Rotax 912/914 series FAQ's

OIL related:

-***What oil should I use?***

Our subscriber feedback indicates excellent results with Mobil MX4T. These same positive results are also being reported by the engine overhaul shops. Even so if you use more than 30% Avgas it is recommended to use a semi-synthetic oil as it captures lead better and carries less risk of lead paste formation due to the ester in synthetic oils reacting with the lead in the fuel. For more info see SI-912-016.

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-My oil level is always low, where is it going?

Oil will "hide" in the crankcase; you must return this oil back to the oil tank before checking the dipstick. Follow instructions in section 10.3.3 of the Operator's Manual or SI-27-1997 "Oil level check"

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-Gearbox additives; are they important?

Most motorcycle oils contain extra gearbox additives that cushion the gear contact surfaces. This is mostly Zink. (Zink is not used in automotive oils as it plugs the catalytic converters).

Note: This is not the same as the "oil additives" you can buy at the local auto parts shop; we do NOT recommend any such additives be used.

The Rotax 912/914 gearbox is lubricated by the engine oil, just like a modern motorcycle engine, but, there are some issues with using motorcycle oils:

- Premium quality car oils protect the gears almost as well as motorcycle oil at half the price.
- More is not necessarily better; having a larger amount of gearbox additives is shown to actually decrease the oils ability to protect the gears. For this reason you should purchase well known brand-names that do not make exaggerated claims about extra gear additives.
- Good operating practices and frequent oil changes have more effect on gear wear than the presence of gear additives. Also see SI-912-016 for more info.

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-Should I use an oil thermostat?

An oil thermostat (stat) is useful for quicker warm-ups and to keep operating temps up in cold weather. Field reports have been very positive. See SL-912-011 for more information.

- Caution must be used during installation of the stat and during oil system maintenance as the stat can trap air in the oil cooler.
- The stat must be tested to ensure it does not restrict the oil flow; see SI-912-005 to learn how to perform this test.
- Straight fittings must be used to connect the oil hose; angled fitting may cause oil restriction.

Perma-cool and MOCAL are good brands that have suitable "stats"

-What oil hose should I use?

The important point to remember when buying oil hose for the Rotax 9 series engines is that the oil hose is under "suction" from the oil tank to the oil pump. (See Oil system article)This is why it is important to have an oil hose that will not kink or collapse during high heat/high suction conditions. Choose an oil hose that is rated for "negative pressure" or "vacuum" operation and a temperature rating of at least 300^{o}F.

- Any oil or fuel hose in the engine compartment should be fire-sleeved. See Fire-sleeve info
- Do not bend the hose below a 3 inch radius. (see Installation Manual)
- Do not use "automotive" Teflon hose that has steel braid in the construction. It can get pin holes from static discharge. "Aircraft" Teflon hose is lined with conductive barrier that prevents this.
- Do not use industrial right angle fittings! Use "full flow" fittings that do not restrict the oil flow. See full flow fittings diagram

Aeroquip (AQP series and Startlite) and Stratoflex both make several varieties of hose that meets these requirements.

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-I heard that the oil change is complicated, is this true?

No, the oil change is basically: warming up the engine, drain & re-fill the oil tank, change the filter, run engine & check for leaks. That's it! Keep it simple.

See SI-912-010 "Oil change" and "Oil change for the 9 series" article for more information.

The complications happen when people do not follow the published instructions:

WARNING: The following are maintenance errors:

- Do not drain the oil cooler!
- Do not blow out the oil hoses!
- Do not remove the crankcase oil ports on the bottom of the engine!
- Do not rotate the prop with the filter off to "get the dirty oil out"!

The maintenance instructions do not allow or instruct you to do these actions!
Severe engine damage has been caused by these errors.

-First start up, what do I do?

This is possibly the most important time in your engines life. Have someone credible and experienced with Rotax 9 series engines assist you and double check your work! Use the First start checklist to guide you through the process.

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-Fire-Sleeve information

Fire-sleeve protects hose in case of a fire; it is not just to protect the hose from hot surfaces such as exhaust pipes.

- All fuel and oil hoses in the engine area should have proper fire-sleeve covering.
- The fire-sleeve should cover all the rubber hose and extend half way up the connector to prevent flames from getting at the rubber.
- The end of the fire-sleeve should be "dipped" to prevent wicking of oil.

See Fire-Sleeve info

Fuel related:

-What fuel do I use?

