a forced landing; the terrain elevation was approximately 500 feet. As he approached his selected field from the south-west he noticed a hedge at the southern end of the field but expected to clear it. However, the aircraft stalled just short of the hedge and the aircraft hit the ground hard, causing the main landing gear to collapse and the forward fuselage structure to buckle; it stopped with no ground roll. The pilot estimated that the aircraft "fell" about 15 feet at a speed of less than 55 mph. The pilot was wearing a lap strap and shoulder harness, but suffered a broken left forearm and a fractured right eye socket and cheekbone, which the pilot attributed to his body rotating to the left and the right side of his head striking the instrument panel.

Aircraft examination

The aircraft was examined on site by the LAA inspector who had carried out the engine installation. He noted that the engine turned freely and that there were a number of spots of coolant on the engine. The left radiator had a hole in it and was oozing coolant and a number of coolant hoses had been disrupted on impact. He reported that the ground beneath the fuselage was damp – possibly from coolant leakage. He did not see any evidence of coolant on the tail surfaces or brace struts.

Engine examination

The aircraft was recovered to the AAIB where the engine was examined and stripped with the assistance of two engineers from a Rotax agent. The examination revealed that the piston, in the forward ('power takeoff'[1]) cylinder, had scoring marks on opposing sides of its walls (Figure 1). The walls of the 'power takeoff' cylinder were similarly scored and this damage was consistent with the piston having seized during operation. The piston and cylinder walls of the aft ('magneto') cylinder were undamaged. There was no evidence of detonation on the piston surfaces, which

Figure 1

'Power takeoff' piston showing vertical scoring marks consistent with piston seizure

Footnote

[1] The cylinder closest to the propeller flange is referred to as the 'power takeoff' cylinder, while the cylinder closest to the magnetos is referred to as the 'magneto' cylinder.

indicated that an excessively lean mixture was an unlikely factor. There was sufficient oil in the engine and no evidence of oil pump failure or noticeable lack of oil surrounding the pistons. According to the engineer from the Rotax overhaul organisation, the evidence of scoring on opposing sides of the cylinder was consistent with overheating from insufficient cooling by the liquid cooling system. In his experience piston seizure from inadequate lubrication would have resulted in scoring around the entire circumference of the piston, which was not the case here. The piston-to-cylinder wall clearances were measured and were within specification.

Radiator examination

The radiator in this model has a capacity of 2.75 litres, but only 0.4 litres of coolant were recovered from the radiator and overflow bottle. There was clear evidence of impact damage to the radiator, its fittings and hoses, which would have resulted in much of the coolant loss. It was therefore not possible to pressure-test the system to examine for possible pre-impact leaks. The coolant level in the overflow bottle was below the 'minimum cold' red line; it was just under ¼ full, but should have been at least ⅓ full. This level was probably a reliable 'pre-impact' indication as the aircraft did not turn over. The red line on the overflow bottle was not initially visible, as it was covered by a circular strap bracket retaining the bottle (Figure 2). It was only when the bottle was pushed upwards into its correct seating position that the red line became visible (Figure 3). The pilot considered that he would have noticed if the bottle had not been correctly seated prior to the first flight of the day, and believes it more likely that the bottle slipped in its bracket during the impact.

Apart from the incorrect position of the overflow bottle, the radiator installation was found to be in accordance

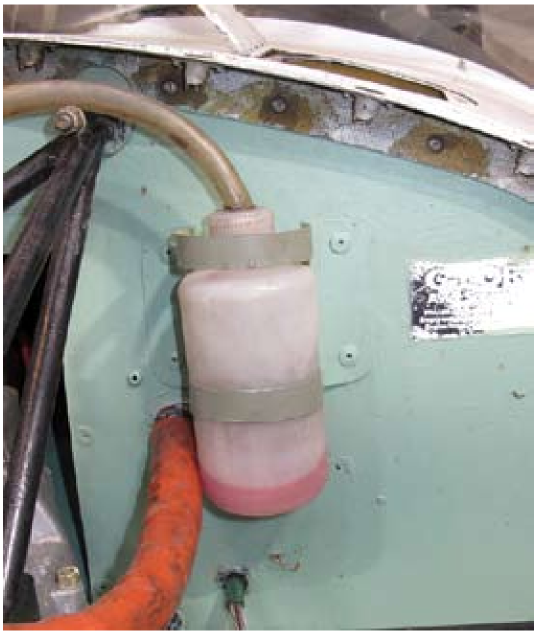

Figure 2

Radiator overflow bottle in the as-found position with the as-found coolant quantity

Figure 3

Radiator overflow bottle after being pushed up into its correct seating position (red 'minimum cold' line visible) with the build manual for the Avid Speedwing Mk4[2], but was different to the installation described in the Rotax installation manual. The Rotax installation manual describes an installation with a single radiator and does not describe how to install a dual radiator system. The Rotax manual also depicts an expansion chamber that is significantly larger than the one fitted to G-LORT (Figure 4). In the G-LORT dual-radiator installation the coolant flows from the top of the right radiator ('RT') to the top of the left radiator ('LT') as depicted in Figure 4. The Rotax agent engineer suggested that with this installation and the small expansion chamber it might not require a significant coolant loss before the air gap was large enough in the upper connecting hose to stop the coolant flowing from the right radiator to the left radiator. The LAA were contacted regarding this installation and they confirmed that it was installed in accordance with the Avid build manual for the type, and that the LAA had approved the type based on successful in-service experience. They were not aware of any particular cooling issues on this version of the type. The builder of the aircraft stated to the LAA that he had not experienced any overheating problems with G-LORT.

