Aeroprakt A22 Foxbat, G-FXBT

AAIB Bulletin No: 11/2003	Ref: EW/G2003/05/12	Category: 3
Aircraft Type and Registration:	Aeroprakt A22 Foxbat, G-FXBT	
No & Type of Engines:	1 Rotax 912ULS piston engine	
Year of Manufacture:	2002	
Date & Time (UTC):	9 May 2003 at 1850 hrs	
Location:	Mapperton Farm, near Wimborne, Dorset	
Type of Flight:	Private	
Persons on Board:	Crew - 1	Passengers - 1
Injuries:	Crew - None	Passengers - None
Nature of Damage:	Damage to nose wheel, underside of nose, cabin floor, engine firewall and engine bearer	
Commander's Licence:	Private Pilot's Licence with microlight rating	
Commander's Age:	66 years	
Commander's Flying Experience:	669 hours (of which 36 were on type)	
	Last 90 days - 14 hours	
	Last 28 days - 3 hours	
Information Source:	Aircraft Accident Report Form submitted by the pilot	

History of flight

The aircraft was kept in the open at a farm strip, but was equipped with a full set of covers. Prior to the flight, in accordance with his normal procedure, the pilot drained the first litre or so of fuel from each wing tank via a common drain valve located at the lowest point of the fuselage. He then added fuel so that each tank was slightly over half full. After starting, the engine, which the pilot described as usually being slow to warm up, was run at 2,500 rpm for 5-10 minutes.

The takeoff was uneventful and the aircraft was initially flown at around 600 feet above ground level, with the right fuel tank selected. After approximately three minutes the engine suddenly faltered and the RPM reduced, followed some 3-5 seconds later by a complete stoppage. The pilot immediately selected a field for a forced landing, as he considered he was too low to attempt to restart the engine. In any case, it occurred to him that the manner in which the engine stopped appeared to be final.

The selected field had a significant up-slope for the first portion, leading to a level area thereafter. The surface of the field was grass pasture and was quite rough. The pilot considered that the landing direction was approximately into wind.

The final approach appeared satisfactory other than the speed was high. The initial touchdown was on the nose and left main wheel. Following a short bounce the aircraft then landed on all three wheels. Subsequent examination of the groundmarks indicated that the aircraft continued for 30-40 metres before the nosewheel entered a pothole, causing damage to the spat. After another 18 metres the nose leg collapsed, allowing the underside of the nose to contact the ground. The aircraft came to a halt some 15 metres further on, after veering to the right. The occupants were uninjured and exited via the doors. The pilot was able subsequently to drain much of the fuel from the tanks, indicating that adequate fuel had been available.

Examination of the aircraft

The aircraft owner recovered the aircraft to an appropriate maintenance company, where it was examined and repaired. The investigation concentrated on the engine and fuel system.

The fuel system consists of a tank in each wing with the fuel delivery lines running down behind pillars on either side of the cabin. An ON - OFF selector is fitted in each line, which gives the pilot the option of running the engine from the left, right or both tanks. The fuel lines meet at a T-piece in the centre of the fuselage, with a single line going to the engine. The fuel drain valve is located just downstream of the T-piece. Once in the engine compartment, the fuel is fed to the carburettors via a gascolator, a fuel flowmeter and an engine driven pump.

The engine is liquid cooled, with a dual electronic ignition system. Twin carburettors feed the inlet manifolds, which are heated by the engine coolant; there is no conventional carburettor heat control.

Examination of the engine revealed no defect although when it was subsequently ground run, it was found that fuel was pouring from the overflow on the right hand carburettor. This could have been caused by a piece of grit jamming the float valve, although it was thought more likely to have been the result of the valve becoming jammed by the shock it received in the impact. Despite the overflow condition, the engine continued to run smoothly. When the carburettor bowl and float assembly were examined, no contamination was evident and, after re-seating the float valve, the carburettor operated normally, with no overflow. The fact that an overflow occurred indicated that the fuel pump was operating, although even if it had failed, the high wing design of the aircraft would result in the engine being adequately supplied by gravity fed fuel.

Fuel flow checks from both tanks were normal, and the fuel system appeared to be exceptionally clean, with no contamination found in the gascolator filter or bowl. A boroscope inspection of the fuel tanks was conducted in order to examine for evidence of flakes of fuel tank sealant blocking the otherwise inaccessible coarse filters at the fuel outlets; none was found.

During one of the ground runs, the fuel was shut off at about 4,400 RPM, which was the condition at the time of the failure (take-off RPM being 5,200 with the aircraft stationary). The engine ran normally for about 30 seconds before running irregularly for a few seconds and then stopping. This supported the generally held view that the failure was the result of fuel starvation, as opposed to, say, an ignition problem. The possibility of fuel vapour lock was considered but thought to be unlikely, as the day of the accident was relatively cool.

After extensive checks, the pilot flew the aircraft back to his private landing field. Although it was his practice to fly with either the left or right fuel tank selected, on this occasion he decided to fly with both tanks selected to ON. Prior to his departure, the right tank was less than a quarter full and the left tank was approximately half full. On landing, after a flight of around 15 minutes, he noted that the right tank was almost half full, with the left tank being less than a quarter full. After a period of time on the ground, the fuel levels in each tank equalised.

Additional testing of the aircraft

In view of the observations made during the flight to the private strip, additional tests were conducted on the aircraft, whilst it was tethered on level ground.

