AIRCRAFT ACCIDENT SHORT REPORT

CA18/2/3/9719 ZU-CRF, Mohawk forced landing in Stillbaai River shortly after takeoff

Date and time	:	12 June 2018
Location	:	Stillbaai, Western Cape
Occurrence type	:	Accident
Aircraft registration	:	ZU-CRF
Aircraft manufacturer and model	:	Mohawk
Last Point of departure	:	Stilbaai Aerodrome, Western Cape (elevation 285 ft) (GPS co-ordinates: S34°21'3,21" E021°23'36,58")
Next point of intended landing	:	Stilbaai Aerodrome, Western Cape
Location of accident site with reference to easily defined geographical points (GPS readings if possible)	:	Stilbaai River (S34°21'14,23" E021°24'56,90", at an elevation of 10 ft)
Meteorological Information	:	Surface wind: 8 kt/300°, temperature 28°C, dew point: –1°C, pressure altitude: 1019hPa, CAVOK
Type of operation	:	Private (Part 94)
Persons on board	:	1+1
Injuries	:	None
Damage to aircraft	:	Substantial

All times given in this report is Co-ordinated Universal Time (UTC) and will be denoted by (Z). South African Standard Time is UTC plus 2 hours.

Purpose of the Investigation:

In terms of Regulation 12.03.1 of the Civil Aviation Regulations (2011) this report was compiled in the interest of the promotion of aviation safety and the reduction of the risk of aviation accidents or accidents and ***not to establish blame or liability.***

Disclaimer:

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Figure 1: Mohawk ZU-CRF (Source: Pilot/owner)

1. SYNOPSIS

1.1 The pilot, accompanied by a passenger, took off from Stilbaai Aerodrome (FACY) in the Western Cape Province. The purpose of the flight was a scenic flight over the Stilbaai area.

1.2 Just after the aircraft departed the runway, the aircraft experienced an engine failure at approximately 300 feet (ft) above ground level (AGL). The pilot executed a ditch into the Stilbaai River 0.33 nm from the threshold of runway 09.

1.3 The investigation revealed that the accident was most probably a result of an engine failure due to a cold seizure.

2. FACTUAL INFORMATION

2.1 History of flight

2.1.1 The pilot, accompanied by a passenger, took off at 1230Z from FACY, Western Cape Province. The flight was to be conducted as a scenic flight, and the pilot planned to remain airborne in the area for 30 minutes.

2.1.2 The pilot reported that he completed a pre-flight check and found all to be in order. He also reported to have completed all power checks to his satisfaction. The aircraft was lined up on runway 27, took power and gained airspeed. The aircraft rotated and had climbed to a height of 300ft AGL when it experienced a complete engine failure whilst at a position indicated as point A in Figure 2 below.

Figure 2: Google Earth map showing the track and location of the accident in relation to FACY. (This illustration is not accurate and only represents the flight path explained by the pilot).

2.1.3 The pilot decided to execute a forced landing. The height at which the engine failed did not allow the pilot much options for a landing area. The pilot also had to take into consideration the power lines in the area, while attempting to restart the engine. The engine was unable to restart. The pilot then decided to ditch (point B in Figure 2).

2.1.4 The aircraft sustained substantial damage to the propeller, the airframe, the main landing gear and water damage due to ditching. Neither of the occupants sustained injuries.

2.1.5 The accident occurred during daylight conditions at a geographical position determined to be S34°21'14,23" E021°24'56,90", at an elevation of 285 ft AMSL.

