

SERVICE INSTRUCTION

SELECTION OF SUITABLE OPERATING FLUIDS

FOR ROTAX® ENGINE TYPE 912 AND 914 (SERIES)

SI-912-016 R1

SI-914-019 R1

Repeating symbols:

Please, pay attention to the following symbols throughout this document emphasizing particular information.

▲ **WARNING:** Identifies an instruction, which if not followed, may cause serious injury or even death.

■ **CAUTION:** Denotes an instruction which if not followed, may severely damage the engine or could lead to suspension of warranty.

◆ **NOTE:** Information useful for better handling.

1) Planning information

1.1) Engines affected

All versions of the engine type:

- 912 (Series)
- 914 (Series)

1.2) Concurrent ASB/SB/SI and SL

In addition to this Service Instruction the following additional Service Bulletin must be observed and complied with:

- SB-912-043, SB-914-29, "Change of coolant specification" current issue.

1.3) Reason

Field experience has shown that additional information about the choice of suitable operating fluids, such as motor oil, coolant and fuel, and about oil change and maintenance intervals for ROTAX® engine types 912 and 914 is necessary.

1.4) Subject

Selection of suitable operating fluids for ROTAX® engine type 912 and 914 (Series)

- This information should help the aircraft builder and operator ensure that the operating conditions and installation are correct and thereby achieve optimum performance and reliability.

1.5) Compliance

According Maintenance Manual of engine type ROTAX® 912 and 914 (Series), current issue.

▲ **WARNING:** Non-compliance with these instructions could result in engine damages, personal injuries or death.

1.6) Approval

The technical content is approved under the authority of DOA Nr. EASA.21J.048.

1.7) References

In addition to this technical information refer to current issue of

- Operators Manual (OM)
- Maintenance Manual (MM)
- Installation Manual (IM)

2) Material Information

2.1) Material - cost and availability

None.

3) Lubricant

3.1) General

Foreign particles formed during combustion are suspended in the motor oil. Together with oil components that are not sufficiently resistant to heat, these foreign particles can cause parts such as pistons, piston rings, exhaust valves, etc., to seize and lead to problems.

On turbocharged engines, failing to ensure an adequate cool-down period prior to shut-off may lead to particle deposits and cause damage to bearings and seals. Hard oil residues can obstruct parts of the oil system and lead to damage.

- In addition to insufficient cool-down periods, the use of unsuitable oils and not obeying oil change intervals can especially cause such damage.
- Long-term operation with an engine that is too cold and operating too long with an overly rich fuel mixture can cause water and fuel contamination in the oil, reducing its lubrication capacity.
- Furthermore, long down times with oil that contains water and contaminants can cause corrosion damage, especially on the bearings, with serious consequential damage.

The criteria for correct motor oil selection are:

- Correct oil viscosity for cold starts and sufficient oil pressure at high temperatures.
- Good gear wear protection.
- Avoidance of clutch slipping due to incorrect additives.
- Insufficient oil flow capability so that too much volume remains in the engine, leading to low oil level in the external oil tank. This can only be detected during testing with an oil level indicator installed on the oil tank.
- Ability to withstand combustion products containing lead, which enter the oil during AVGAS operation.
- High oil temperature durability. This is especially important for the turbo engine due to the risk of oil carbon build-up on the bearing and sealing seats of the turbocharger. The oil carbon build-up (coking) can also flake off and block/restrict the oil return passage.

Conclusions

- If possible, operate the listed engine types using **unleaded** or low-lead fuel. (AVAGS 100 LL is not considered low leaded in this context.)
- Use the recommended motor oils according to sections 3.2 and 3.3 of this Service Instruction.
- Use only oil with API classification „**SG**“ or higher!
- Due to high stresses in the reduction gears, oils with gear additives such as good quality 4 stroke motorcycle oils are highly recommended.
- Because of the incorporated friction clutch, oils with friction modifier additives are unsuitable because this could result in clutch slipping during standard operation.
- Heavy duty, semi- or fully synthetic (depending on fuel type used) brand name oils offer many advantages and are generally the best choice.
- Avoid oils designed strictly for use in Diesel engines. These may not be suitable due to insufficient high temperature properties and additives that may affect the operation of the slipper clutch in the gear box.
- In case of severe operating conditions (i.e., flight school, towing, near-idle operation over a long period, over-use of carburetor preheating, etc.) the time between maintenance intervals must be generally shorter and in particular, the frequency of oil changes must be increased regardless of the type of fuel mainly used (MOGAS or AVGAS).
- On turbocharged engines, always conduct a cool-down run before shutting down in accordance with the relevant Operators Manual.
- Careful attention to engine operation tips (see section 6).