Both Avgas and Autogas/MOGAS are approved. The engine does not require any lead for proper operation (common misconception). The engine prefers Autogas/MOGAS as the lead in Avgas causes maintenance issues such as fouled piston rings, deposits on spark plugs, deposits in combustion chamber/exhaust port and sometimes sticking valves. The lead also accumulates in the overload clutch, hindering its proper operation.

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-Can I use car gas?

Yes, the engine was designed to use car gas (also called Autogas and MOGAS)

-Can I use Avgas?

Yes, Avgas is approved. But; special consideration must be given to the lead contained in Avgas. This lead will be found in the oil and combustion area as it is not completely burned by the engine.
Please note the following for Avgas use:

- Changing the oil every 25 hours
- Use a semi-synthetic oil as a fully synthetic oil does not capture the lead.
- Use Good operating practices such as high manifold pressure high RPM to minimize the build up of lead. An engine that is “lugged” will accumulate more lead as it is not burned off in the combustion chamber.
- Watch for sticking wastegate on the 914. Lead will gum this up as well.

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-What about ethanol?

The concerns about ethanol and the percent allowed in fuel are covered in SI-912-016. Field experience has shown that ethanol does not harm the engine components and the engine performs well with it. The main concern is the ability of ethanol to capture and hide water. Proper storage and water detection is critical for ethanol use.

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Ignition related:

-Does the ignition system need a battery to run the engine?

No, the ignition system is completely self generating and redundant (two separate ignition systems)

-I have a bad mag drop, what do I do?

First determine if you have a carburetor problem or an ignition problem;
(WHAT?? Yes, the Rotax 9 series dual carb system can confuse the owner as a carb problem may show up as a high mag drop on one ignition system)
Procedure:

- Run the engine at 4000rpm (approx 1700 prop rpm) and perform a mag check. Record the numbers.
- Slowly pull the choke out half way, the RPM should rise about 200 RPM.
- Try the mag drop and record numbers.
- If the problem is worse or better the carbs are suspect.
- If there is no change the carbs are not suspect, you likely have an ignition problem.

If you have an ignition problem use the Ignition troubleshooting guide to find the source.
If you have a carb problem see Carb troubleshooting

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-How does the electronic ignition work?

Power is generated by rotating magnets in the flywheel passing over 2 separate coil windings on the stator. This power is sent via two red wires to the CDI modules where it is stored in a capacitor. A signal from the “triggers” tells the capacitor when to send the power to the secondary coils. The secondary coils boost the voltage and send it, via the ignition cables, to the spark plugs.

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Gearbox related:

-what does the clutch do?

The overload clutch protects the crankshaft in case of a propeller strike. It does not slip during normal operation.
It is constructed of inner and outer plates that are forced together with spring pressure. If the propeller suddenly stops these plates “slip”, this isolates the shock from the crankshaft. The method of testing the clutch is to measure the amount of torque required to “slip” these plates and is therefore called “slipping torque”

-Slipping torque; same as friction torque?

No, slipping torque refers to the overload clutch. (See “what does the clutch do” above)
The clutch is removed from the gearbox and placed on a mount; it is then rotated with a torque wrench and extension bar. When the plates “slip” the measurement on the torque wrench is recorded. You calculate the torque and the length of the extension bar and you have your slipping torque. This can be done on-aircraft but is normally done on the test-bench due to the amount of force required

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-What are Dogs?

The Rotax gearbox design is a model of simplicity and ruggedness. A geared piston aircraft engine must deal with an incredible amount of “argument” between the propeller and the pistons. The cure for this argument is “Torsional Damping”. The propeller is a huge rotating force that does not want to move (inertia) and the pistons are constantly producing “pulses” as they go through the firing order. Something has to absorb this “argument” or parts fail. This is why so many automotive engine conversions have gearbox problems; they do not have an adequate torsional dampener.
The Rotax torsional dampener is large triangular metal dogs that mesh with each other. The dogs are angled in the contact area so they can “ramp-up” when they are twisted. This ramping-up allows the movements necessary to prevent the piston pulses from reaching the propeller. The dogs are forced together with “disc springs” that further dampen out pulses. The dogs are large and strong and have lots of wear allowance. This gives the gearbox its legendary longevity.

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-Friction torque, what is it and why is it so important?