2.2 Additional Information

2.2.1 The Rotax 582 UL DCDI mod. 99 had been installed on the Mohawk. This system includes:

- a two-stroke engine, with two cylinders in line with a rotary valve inlet
- liquid-cooled cylinder head and cylinders
- an integrated water pump
- mixture lubrication or oil-injection lubrication
- dual ignition of a breakerless magneto capacitor discharge design.[1]

The cylinder:-

- constructed using two light alloy cylinders with cast iron sleeve [5]
- Linear Temperature Expansion Coefficient 10,8 x 10^{-6} m/mK [4]
- Specific heat cast iron 0,46 kJ/(kg K) [6]

The piston:-

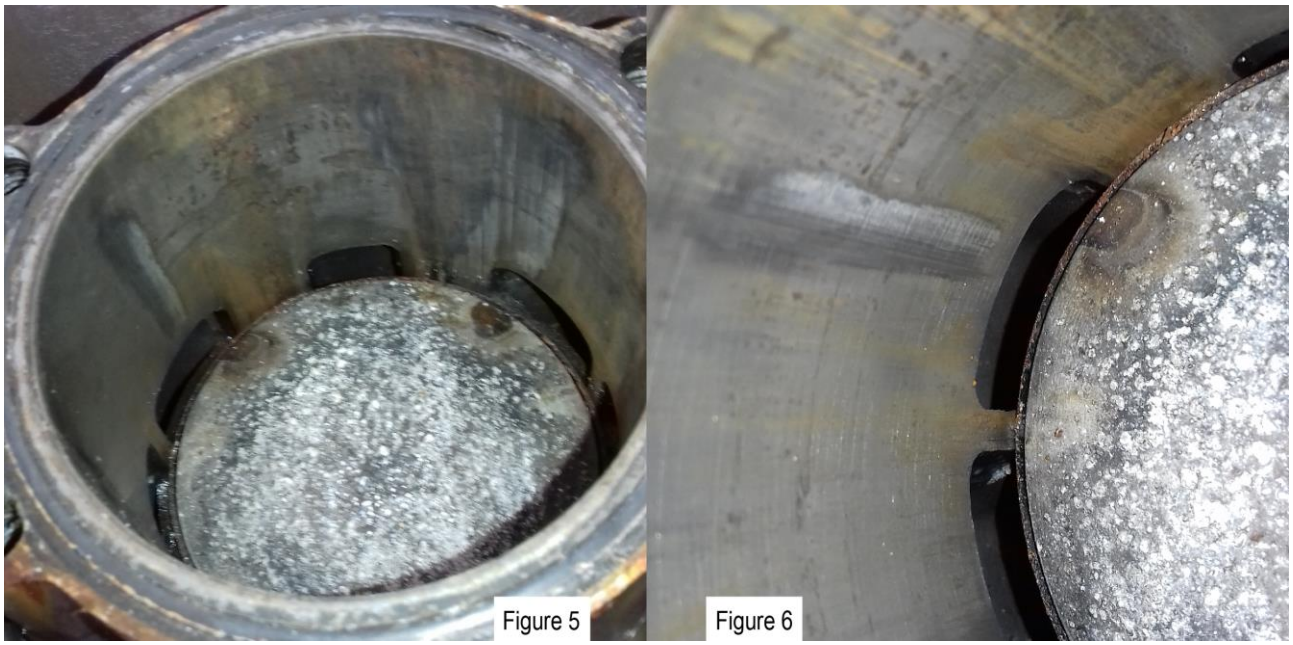
- constructed using cast aluminum piston with 2 piston rings [5]
- Linear Temperature Expansion Coefficient 24 x 10^{-6} m/mK [4]
- Specific heat aluminum 0,9 kJ/(kg K) [6]

2.2.2 The engine was inspected by an approved person (AP) and no abnormalities were found except for the scaring shown in figure 5 and 6. These abnormalities indicate a cold seizure occurring.