3.2) Operation with unleaded and low-lead fuel (less than 0.1 g/liter lead content)

■ **CAUTION:** When operating primarily on unleaded fuels or MOGAS, the maintenance intervals remain unchanged from the published maintenance schedule found in the currently valid Maintenance Manual for the engine type.

In case of severe operating conditions, the time between maintenance intervals must be generally shorter, and in particular, the frequency of oil changes must be increased regardless of the type of fuel mainly used (MOGAS or AVGAS).

Use the following oils and observe the oil specification indicated:

Motor oils recommended (for use with unleaded fuel or MOGAS)

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| Marke / brand | Bezeichnung / description | Spezifikation / specification | Viskosität * / viscosity | Code ¹⁾ / code ¹⁾ |
|---------------|--|-------------------------------|--------------------------|---|
| SHELL® | AeroShell Sport Plus 4 | API SL | SAE 10 W-40 | 2 |
| SHELL® | Advance VSX 4 | API SG | SAE 10 W-40 | 3 |
| SHELL® | Advance VSX 4 | API SG | SAE 15 W-50 | 3 |
| SHELL® | Advance Ultra 4 | API SJ | SAE 10 W-40 | 1 |
| SHELL® | Formula Shell Synthetic Blend | API SL | SAE 10 W-30 | 4 |
| MOBIL® | Mobil 1 | API SJ/CF | SAE 5 W-30 | 5 |
| MOBIL® | Mobil 1 | API SJ/CF | SAE 15 W-50 | 5 |
| MOBIL® | Mobil 1 MX4T | API SG/CF | SAE 10 W-40 | 1 |
| MOBIL® | Mobil 1 V-Twin | API SG/CF | SAE 20W-50 | 1 |
| MOBIL® | Mobil 1 Clean 7500 | API SM/SL | SAE 10W-30 | 4 |
| Yacco® | MVX 500 Synthetic | API SJ | SAE 10 W-40 | 3 |
| EVVA® | EVVA Mehrbereichsöl C52 / multigrade oil C52 | API SJ/CF | SAE 15 W-50 | 3 |

¹⁾ recommendation code

- 1 Full-synthetic motorcycle oil with gear additives. Highly recommended for high oil temperature operation (higher than 120 °C / 250 °F) using only unleaded fuels.
- 2 Semi-synthetic aviation oils with gear additives. Highly recommended for normal (lower than 120 °C / 250 °F) and high oil temperature (higher than 120 °C / 248 °F) operation using leaded or unleaded fuels.
- 3 Semi-synthetic motorcycle oils with gear additives. Highly recommended for normal (lower than 120 °C / 250 °F) and high oil temperature (higher than 120 °C / 248 °F) operation using leaded or unleaded fuels.
- 4 Semi-synthetic oil. Recommended for normal (lower than 120 °C / 248 °F) and high oil temperature (higher than 120 °C / 250 °F) operation using leaded or unleaded fuels.
- 5 Full-synthetic oil: Recommended for high oil temperature operation (higher than 120 °C / 248 °F) using only unleaded fuels.

* The viscosity column is only a guideline. Substituting other than that shown is acceptable.

Example: Formula Shell Synthetic Blend SAE 5W-30 is a substitute for 10W-30. The guidelines given here must, however, be obeyed in all cases, using only those oils with which there have already been good operating experiences on ROTAX® engine types 912 and 914 (series).

◆ **NOTE:** The coefficient of viscosity indicates the tendency of oil to flow but it is not necessarily a quality code. Country specific deviations of the viscosity are possible.

