The cooling run of the turbocharger

…. and what happens if you don't comply with it

.... A story with a good ending:

a motorized glider comes in for a landing, trailing a subtle plume of oil behind it. The pilot is immediately informed of this from the ground.
The pilot lands, immediately switches off the engine and taxis as far as possible to the hangar. The rest of the way is pushed.

The main issues have now been clarified:

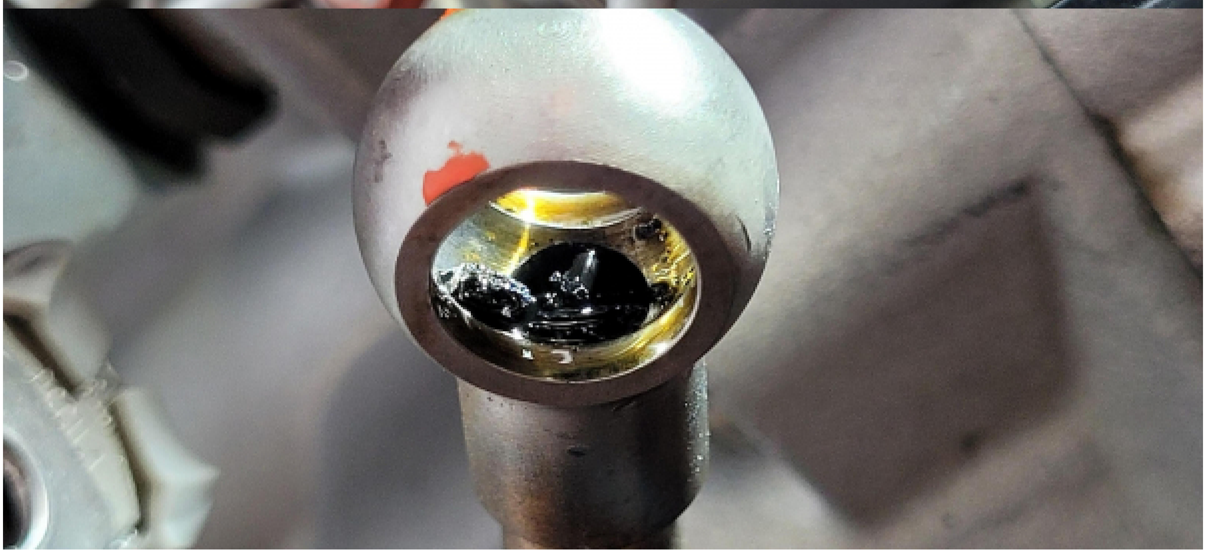
- no leak was detected on the engine
- there was always oil pressure in flight
- the oil level on the dipstick is just below minimum