COLD SEIZURE:

"A cold seizure is the result of the piston expanding too fast with respect to its cylinder in an internal combustion engine. The engine is constructed using many different types of materials all housed together and designed to work as one system. All internal engine components, when heated (running engine) will expand to some extent. This expansion is normal and unavoidable. Different components will expand at different rates and will expand to different extents. When you fire an engine that has cooled down (all components are at their natural state, meaning there is no expansion occurring due to heat), these components will begin their expansion all over again. It is these expansion rate differences that will cause an engine to cold seize. The whole engine is being heated and, as a result, all of its internal components are expanding at different rates. The initial expansion is what needs to be considered to avoid a cold seize. Once these engine components have reached their full expansion, then the engine should operate within its design specification and be safe to run. If the cold engine is fired up and immediately receives large amounts of heat to the components, there is a high risk that these varying expansion rates collide and cause seizure."[2]

Figure 4: The aircraft as it was positioned after ditching in the Stilbaai River. (image/photograph courtesy of first responder to the crash site)



Figures 5 & 6: The damage experienced by the piston with respect to its cylinder.
(image/photograph courtesy of approved person inspecting the engine)

3. FINDINGS

3.1. The pilot was issued with a commercial pilot licence on 15 September 2005. He conducted a CPL renewal on the 27 March 2018 with an expiry date of 31 March 2019. He was also issued a medical certificate on 22 March 2018 with an expiry date of 30 September 2018 and his licence was type endorsed.

3.2. The aircraft is privately owned and operated under Part 94 of CARs 2011.

3.3. The aircraft was issued with an Authority to Fly certificate, which expired on 8 February 2019, in accordance with the regulatory requirements.

3.4. The aircraft had flown a total of 63.9 hours prior to the accident.

3.5. An annual inspection was performed on 25 October 2017 at 55.9 hours. The next service was the 25-hour inspection, which was due on 24 October 2018 or at 80.9 hours.

3.6. The pilot opted to perform the forced landing over the Stilbaai River due to the prevalence of wires found after departing FACY runway 27.

3.7. The aircraft was substantially damaged. A propeller blade broke off on impact. The airframe bent due to the forces experienced on impact. The aircraft experienced water damage due to ditching.

3.8 An engine teardown was conducted by the relevant maintenance personnel, and except cold seizure no other abnormalities were found.

3.9 The weather report was obtained from the South African Weather Service. The METAR for 12 June 2018 at FAGG was as follows: Wind: 300/08kts, Visibility: CAVOK, Temperature: $28^{0,}$ Dew point:-01 and QNH: 1019. The weather at the time leading to the accident had no bearing on this accident.

4 ANALYSIS

4.1 Considering a cold seizure, the sudden rise in high-pressure wave force and extreme, high temperature generated when pre-ignition, detonation, combustion instabilities, etc. occurs could result in excessive expansion, buckling, or damage of components parts of the engine. The linear temperature expansion coefficient for cast iron is half that of aluminium. Since a piston is subjected to very high temperature condition along with extreme and sudden compression and tensile forces on combustion as well as on thrust side, it calls for a material, which has a very high strength to weight ratio, and has a very high heat conductivity in order to minimize thermal fatigue.[3] This outcome rarely occurs and it is difficult to prove considering the engine parameters (temperature) are not recorded and saved. The warm up period before flight should ensure all temperatures are within safe limits (in the green).

5 PROBABLE CAUSE/CONTRIBUTING FACTOR

5.1 A cold seizure stopped the engine from running due to the restrictions experienced by the piston. This followed with the pilot conducting a forced landing.

6 REFERENCES USED ON THE REPORT

6.1 Rotax Aircraft Engines – Operator's Manual for Engine Types
(Rotax 582 UL DCDI mod. 99)

6.2 https://www.2strokeheads.com/index.php/site-map/articles/80-technical/81-what-causes-a-2-stroke-engine-to-cold-seize

6.3 http://www.theijes.com/papers/v5-i1/E0501030035.pdf

6.4 https://www.engineeringtoolbox.com/linear-expansion-coefficients-d_95.html

6.5 Rotax Aircraft Engines – Maintenance Manual (Rotax 582 UL DCDI mod. 99)

6.6 https://www.engineeringtoolbox.com/specific-heat-metals-d_152.html

6.7 http://www.rotaxservice.com/rotax_tips/rotax_feed2.htm

7 SAFETY RECOMMENDATION

7.1 None.

8 ORGANISATION

8.1 None.

This Report is issued by:

Accident and Incident Investigation Division
South African Civil Aviation Authority
Republic of South Africa