See “dogs” above. Friction torque only applies to gearboxes with an overload clutch.
Friction torque is the measurement of the disc spring force being exerted onto the “Dogs”. If you measure how much torque is required to turn the dogs you can

calculate how tight the springs are. See maintenance manual for complete instructions.
Method:

1. Lock the crankshaft with the locking pin or have someone hold a wrench on the flywheel nut.
2. move prop tip back and forth, this is the area of movement between the dogs (usually 30 degrees of movement)
3. Measure 30 inches out from the center of the prop hub and mark the spot with masking tape.
4. Attach a spring scale (fish scale) to the prop with a piece of soft rope at the 30 inch mark
5. Pull the prop with the spring scale and note the average reading.
6. Multiply the fish scale reading times the 30 inches and you have the friction torque. (example: fish scale average = 13 lbs X 30inches = 390 inch pounds)

Friction torque is important for the maintenance of the Rotax engine as it measures how "tight" the gearbox is. A loose gearbox allows excessive movement between the parts and this leads to worn out parts. A loose gearbox has a distinctive "rattle" at low RPM, if allowed to continue, the rattle will get worse and the internal parts will wear progressively faster. Fortunately the Rotax gearbox is easily removed from the engine if any repairs are needed.

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General:

-Sprag clutch - What is it?

The Rotax starter motor is unique as it has no "bendix" or other moving engagement mechanism. The starter connects the sprag clutch to the crankshaft via a freewheel gear. When the starter motor is turned, small oblong rollers in the sprag engage the freewheel gear, forcing the crank to turn. Once the starter is turned off the freewheel gear stops and the oblong rollers retract into the sprag assembly.

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- Good operating practices

Successful operation of the 9 series engines depends on understanding its differences from conventional engines and treating it accordingly. The basic difference is that this is a geared engine that is designed to run at 5500rpm. The other conventional aircraft engines are direct drive and run at about 2500 RPM.

- Gearbox: anytime you have a propeller and pistons connected you can have problems, huge forces are at work and the gearbox is able to handle them but the operator must treat the engine properly in order to maximize the longevity and reliability.

- This is not a snowmobile or chainsaw, do not use rapid throttle movements as this causes undue wear on the gearbox. Smooth and steady is the mark of an expert.
- Avoid low idle speeds; at idle the piston pulses are more pronounced and the gearbox has to deal with a lot of pulsing. This is worse when compounded with a heavy prop. (Rotax has a limit for the propeller "moment of inertia")
- Do not take off or cruise at low engine speeds. The engine was designed to take off at 5800rpm and run its whole life at 5500 rpm; the ignition, carburetion and valve timing are all designed to be at their best at this rpm.
    - Low piston speeds actually contribute to piston wear as the "rocking motion" duration is increased.
    - High prop loading at low rpm increases stress throughout the drivetrain.
    - More combustion byproducts (carbon and lead) build up in the cylinder head with low engine speeds.
- Avoid excessive carb heat; this is not a C-150, this engine is not prone to carb ice so the teachings of the average C-150 pilot are not relevant. If safe and sensible a quick check for a normal rpm drop when carb heat is applied is all that is needed.

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- Frequent oil changes

Changing the oil frequently (every 25 hrs for avgas use) is the cheapest insurance you can buy. Oil has many jobs; it must clean the engine, cool the moving parts and protect against direct contact. Frequent changes prevents a let-down in any of these jobs.

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-What gear ratio do I have?

- All 912S & ULS engine have a 2.43:1 gear ratio
- 912 may have a 2.27:1 or a 2.43:1 ratio
- Old V series (pre-production) 914 may have a 2.27:1 or a 2.43:1 ratio
- Serial production 914's have a 2.43:1 ratio

You can calculate the ratio by using an optical tach and dividing its reading by the crankshaft speed.

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-Why does my tach needle jump around?

Most tach problems are from electrical interference. The tach trigger coil sends a small AC voltage signal to the tach once every revolution of the crankshaft. This

signal can be interfered with by the ignition system, generator or other electronic devices. See Tach troubleshooting for more information.

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-Is the 912/914 series engine reliable?

Yes, most engines go beyond TBO as proven by flying schools with good maintenance and good operating practices. Having properly trained maintenance technicians and instructors is the key to success. Teardown reports of these engines show that wear dimensions are often well within factory wear limits, including the piston and cylinder dimensions.

- Cylinder cracking is virtually unheard of.
- Top end maintenance is mostly cleaning out the lead (from Avgas use) very few parts are required.
- Gearbox removal is simple and overhaul/repair work is normally done in a couple of hours.
- The ignition system is very reliable.

-Do the 912/914 engines reach TBO?

Yes, with good maintenance and good operating practices you should expect to reach TBO.

