

## **E - ROTAX Aircraft Engines Tech Tips.....**

**Category : Technical**

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ROTAX Aircraft Engines Tech Tips...

In this section we will try to answer many of the technical questions which arise during installation or use of Rotax engines. We will break down this section into different areas, for ease of use.

Installation / Break-In Issues  
Frequently asked Questions  
Electrical Systems  
Lubricants  
Fuel Systems  
Propellers  
Exhaust Systems  
Troubleshooting

Installation Issues:

### 1) Engine Mounting

-The preferred mounting position of the Rotax engine is in the upright manner, i.e. spark plugs up. Many aircraft designs have the engine 'plugs down', and though this will work fine, there are some disadvantages. Spark plug life tends to be shorter, and engine starting can be more difficult due to easy flooding of the cylinders. In 2 cycle engines, spark plugs need to be changed every 20-25 hrs. We found easy way to tell if they need changing is the engine will start idling rougher than normal, even slightly above 2000 rpm.

-The engine should always be mounted with rubber dampeners to reduce vibration being transmitted to the airframe.-If installing an air-cooled engine, be sure there is adequate open area around the fan opening to allow fresh cool air to flow around the cylinders. Especially important on aircraft with cowlings.-If liquid cooled, the radiator must be large enough to permit temperatures never to exceed 175 deg F during flight. In hotter climates, especially in pusher installations, a larger radiator will be required than Rotax typically recommends.

### 2) Fuel Pumps - (applies to 2 strokes only)

-Mikuni fuel pumps should not be installed to the engine directly, use a rubber dampener, or mount the pump to the firewall if possible. Regardless, the pulse line which operates the pump should not be longer than 12". The shorter the better! Also on the rear side of the pump you will see a 'weep hole'. This hole needs to be mounted in the down position. The purpose? To allow any condensation buildup to drain out of the pump. If this did not drain out, the result is the pump diaphragm not being

able to move. If it doesn't move, neither does your fuel!

### 3) Oil injection Systems

-If using the oil injection system, you will need to mount the oil tank higher than the oil pump located on the engine, as it is a gravity fed system.-If you are going to use premix, and your engine is the Rotax 582, you will need to disable the oil injection system. We will have a future article in the future on this.

-On all Rotax engines except the 618, use either Pennzoil or Amsoil oil.

### 4) Exhaust Systems

-The exhaust system supplied with your Rotax engine is specially tuned for each engine. Do NOT modify the length of the muffler system, or performance will be affected (almost always for the worse!). The system must be mounted with vibration dampeners to avoid cracking of the system. Exhaust springs must be loosely safety wired and should have a bead of high temp RTV on them.

#### Break-In Tips:

Does my engine require a break-in period? Yes, all Rotax 2 cycle engines require a break-in before flying. Follow the Rotax break-in chart in the engines manual, which specifies a certain Rpm over Time. The 4 cycle engines (912, 912S, 914) are run at the factory, you may install them and go fly. You may notice that the 4 cycle engines loosen up after a few hours use, and you may gain some RPM requiring re-adjustment of the prop.

#### Electrical Systems:

The most common questions on electrical systems deal with the connections of the wiring.

On a point ignition engine, the wire harness colors are:

- Brown - Engine Ground
- Black - Ignition coil #1
- Black - Ignition Coil #2
- Green - 30 watt charging coil
- Yellow - 110 watt charging coil

On a Ducati ignition engine, the wire harness colors are:

- Gray - Tachometer Signal
- Heavy Yellow 170 watt lighting coil
- Heavy yellow w/ black stripe 170 lighting coil
- Yellow - Ignition Kill Switch #1
- Yellow - Ignition Kill Switch #2
- Brown - Engine Ground

Note that a new engine shipped from Rotax on a Ducati ignition will have the 2 yellow lighting coil wires connected with a clip for identification purposes.