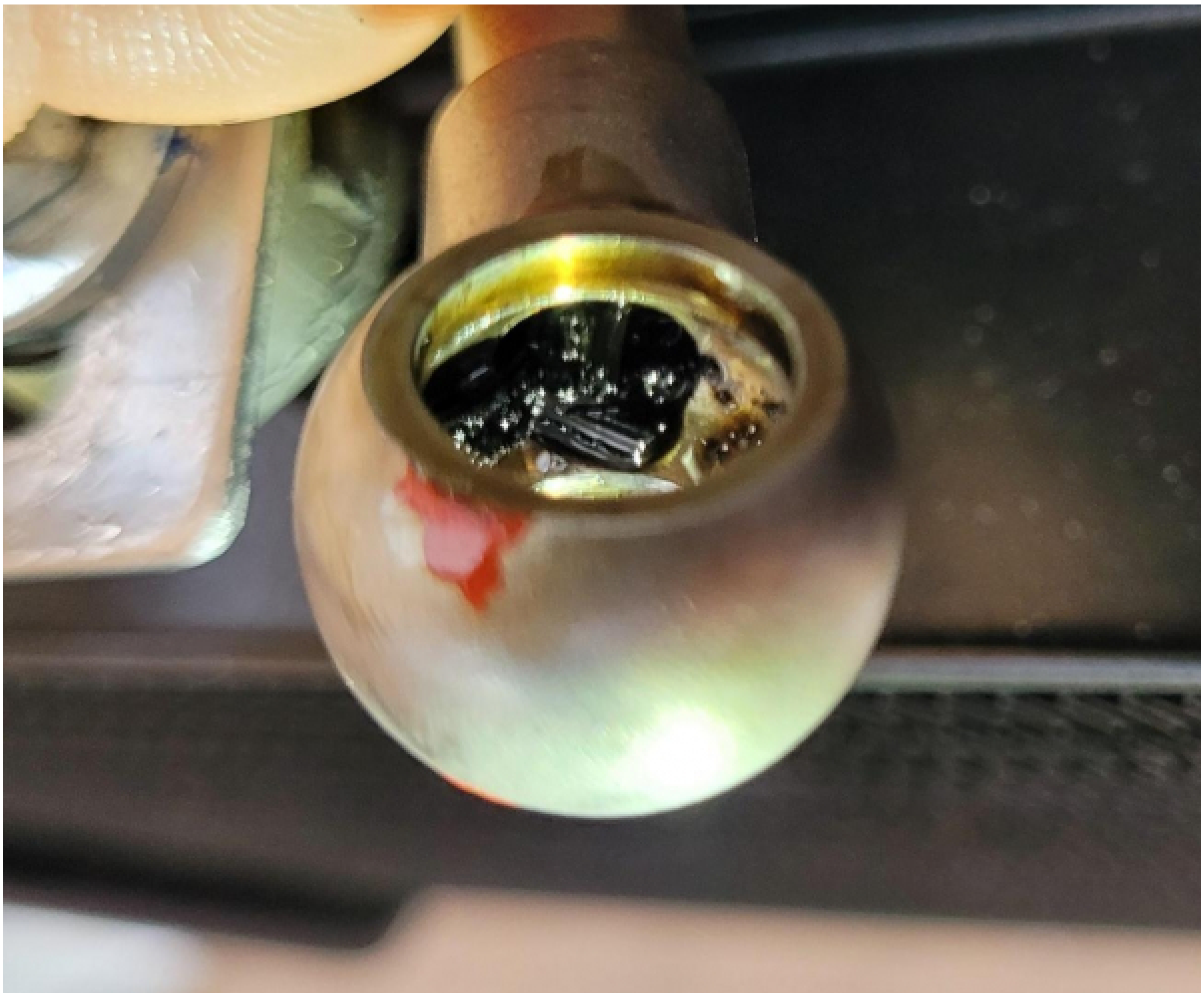
After a few phone calls, the strategy is determined.

- Dismantle the oil tank, filter the engine oil through a colored sieve and check for foreign bodies.
- Remove the banjo bolt of the oil suction line from the turbocharger at the oil pump and check for foreign bodies.
- Remove the oil sump from the turbocharger and check for foreign bodies.
- Check the oil suction line for passage and foreign objects.

.... Here are the pictorial results:

[1]





Anyone who flies a 914 should know this:[2]

3.8) Engine shut-off

General note Normally the cooling down of the engine during descending and taxiing will be sufficient to allow the engine to be shut off as soon as the aircraft is stopped.

At increased operating temperatures make an engine cooling run of at least minimum 2 minutes.

Of course, this was also the case here, which is why I was so surprised to find such lumps.

I know that the cooling run was actually always maintained - at least on the ground after landing.
The question is what the cooling run was like before you wanted to sail with the plane.
After all, it's a motor glider and that's what it was built for.

Unfortunately, the question could not be clearly answered, but it is reasonable to assume that the times of the cooling run were too short at some point.

However, it is quite clear that the „good outcome" of the story is due to the fact that the banjo bolt in front of the oil pump was not yet completely blocked. The amount of oil that could still pass through here was apparently just under the amount that was pumped to the center section to lubricate the turbocharger. The quantity that was not returned caused the oil to overflow at the points where the turbocharger shaft was positioned. As a result, the oil was forced out on both sides of the turbo, some of which ended up in the exhaust and some in the airbox, causing the oil plume.

The moral of the story, don't shorten the cooling run!

I keep preaching that the cooling run should be about 5 minutes **if at all possible**
Pilots are taught so many rules, which they usually follow, but this is where it somehow stops.
In this case, if the banjo bolt had been completely blocked by a large chunk, it is highly likely that a new engine would have been necessary. If the banjo bolt is closed, it takes approx. 1 minute until the oil pump only sucks in air and the engine goes to the eternal hunting grounds due to a lack of oil. The oil loss is then so high - and the oil plume so thick - that an oil tank is empty after one minute.

Unfortunately, the temperatures of the turbocharger center section on the Rotax are completely unknown.
That would be very helpful, because you could customize the cooling run with a temperature display or warning light. As we have seen here, a general time specification is not accurate, as the installation and thus the flow conditions under the cowling are usually unknown and the previous load of the engine cannot be taken into account.