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-How do I go "on-condition"

Going on-condition is not for everyone and is also dependant on your aviation authority's regulations. It involves maintaining the engine and monitoring its condition to see if it shows signs of problems. You must start an on-condition program before reaching TBO to establish a "baseline". At each inspection compare compression test, power output, oil analysis, and other parameters to this baseline. If anything is out of the normal range it must be repaired or the engine sent for overhaul. See Guidelines for going on-condition

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-What is the warranty for the 912/914?

- 24months/400 hours for certified engines
- 12 months/200 hours for UL engines

See SL-912-012 for more details.

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-My oil pump leaks, what should I do?

Most oil pump leaks are not the actual pump at all; instead the following are more likely culprits;

- Residual oil from filter changes
- Leaking fittings (inlet to pump, pressure sender, etc.)
- Residual oil trapped in the cavities of the pump body.

Clean the area well and perform a short engine run (less than a minute) inspect for the source of the leak. Any oil leak from this area will be blown around the engine by the propwash so it is important to do a short run-up at low power in order to diagnose the problem.

- If the oil is coming from the around the bolts it is just residual oil trapped in the cavities between the pump and the crankcase. It should clear itself up soon. Caution: Do not over torque the pump bolts, this will just distort the pump and make the leak worse.
- Leaking fittings should be removed and Loctite 243 applied to the threads. Loctite 243 has an oil dispersant primer that allows it to seal even with oil coming out of the hole.

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-Where is the mixture control?

The Rotax 9 series has automatic mixture control as a feature of the carburetors.

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-What is the difference between a 912 and a 912S?

The 912 and 912S/ULS are basically the same. They share most components except for the following:

- 912S has larger diameter pistons. The stroke of the piston is the same. The cylinder heads and cylinders are different to accommodate the bigger bore.
- 912S has a different camshaft. It is designed for higher compression
- The 912S has a 2.24:1 (taller) gear ratio but this is an option for the 912.
- The 912S jets and diffuser in the carbs are slightly different.

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-My 912S does not start, what's going on?

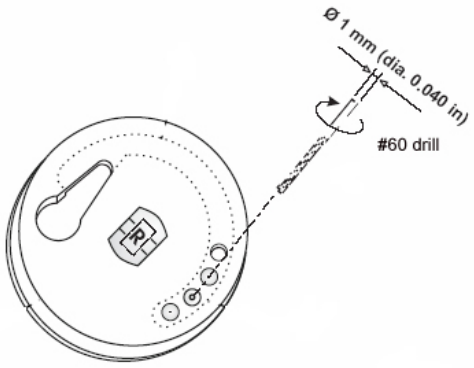
All of the Rotax 9 series engines are known to start quickly and readily. (Many people report their engines start within 1 revolution of the crank).
The 912S/ULS is a high compression engine and that can cause the engine to move (shake) in the engine mounts if the engine mount is not strong enough. Many 912S installations are designed for the lower compression 912UL engine and are not "beefed up" when the 912S is installed. This is the root cause of many 912S starting/operating issues and must be cured before proceeding with any other actions.

Here are the factors related to hard starting:

- ❖ Engine shaking during the start cycle. This causes the fuel in the carbs to froth and spill into the venturi and/or the vent lines. With the fuel system disrupted the engine cannot start.
- ❖ Carb shaking; even with a proper engine mount you can still have carb shaking problems. The best solution is installing the Rotax 912S airbox as it rigidly fixes the carbs, preventing most shaking. A side benefit is that SB-912-030 (inspection of the carb flanges) is not applicable with the airbox installed.
- ❖ Loose gearbox; If the gearbox is allowed to lose its spring pressure (see Gearbox related FAQs) the engine will not want to start as the prop will be fighting the compression strokes. Basically the engine gets into a cycle of kicking back and forth between the compression/ignition pulses and the prop forces hitting the dogs in the gearbox. Remove and send your gearbox to a qualified service center for re-shimming of the springs.

Tips for hard starting in cold weather:

- Increase starting jet size to allow more fuel. (SI-03-98) It may be necessary to switch back to small jets in warmer weather.
- Modify choke rotary disc (SI-03-98)
- Reduce spark plug gap to minimum.
- Make sure you have a good battery. Does jump starting help? If it does you may want to change batteries.
- Battery wire size, connections and grounds. Check for voltage drop between battery and starter.
- Preheat is always a good idea. Avoid rapid methods of preheating (flame/heat guns) as it can damage your aircraft components.
- Check to see if the choke is full on and both are equal. Proper set up of the cables is critical.



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