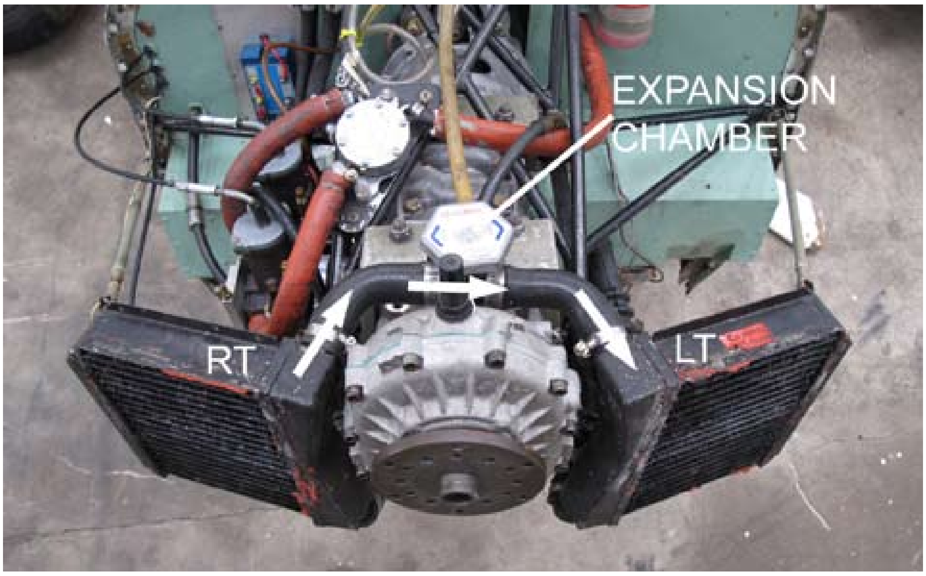

Figure 4

Dual radiator installation on G-LORT; white arrows show direction of coolant flow

The thermostatic valve inside the radiator was removed and placed in water at 80°C whereupon it started to open immediately. It started to close when the water temperature had dropped to 60°C. This was in accordance with its nominal operating temperature of 65°C.

The radiator filler cap was of the correct type with a vent pressure of 90 KPa (13 psi). An inspection of the radiator pump and its impeller did not reveal any anomalies.

Coolant temperature sensor and gauge examination

The coolant temperature sensor and temperature gauge were removed from the aircraft and tested together. At a water temperature of 196°F (91°C) the gauge was indicating about halfway between the 100° and 180° marks (Figure 5). The scale on the gauge did not appear to be linear so it was not possible to determine what the two marks between 100° and 180° represented, but it was apparent that the gauge was under-reading by about 40°F to 60°F.

The pilot reported that during normal operation the gauge had never indicated more than just over the 100°F mark. He had been advised that the needle must be "off the stop" but that a low reading was "OK". The Rotax 582 operator's manual lists the minimum coolant temperature as 150°F (65°C) and the maximum

Footnote

2 Rotax mod 99 was embodied

as 175°F (80°C). These figures are consistent with the gauge under-reading by about 40°F to 60°F when it was indicating just over the 100°F mark. During the accident flight the pilot saw the gauge needle rise rapidly to the vertical position, which is about the 200°F mark. Therefore, the coolant temperature had probably risen to about 240°F to 260°F, well above the maximum operating limit. The coolant temperature is measured at the cylinder head block.

Figure 5

Coolant temperature sensor and gauge test
(91.3°C = 196°F)

Coolant level checks

In order to check the coolant level on this engine installation, the engine cowling must be removed, which involves removing about 25 screws. The pilot stated that he removed the engine cowling and checked the coolant level in the radiator prior to his first flight to Eaglescott and that it was about ½″ below the radiator filler cap, and although he could not recall checking the level in the overflow bottle, he believes he would have noticed if it had been below the red line. Prior to departing Eaglescott, and prior to departing Bodmin, he did not re-check the level in the radiator or the overflow bottle. The pilot stated that he did not notice any water dripping beneath the engine at any stage.

Analysis

The evidence from the scored 'power takeoff' piston was indicative of the piston having seized due to overheating. This evidence was consistent with the pilot's report that the engine stopped suddenly after a rapid rise in coolant temperature. The pre-impact coolant level quantity in the radiator could not be positively established due to multiple leaks suffered following impact, but the coolant level quantity in the overflow bottle was below the minimum required. This may have been an indication that the radiator was suffering from a leak, because if the level in the radiator was reducing due to a leak, then replacement coolant from the overflow bottle would have been sucked in. The design of the dual radiator installation, with the small expansion chamber, meant that it was probably less tolerant of a coolant leak than the Rotax-recommended installation - meaning that a smaller loss of coolant was necessary to stop the flow. The amount of coolant that would need to be lost, in the G-LORT installation, to stop the flow was not established. There were no defects with the radiator pump or thermostatic valve so the most probable cause of the engine overheating was a loss of coolant. It could not be established where the coolant leak occurred, when it started, the leakage rate, or why it was not noticed.

The fact that the coolant temperature gauge was under-reading by 40°F to 60°F was not picked up, even though it was indicating well below normal minimum operating temperature in flight. If this problem had been fixed, and if the temperature gauge had been marked with the minimum and maximum limits, then it is possible that the temperature exceedence would have been noticed sooner, providing the option of a precautionary landing under power. In the event the engine stopped, and although the aircraft had sufficient height for a successful forced landing, the pilot stalled the aircraft just short of his intended field. The pilot candidly admitted that his lack of currency on type was probably a contributory factor.

Conclusions

The engine seized in flight due to overheating and the pilot attempted to carry out a forced landing into a field but stalled the aircraft at a height of about 15 feet just short of the field. The engine probably overheated due to a loss of radiator coolant from an unidentified leak.