The alternator circuit output is in AC voltage, and at this point varies in voltage from 6 to 60 volts. Before you can connect any electrical equipment to your system, this voltage needs to be rectified

into DC voltage, and regulated into a usable voltage.

A rectifier / regulator must be used. There are 2 types:

#### Single Phase-

This regulator MUST be used with a 1 amp load or battery to provide the load necessary for it filter the voltage and amperage. A UltraStart / UltraBat 13 battery or equivalent can be used, however no less than a 16 amp battery should be used or overcharging will result.

Wiring Color code:

Yellow - connect to engine alternator  
Yellow w/ Black stripe - connect to engine alternator  
Red - positive DC output  
Black - Connect to Ground

#### 3 Phase-

This regulator has a built in load, so no outside 1 amp load is necessary for this unit to operate. It also comes equipped with a back up circuit. To help dissipate the heat from regulating the current, this unit has fins located on the outside of the case.

Wiring Color code:

Yellow - connect to engine alternator  
Yellow w/ Black stripe -connect to engine alternator  
Black - Connect to POSITIVE (yes this is correct)  
Ground is the base of the rectifier / regulator!

#### Key West Regulator

Though the Rotax regulators take care of the job of changing AC to DC current quite well, the Key West Regulator however does a much better job of filtering the DC current that is rectified. This cannot be seen unless the output of the rectifier is connected to an oscilloscope. If your using a large battery for your electrical system, this won't be a problem as the battery will filter the spikes. However, if your battery is low on charge, your sensitive electronics will be subjected to these spikes with the Rotax rectifiers.

Fuel Related Issues:

One of the most important systems on your aircraft is your fuel system. Without a properly operating fuel delivery system, your aircraft engine cannot do its job of producing power. Let's start at the source of the system and work our way to the engine:

#### 1) The Fuel Tank

Your fuel tank should be of sufficient capacity for the size engine you are going to run. It should be made of a material which will allow easy visual reference during flight of the fuel level remaining. If

the tank will not be visible, then a secondary method such as a site tube or fuel gauge should be used. In a plastic type tank, unless the tank has pre-molded fittings for use with a site gauge, we do not recommend drilling into the tank. It can be very difficult to seal these types of fittings. The tank should have a good way of venting to allow air in as fuel is drawn from the tank. The vent may be within the fuel cap, or a separate area on the tank itself for fitting a vent line. Also, be sure the fuel pickup has a screen on the end of the pickup tube.

## 2) Fuel Filter

The fuel filter should be the next item in the line. Mount it in a accessible place, as you want to be able to view it and clean / replace it on a regular interval. 2 types are available. One type is a plastic, one piece unit usually made from a white type plastic. This type is a toss away when expended. The second type, though more expensive, has a glass barrel in which the filter may be viewed for obstructions and the filter element removed for cleaning or replacement.

## 3) Gascolators (optional)

A gascolator is simply a bowl mounted inline in the fuel system, and mounted at the lowest point of the fuel system. Any water in your gas will collect in the bottom of the bowl, and with a quick drain located in the bottom, it may be drained from the system before it reaches your engine. In a tractor mounted configuration, it is a simple matter of bolting a gascolator on the firewall. However on a pusher installation where the fuel tank is lower (as in the Aventura, where the bottom of the tank is at the hull level), it is not a practical solution. Filtering your fuel with a Mr. Funnel is your best bet.

## 4) Primer Bulbs

The function of the primer bulb is to 'prime the system' bringing fuel through all the fuel lines and filling the float bowls to the proper level. Don't use a cheap bulb, use a good quality marine type bulb. One note of caution here: An aircraft which sits without being run will eventually have its fuel drained from the lines and the bulb. An empty bulb will harden over time, and should be replaced. We recommend annual replacement. Another good thing to do is to use a 'bypass' in the system. Primer bulbs have a check valve which allows fuel to flow only in one direction. Should one of these check valves go bad, your fuel flow would be cut off without the 'bypass'. Only one drawback to the bypass, when you use the primer bulb you will have to close off the bypass line.