One more thing about the carbon crumbs:

they are caused by coking of the engine oil on the shaft, mainly in the area of the bearing at the turbine wheel (the side that is driven by the exhaust gases). When the engine is running, the engine oil cannot coke here, as there is always a certain amount of cooling due to the lubrication process. If the oil is not pumped and the shaft is not yet cold enough, the oil that has come to rest boils away and forms nice lumps of carbon. These then eventually fall into the oil sump, are sucked towards the oil pump by the suction line and possibly clog the banjo bolt in front of the oil pump.

This is another reason why I always recommend removing the oil reservoir and checking for carbon crumbs when changing the oil. Small black crumbs in the oil filter mat are another warning sign!

Supplement

We measured the temperature of the center section and were amazed at how cool it stays.
We fitted the sensor to the oil inlet of the center section of a Turbo-Dimona as a replacement for the copper seal that is fitted under the valve housing.

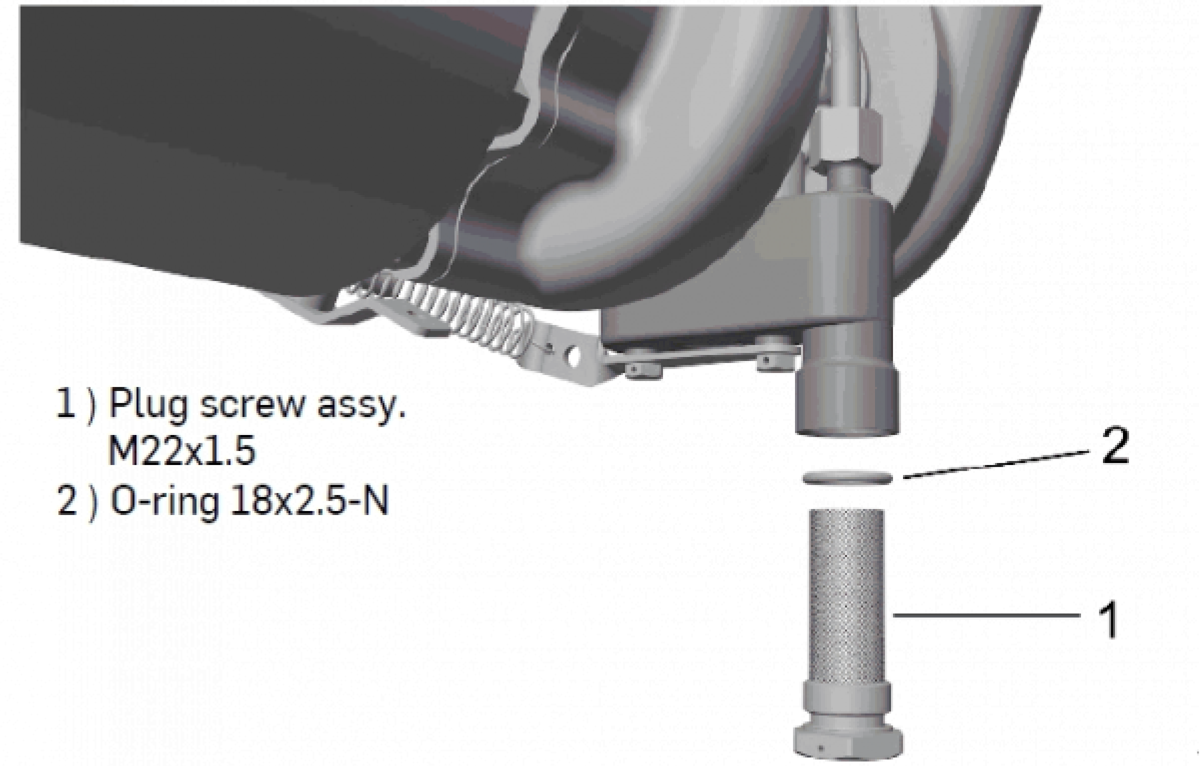
We had just 120°C in flight after 5 minutes of take-off power. After landing and the cooling run approx. 100°C .

The temperature rose to approx. 130°C after parking.

However, these are temperatures that do not lead to carbonization.
Consequently, carbon formation only takes place on the shaft in the area of the turbine wheel.

Remedy

There is now an excellent solution to prevent engine damage caused by carbon crumbs.
See also the
SI-914-039 Introduction of a new oil sump assy for ROTAX Engine Type 914 (Series) from 20.02.2023



A strainer is integrated into the oil sump vessel here, which prevents carbon crumbs of one size from reaching the banjo bolt of the return line, which can clog it.
I recommend everyone to install this unfortunately not quite cheap part.
**However, engine damage is much more expensive.

[1] thanks Sascha, for the pictures

[2] from the operating manual for the 914 from 2010