3.3) Operation with leaded AVGAS fuels

If the engine is mainly operated with leaded AVGAS fuels, the following maintenance operations are necessary in addition by latest after **every 50 operating hours**:

- change of oil filter
- change of engine oil
- oil level checks, etc., according to the most recent Maintenance Manual.

In addition, compliance with the following operating conditions is required:

■ **CAUTION:** The engine is considered to be operated mainly on leaded AVGAS, when run for more than 30% of engine operating time on leaded AVGAS fuel.

◆ **NOTE:** When operating primarily on leaded AVGAS fuel, we **recommend** to make a change of engine oil **every 25 operating hours**.

More frequent oil changes will assure timely removal of residues and oil sludge thus avoiding increased wear or operating troubles.

Use the following oils and observe the oil specification indicated:

Motor oils recommended (for use with leaded AVGAS)

| Marke / brand | Bezeichnung / description | Spezifikation / specification | Viskosität * / viscosity | Code ¹⁾ / code ¹⁾ |
|---------------|--|-------------------------------|--------------------------|---|
| SHELL® | AeroShell Sport Plus 4 | API SL | SAE 10 W-40 | 2 |
| SHELL® | Advance VSX 4 | API SG | SAE 10 W-40 | 3 |
| SHELL® | Formula Shell Synthetic Blend | API SL | SAE 10 W-30 | 4 |
| SHELL® | Formula Shell | API SJ | SAE 10 W-30 | 5 |
| SHELL® | Formula Shell | API SJ | SAE 20 W-50 | 5 |
| Valvoline® | DuraBlend Synthetic | API SJ | SAE 10 W-40 | 4 |
| MOBIL® | Mobil 1 Clean 7500 | API SM/SL | SAE 10 W-30 | 4 |
| EVVA® | EVVA Mehrbereichsöl C52 / multigrade oil C52 | API SJ/CF | SAE 15 W-50 | 3 |

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¹⁾ recommendation code

2 Semi-synthetic aviation oils with gear additives. Highly recommended for normal (lower than 120 °C / 248 °F) and high oil temperature (higher than 120 °C / 248 °F) operation using leaded or unleaded fuels.

3 Semi-synthetic motorcycle oils with gear additives. Highly recommended for normal (lower than 120 °C / 248 °F) and high oil temperature (higher than 120 °C / 248 °F) operation using leaded or unleaded fuels.

4 Semi-synthetic oil. Recommended for normal (lower than 120 °C / 248 °F) and high oil temperature (higher than 120 °C / 248 °F) operation using leaded or unleaded fuels.

5 Petroleum based oil. Recommended for use only when oil temperatures remain below 120 °C (248 °F) and when using leaded fuels.

* The viscosity column is only a guideline. Substituting other than that shown is acceptable providing all temperature limitations are respected.

Example: Formula Shell Synthetic Blend SAE 5W-30 is a substitute for 10W-30. The guidelines given here must, however, be obeyed in all cases, using only those oils with which there have already been good operating experiences on ROTAX® engine types 912 and 914 (series).

◆ **NOTE:** The coefficient of viscosity indicates the tendency of oil to flow but it is not necessarily a quality code. Country specific deviations of the viscosity are possible.

3.4) Motor oils not suitable for engine types 912 / 914 Series

Experience has shown that only some oils are suitable for use in ROTAX[®] engine types 912 / 914 and careful selection is advised following the recommendations in this Service Instruction.

◆ NOTE: In principle ROTAX[®] has not approved any specific oils, but oils must meet certain quality requirements. ROTAX[®] only recommends the oils described in Sections 3.2 and 3.3 of this Service Instruction.