- With the fuel tanks initially empty, some 18-20 litres of fuel were placed in each of the 35 litre capacity tanks. However, when both tank selectors were turned ON, no fuel appeared on operating the drain valve. The pilot commented that he had observed the same phenomenon when he originally built the aircraft, with fuel not flowing until he applied suction at the drain tube. This was difficult to explain, as, although the fuel feed line initially arched in an upwards direction immediately after the tank outlet, this did not appear to take it above the level of the tank. The drain valve was closed and an attempt was made to start the engine, with suction thus applied via the engine driven fuel pump. The engine started after being cranked for some 7-8 seconds and ran normally. Thereafter, with the system now primed, subsequent starts were virtually instantaneous.

- Each fuel tank vent line consisted of a tube attached to an outlet at the top of the forward section of the tank, and which terminated in a forward facing tube on the underside of the inboard area of the wing. Thus the tanks were pressurised by ram air entering the tubes, the locations of which would cause them to be additionally influenced by the propeller wash. An attempt was made to assess whether the pressure was the same under each wing. This was achieved by attaching a length of plastic tube to the pitot head and taping the open end to the underside of each wing in turn, adjacent and parallel to the vent tube. The engine was run up to 4,400 RPM, and the airspeed indication was noted in each case. The results for the left wing were 60 mph, ± 5 mph, with the right side reading being 45 mph, ± 5 mph. The propeller on this aircraft rotated in a clockwise direction when viewed from the rear, and it was apparent that the "corkscrew" nature of the propeller wash was causing differential pressurisation of the fuel tanks. The results obtained here of course did not give an indication of the likely magnitude of the pressure difference between the tanks with the aircraft in the cruise. However, they did suggest an explanation for the fuel transfer that occurred during the previous flight.

- The drain valve was opened and the time for one litre of fuel to flow into a measuring jug was taken for each tank in turn. The results were 20 seconds for the right tank, and just over 18 seconds for the left. The test was repeated with the fuel line disconnected immediately downstream of the fuel flowmeter, where the flow rate was found to reduce to 50 seconds and 46 seconds for the right and left tanks respectively. (Note: the fuel flow indicator was turned on for the latter tests, and indicated a broadly compatible 60+ litres/hour. The maximum demand of the engine is around half this value.) The fuel flowmeter was from a different manufacturer than with some other Rotax 912 installations, and which have caused engine failure when the internal rotor becomes seized. (See, for example, AAIB Bulletin 1/2003, incident to Europa XS, G-IOWE.) However, although it was not possible to disassemble the flowmeter from G-FXBT without losing the calibration, the manufacturer claimed that any seizure of the rotor would not impede fuel flow.

- A pitot tester was attached to each tank vent tube in turn and the tank "pumped up" to a pressure equivalent to 90 mph (a typical cruising speed). The fuel flow was measured for each tank by operating the drain valve. The results were 19 seconds/litre and 17 seconds/litre respectively for the right and left tanks, ie approximately 1 second faster than the unpressurised values.

- The pitot tester was connected to the left fuel tank vent and a pressure equivalent to 30 mph was applied, which was twice the difference observed with engine running at 4,400 RPM. Both fuel tanks were selected ON and although the gauges were not sufficiently accurate to provide a quantitative indication, it was noted that a "significant" amount of fuel was transferred from the left tank to the right. After 10 minutes the transfer process stopped as the increased pressure in the left tank became balanced with the higher head of fuel in the right tank. The result suggested that the differential fuel tank pressure would be unlikely to empty the left tank.

Following these tests both fuel tanks were removed from the aircraft and subjected to a detailed boroscope inspection that attempted to be more thorough than the examination carried out earlier with the tanks in situ. In the event, the tight internal baffling prevented the boroscope probe reaching some of the areas, including the fuel outlet area. Some debris was observed in both tanks, this mostly consisting of terracotta-coloured particles lightly adhering to the internal surfaces. One of the larger particles was examined at QinetiQ's Fuels and Lubricants Centre at Farnborough. The analysis revealed the substance to be a friable agglomeration of alumino-silicate and an aliphatic ester. There was no clue as to its origin, although it is possible that it came from the fuel containers or the hand operated pump (used for transferring the fuel from the containers to the aircraft).

Summary

No conclusion was reached with regard to the cause of the engine failure, despite the examination of the engine and fuel system. The observations made during the flight that followed the repair of the aircraft suggested a possible restriction in the fuel line from the right tank. In the event, the series of tests conducted following this flight indicated that the left tank vent line was being subjected to a higher dynamic pressure than the right, which caused a certain amount of fuel to be transferred. As a result of this finding, the aircraft kit importer and the Popular Flying Association, (the organisation responsible for the airworthiness of this type of aircraft) are considering a modification in the form of a tube that links together both tank vent lines. This will ensure that both fuel tank pressures are equal.

The origin of the contamination in the fuel tanks was unexplained, although some of the particles would have been large enough to restrict the fuel flow out of the tank. The possibility of the debris being responsible for the engine failure may have had more credence if small particles had also been present in the gascolator. The nature of the tank construction was such that examination of the fuel outlet was impossible, which although an undesirable feature, is no different to the installations in a number of PFA aircraft.

Finally, it should be noted that since the aircraft was repaired, the engine has been performing satisfactorily.