## 5) The Primer System

Don't confuse the primer with the primer bulb. As mentioned earlier, the function of the primer bulb is simply to get fuel to the carburetors. The function of the primer system is to manually shoot a small amount of fuel directly into the carburetor throat for starting purposes. Usually 3-4 squirts does it on the 2 strokes, 5 on the 4 strokes.

## 6) Fuel Pumps

The standard fuel pump supplied with the Rotax 2 cycle engine is a pulse type pump, operated off of crankcase pressure. These pumps are quite reliable, if installed correctly. First never mount the pump directly to the engine, always use a type of vibration mount, or mount the pump somewhere off the airframe. The pulse line which operates the pump should not be longer than 12", and should be made of a hard rubber to prevent collapse. If the hose should collapse under the pressure / vacuum

cycles, your fuel pump will not operate and you will soon be landing quicker than you anticipated!

As for pump rebuild kits, we don't recommend them. They usually don't seal correctly when a customer installs the new gaskets. For a few extra dollars buy the complete pump. Personally, I would hate to think that I had to put my plane down at the end of the runway into a fence, trees or whatever, over a few dollars I didn't spend....However, for those who would like to rebuild their pumps, we do offer rebuild kits for Mikuni fuel pumps.

The Rotax 912, and 912S use a mechanical driven pump direct off of the crankshaft. If you wish to install a secondary electric pump for safety, it must be plumbed into the system in parallel, not in series. In other words, do not plumb the system such that the electric pump forces fuel through the pulse pump. The resulting pressure will be too high at the carburetor, resulting in fuel spilling through the overflow tubes. The electric pump should have a psi rating of 2-4 psi only.

FYI, the Rotax 914 comes with two electric fuel pumps as standard equipment.

#### Exhaust Systems:

The exhaust system of any 2 cycle engine is a crucial part of the engines performance. Not only do they help quiet these beasts, but also help to extract the power that these lightweight engines can truly deliver. Mounting your exhaust properly is a must. Several different styles are available from Rotax. Should you need to modify a system, you may cut and re-weld to suit your needs, do NOT change the length of the muffler system.

A muffler system in a 2 cycle engine works by creating a wave of pressure bouncing back and forth within the chamber. This 'wave' helps to draw scavenge out exhaust gasses AND draw in the next fresh charge of fuel for combustion. Changing the length of these pipes WILL affect the 'tuning' this wave creates within the muffler system. Simply don't do it, it's just not worth it!

Most manufacturers have engineered a way to mount the Rotax exhaust systems for use on their designs. For best results you should mount the system with shock mounts as a entire unit bolted to the engine. If any part of the muffler system is bolted to the airframe, it will be subjected to high vibrations as the engine moves on its mount while the other parts are held stationary to the airframe. To help compensate for this, Rotax uses a double ball joint system to allow different parts to vibrate.

These ball joints are held together with springs through welded on tangs on the respective parts of the muffler system. Even these springs are subject to high vibration, and they will eventually break and need replacement. As a precautionary measure (especially on a pusher aircraft), you should LOOSELY safety wire through the tangs and each spring. Why loosely? If they are tight, and the springs are flexing, the safety wire will break. After safety wiring these springs, run a bead of high temperature RTV across them. This will dampen the vibration of the spring itself, and hold any individual rings of a broken spring in place.

Preflight your muffler carefully before flying..... I recently heard of a gentleman whose muffler canister had dropped onto the top of his wing after a bracket had cracked over a period of time. The muffler melted a hole in the top of his Dacron wing a foot square!

#### Lubricants:

So, what type of oil should I use?

2 cycle engines:

The choice of a 2 cycle lubricant for your engine is not an easy one. Mineral based or synthetic based? These days the fuel we pump into our vehicles has all kinds of additives. Since 1988, additives have been required by the govt. as an economical way to increase the octane rating of lower grade fuels.