ROTAX[®] is aware of formulation changes to some oils previously recommended for use in this Service Instruction. As a result, ROTAX[®] no longer recommends following oils and these should not be used anymore.

| Marke / brand | Bezeichnung / description | Spezifikation / specification |
|----------------------|---------------------------|-------------------------------|
| Castrol [®] | Castrol Power 1 | API SJ |
| Castrol [®] | GPS | API SG / CD |
| MOTUL [®] | 5100 Synthetic Blend | API SJ |

4) Coolant

4.1) General

All engine types 912/914 have liquid cooled cylinder heads and ram air cooled cylinders. The function of the coolant is to protect the cylinder heads from over-temperature by means of heat dissipation. Protection against corrosion of the engine components and freezing of the coolant is achieved with appropriate additives.

In principle, 2 different types of coolant are permitted:

- Conventional coolant based on ethylene glycol with 50% water content
- Waterless coolant based on propylene glycol

4.2) Conventional coolant

Conventional coolant (with about 50% water content) has a specific thermal capacity that is higher than waterless coolant. It gives excellent corrosion protection, especially for aluminum, and protection against freezing.

◆ **NOTE:** For exact monitoring of the coolant temperature, a limit has been set. This is necessary because standard coolant based on ethylene glycol such as BASF Glysantin in a 50/50 proportion mixture can boil at a temperature as low as 120 °C (248 °F). Refer to the current Installation Manual for more information and instructions.

■ **CAUTION:** The certification and determination of the correct coolant type must be conducted by the aircraft manufacturer. As each aircraft type has different characteristics, testing must be done to determine the most suitable coolant and instrumentation for each aircraft type.

Recommended coolant with a mixture of 50% antifreeze and 50% water

| Marke / brand | Bezeichnung / description |
|---------------|---|
| BASF® | Glysantin Protect Plus/G48 |
| CASTROL® | Antifreeze All-Climate |
| CASTROL® | Antifreeze Anti-Boil |
| YACCO® | LR-35 |
| SHELL® | DEX-COOL |
| VELVANA® | FRIDEX G48 |
| TEXACO® | Havoline Extended Life Antifreeze / Coolant DEX-COOL |
| PETROL® | Antifreeze Concentrate / Antifreeze G 11 |

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4.3) Waterless coolant

Waterless coolant has advantages to prevent boiling of the cooling system because of its high boiling point. However, the specific thermal capacity is lower than with conventional coolant resulting in slightly higher running temperatures.

The cooling system of ROTAX[®] engine types 912 / 914 is designed for operation with waterless coolant and thus must not be modified, i.e., drainage or ventilation holes must not be closed.

◆ **NOTE:** With waterless coolant based on propylene glycol such as EVANS NPG+, it is sufficient to monitor the cylinder head temperature since the boiling point is very high.

■ **CAUTION:** The certification and determination of the correct coolant type must be conducted by the aircraft manufacturer. As each aircraft type has different characteristics, testing must be done to determine the most suitable coolant and instrumentation for each aircraft type.

Recommended coolant (100% concentrate)

| Marke / brand | Bezeichnung / description |
|--------------------|---------------------------|
| EVANS [®] | NPG+ |
| EVANS [®] | NPGR |

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■ **CAUTION:** EVANS NPGR contraction point is approx. -23 °C (-10 °F) . It will not freeze and expand like conventional coolant. Do not use if conditions expose the engine to non-operational temperatures below -23 °C (-10 °F).

4.3.1) Warnings for operating with waterless coolant

- Water or coolant containing water must **never** be added to the cooling system!
 - The max. water content must not exceed 3.6 %; it can be tested using a Brix refractometer.
 - Any water present in the cooling system is separated out as vapor. This can cause the cooling system to fail due to insufficient coolant quantity.
 - If EVANS NPG+/NPGR is not available locally for servicing the cooling system, a conventional coolant based on ethylene glycol can be used temporarily. However, the coolant must be replaced again with EVANS NPG+/NPGR within the next 15 days.
- **CAUTION:** As some conventional coolants are available in a pre-mixed formula (water added) be sure you only add 100% pure ethylene glycol if EVANS NPG+/NPGR is not available.
- **CAUTION:** The above warnings are taken from the manufacturer's user manual, however the original text and description in the user manual is binding.

