Heat exchanger for the Rotax aircraft engine

The pros and cons of using a heat exchanger.

The question of how useful a heat exchanger is for a Rotax aircraft engine comes up again and again. There is no general answer to this question, so here is my opinion.

It is well known that airplanes are designed according to aerodynamic requirements. Unfortunately, any openings around the engine that are also intended to guide the air through radiators are completely out of place. This then leads to the poor operating conditions for the combustion engine that are well known in some aircraft. It is always working at the limits of the thermal load.

Basically, a heat exchanger between the coolant and engine oil is a great thing. The oil warms up faster and you only need one radiator. It just has to be big enough to dissipate all the heat from the engine. This is not a problem with cars and motorcycles and works very well.

Now let's take a look at the Rotax engine:
The cooling of the engine is based on three pillars:

1. air-cooled cylinders
2. and a radiator in the oil circuit
3. Liquid-cooled cylinder heads with corresponding radiator

Each of the three systems dissipates a certain amount [1)] of the heat generated during combustion.
If one of the systems fails, the following situation arises for the individual systems **according to the specifications in the installation manual** (912)

1. the cooling of the cylinders will probably not fail, unless a bird builds its nest unnoticed at a point in the system that no more airflow reaches the cylinders. Since the proportion of cooling capacity is only approx. **14.6%** (912UL) and **13.6%** (912S/ULS), the problem may not lead to a sudden failure of the engine.
2. If the cooling of the oil circuit fails, there is a possibility that the pilot will find a suitable landing site in time by increasing the temperature in the display or that he will clean/replace the oil cooler beforehand. If there is a leak in the system, the oil pressure drops and engine failure is unavoidable. Oil cooling accounts for approx. **24.4%** (912UL) and **22.7%** (912S/ULS) of the total heat balance.
3. If the liquid-cooled system fails, the engine will overheat quite quickly. Unfortunately, the failure often goes unnoticed because the temperature sensor in the cylinder head has a plastic insulator, which melts out and the inner part of the sensor is then only attached to the cable. The instrument then no longer displays the temperature - it is probably defective. The proportion of the cooling capacity is approx. **61%** (912UL) and **63.6%** (912S/ULS).

If you now have a loss of coolant with a heat exchanger, you no longer have any cooling capacity of the fluids.
This means a loss of approx. 85% (912UL) and 86% (912S/ULS) of the cooling capacity.

A loss of coolant in flight is only noticed in the rain when the temperature display suddenly rises rapidly and then goes to zero when the sensor has melted out. However, as this happens relatively quickly, it is very often not noticed because the pilot has other tasks and will not be staring at the

instruments all the time. The thought that the instrument has suddenly failed is now very obvious.

The fatal thing about a loss of coolant is that no coolant can be seen through the relatively tight cowling mounted in front of the cockpit window. The loss of coolant almost always occurs in the direction of the center of the earth.
… and which pilot is able to look under his aircraft in flight?

If the pilot now notices that the engine is running worse and rougher as a result of the loss of coolant, he will have to decide on an emergency landing. This is where the advantage of the separate [2)] cooling systems comes into play. At the end of the emergency landing, every meter that the aircraft can still cover is important, even if it is only to leave a ditch behind it.
So every second that the engine is still running counts.

The Rotax aircraft engine was designed with the separate cooling systems for precisely this reason, as it improves the emergency running characteristics.

If a heat exchanger is fitted and there is a loss of coolant, the cooling component of the engine oil, apart from the cooling capacity of the oil tank, is consequently lost from the cooling system.

… However, **85% cooling capacity** may decide on a **vital distance.**

Table with the cooling capacities of the systems specified in the installation manual, with the percentage in brackets:

System	912 UL	912 S/ULS
Cooling air	6 KW (14.6%)	6 KW (13.6%)
Liquid	25 KW (61%)	28 KW (63.5%)
Engine oil	10 KW (24.4%)	10 KW (22.7%)

[1)]
the data was calculated according to the specifications in the installation manual
[2)]
without heat exchanger