5) Fuel

5.1) General

Different requirements such as air purity laws led to the development of fuel types with different compositions, such as fuel enriched with oxygen. Development is focused more on better and cleaner combustion and less on the effects on the engine, equipment and power. The main focus is environmental protection. The problem is in the variety and changeability of the types of fuel currently available for sale and the damaging effects of some types of fuel.

- Thus it is necessary for the aircraft operator to check with each batch of gasoline that the fuel is suitable for the engine.
- Buy fuel only from large, well-known brands and dealers that openly declare the actual octane number. Do everything to get confirmation that the purchased fuel corresponds to the fuel declared at the fueling point. Obtain technical base data on the fuel used, such as: octane number, addition of ethanol/methanol (as oxygen carrier), seasonal additives, etc.
- In general, oxygen carriers (alcohol additives) are to be avoided. Fuel with more than 5% alcohol added must not be used. Checking the fuel for alcohol content is the only sure way to ensure that your fuel is suitable for your ROTAX[®] engine.

CAUTION: The ill effects of alcohol in your engine are as follows

The alcohol will attract water, this can cause your sediment traps (e.g. in the fuel tank) to flood, plug filters and restrict fuel flow.

Also, and very important, the alcohol competes directly with the lubrication, and depending on your oils ability to combat such, could cause engine damage.

Important also is the alcohol carries water which on engine shut down and storage can create corrosion on vital engine parts such as crank-, main- and rod bearings as well as pins. Once corrosion (pittings) has started, the bearings will fail shortly after.

Seasonal blend crossovers can affect your fuels volatility if you use a winter blend fuel during a hot summer day. This is a common occurrence with people who buy a fuel blend in colder climates in March, but don't use it in their ROTAX until June. Evaporation temperatures of your fuel must be low enough to minimize crankcase and combustion chamber deposits as well as spark plug fouling without fear of vapour locking or boiling. Always make sure you buy your fuel from a high volume user, and avoid fuel which has been in storage for long periods of time, especially between seasons.

Loss of octane rating is a common problem on fuel stored incorrectly, which could lead directly to engine damage or stoppage.

Current FAA guidelines require that auto fuel approved for aircraft (Mogas) meet stricter guidelines than that of regular car gas. This may be the simplest way to maintain some control over what you are using, even so scrutinize carefully!

Alcohol/ethanol will attract and retain water:

- this water can freeze in cold conditions and from the carburation action
- the water lowers the vaporization point of fuel and could cause vapour lock
- the water may not be detectable in your fuel system.

Alcohol is a solvent which could clean deposits in your fuel system and carry them into the filters or carburetors.

Alcohol burns leaner and may cause higher exhaust gas temperatures (EGTs).

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5.1.2) Fuel according to local standards

The following fuels can be used.

| | Usage / Description | |
|-------------------|--------------------------------------|--------------------------------------|
| | 912 UL / A / F | 912 ULS / S - 914 UL / F |
| MOGAS | | |
| European standard | EN 228 Normal ¹⁾ | |
| | EN 228 Super ¹⁾ | EN 228 Super ²⁾ |
| | EN 228 Super plus ¹⁾ | EN 228 Super plus ²⁾ |
| Canadian standard | CAN/CGSB-3.5 Quality 1 ³⁾ | CAN/CGSB-3.5 Quality 3 ⁴⁾ |
| US standard | ASTM D4814 | ASTM D4814 |

| AVGAS | | |
|--------------|--------------------------|--------------------------|
| US standard | AVGAS 100 LL (ASTM D910) | AVGAS 100 LL (ASTM D910) |

| released brand-name | | |
|----------------------------|--------------------------------------|--------------------------------------|
| | HJELMCO AVGAS 91/96 UL ⁵⁾ | HJELMCO AVGAS 91/96 UL ⁵⁾ |
| | HJELMCO AVGAS 91/98 UL ⁵⁾ | HJELMCO AVGAS 91/98 UL ⁵⁾ |

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- 1) min. RON 90
- 2) min. RON 95
- 3) min. AKI* 87
- 4) min. AKI 91
- 5) unleaded, available most important in Scandinavian area

* Anti-Knock Index, (RON+MON)/2

AVGAS 100LL places greater stress on the valve seats due to its high lead content and forms increased deposits in the combustion chamber and lead sediments in the oil system. Thus it should only be used in case of problems with vapor lock or when other types of gasoline are unavailable.

■ CAUTION: Use only the correct fuel for the specific climate zones.

◆ HINWEIS: There is a risk of vapor lock formation if winter fuel is used for summer operation.

6) General engine operation requirements and operating tips

- Keep the motor oil temperature below 120 °C (250° F) over most of the operating period.
- Always insure that the oil type used is adequate for climatic conditions and peak engine operating temperatures. If operational oil temperatures exceed 120 °C (250 °F), use of a mineral or petroleum based oil is not recommended.
- For turbocharged engines ensure an adequate running cool-down period to prevent deposits by coking of oil.
- When operating with unleaded fuels or MOGAS and when engine oil temperatures often exceed 120 °C (250 °F) use of a high quality full synthetic oil is recommended.
- To avoid formation of condensation water in the motor oil, the oil temperature must rise at least once every operational day to at least 100 °C (212 °F).
- When safe and sensible, avoid extended use of carburetor air pre-heating.
- The type of fuel used, operating conditions, and the demands of the engine mission profile may need to increase the frequency of oil changes to avoid the excessive build up of lead and other residues in the engine oil. Always adjust the engine oil change intervals to avoid excessive build up of sludge in the engine oil.

■ **CAUTION:** Do not use oil additives and observe the operating limits as per the relevant Operator's Manual.

Excessive engine vibration, particularly at low idle speeds, can impair the carburetor fuel metering system leading to a too rich mixture condition. This rich mixture condition can further lead to rough engine operation and excessive carbon and lead deposits.

Observance of the following maintenance and operating tips can reduce engine vibration and maintain accurate carburetor fuel metering:

- Regular pneumatic synchronization of the carburetors and synchronization of bowden cable for throttle and choke adjustment can greatly improve the smoothness of engine operation.
- Proper adjustment of the engine idle speed and maintenance of the air induction system can also aid smooth engine operation and helps to maintain the correct air / fuel mixture. Proper air / fuel mixture will reduce the separation of the non - volatile components in leaded AVGAS, and helps to minimize the rate of lead deposition in the engine.
- Whenever safe and sensible, the engine should be operated at speeds between 2500 and 2750 crankshaft RPM (1100 to 1200 propeller RPM with 2,27:1 reduction ratio, 1050 to 1150 propeller RPM with 2,43:1 reduction ratio) after starting and during the initial warm up period.
- Avoid rapid changes in engine RPM immediately after start up.
- Rapid engine cooling down resulting from altitude changes performed at a low power setting, landing approaches flown at low power settings, or rapid engine shut down after landing or ground operations should be avoided.
- Maintain engine speed between 2500 and 2750 crankshaft RPM (1100 to 1200 propeller RPM with 2,27:1 reduction ratio, 1050 to 1150 propeller RPM with 2,43:1 reduction ratio) until engine temperatures have stabilized before stopping the engine.
- Maintaining high friction torque values on the gear reduction unit can reduce vibrations from the torsion load absorber, further reducing overall engine vibrations, particularly at low RPM.
- Correct balancing of the propeller to a tolerated value can greatly reduce engine vibration, decrease wear of engine and gear reduction unit components, improve engine performance, and add to engine life. Recent developments in electronic propeller balancing equipment now allow quick dynamic balancing of propellers without removing the propeller from the aircraft. Other benefits of correct propeller balance include the reduction of cockpit noise and vibration levels, and a reduction in fatigue of exhaust components, air boxes, sheet metal components, cowlings, engine linkages and aircraft sections.
- Regular compliance with SI-912-005 / SI-914-007 „Lubrication System for all ROTAX Engine Types 912 (series) and 914 (series)“, (current version) will assure proper function of the engine lubrication system and optimum engine life.

7) Summary

▲ **WARNING:** Non-compliance with these recommendations could result in engine damage, personal injury or death!

Approval of translation to best knowledge and judgment - in any case the original text in the German language and the metric units (SI-system) are authoritative.