Some of these additives can cause us flyers problems with our Rotax 2 cycles. Certain additives are corrosive to gaskets, rubber O-rings, and don't mix well with the oils we use to lubricate our engines with. Another problem is that the use of alcohol in fuel will absorb the water found in the fuel, but will not mix with the oil.....

What to do? Well, certain types of fuels don't use additives. The only one at this time we are aware of is Amoco. (Or switch to using 100 LL at your local airport) Use of a Mr. Funnel will help to reduce any water present in the fuel (it will eliminate it completely IF the fuel doesn't have any alcohol additives in it).

Over time, fuel with additives will separate with the oil mixed for lubrication. Another good reason to drain the tanks and use a fresh supply if the gas has been in there for awhile. When mixing new fuel / oil, make sure to agitate it too mix thoroughly.

So, what do we recommend? Use of Pennzoil air cooled or Amsoil oils.

4 cycle engines:

The Rotax 4 cycle engines may use any good brand of automotive oil. Rotax states that NO aviation oils are to be used with the 912, 912S, or 914 engines. We have used with great results Valvoline Synthetic, it covers a wide range of outside temperatures and protects your engine throughout the entire operating range of temps set for these engines.

One caveat: Rotax warns that repeated use of 100 LL in the 4 cycle engines with synthetic oils WILL produce a sludge buildup within the engines over a long use time period. Occasional use is okay.

Propellers and your Rotax Engine:

Ask about props to any builder / flyer of an aircraft, and you will receive quite differing opinions to the same questions. In this section we will give the facts only, and leave the decision up to you...

1) What types of props are available for my light aircraft?

Wood or Composite. Fixed pitch or adjustable pitch. 2, 3, 4, or 6 blades...Recreational Mobility carries several different manufacturers. Ivoprop, Warp Drive, UltraProp, and PowerFin.

2) So, which is best for me?

That's a tough one! What kind of flying will you be doing? Hard surface, gravel surface, water operations?

## Wood props

Are good for tractor configurations. They tend to receive quite a beating and should be kept after. A wood prop should NEVER be used for water flying. A wood prop used in water operations will nick the prop, the prop will absorb water and in time rot from the inside out. You won't notice this until a blade departs the aircraft....However, if your going to be operating on a nice grass field or paved runway with a tractor mounted prop, a wood prop is a good choice. Also, turn your wood prop blades horizontally when not flying. This will prevent any water inside the prop from ending up in one blade, causing a unbalanced prop.

## Composite props

Are a much better prop suited for our use, though they do tend to be a bit more expensive. They can take the abuse, and will last for many years. They are ideally suited for water operations, with steel leading edge protection on them. Ivoprop offers 2,3,4, and 6 blade props with ground adjustable pitch settings. Ultraprop also makes an affordable composite prop for smaller horsepower engines. Warp Drive composite props, though slightly higher in initial price offer a lifetime guarantee and is what we recommend over the others.

### 3) Which is best? 2,3, or 4 blades?

Generally, a 2 blade prop will achieve a faster cruise speed, while a 3 blade will be slightly better in climb. A 3 blade will be quieter and smoother running than a 2 blade. Adding more blades becomes quite expensive, and you will need to run the Rotax 'C' gearbox so as not to exceed the inertia requirements. Running more blades also means that the prop operates at less pitch. For instance, a 2 blade prop usually operates at about 13 or 14 degrees of pitch. A 3 blade prop operates at around 10 or 11 degrees. Why? Because you have an extra blade absorbing the horsepower and torque available from the engine.

### 4) Gearbox or belt drive?

The choice of gearbox or belt drive is usually made by the airplane kit manufacturer.

**Gearbox:** Reverses the direction of the prop from the crankshaft. Slightly more noise due to the gears within the gearbox. Engine must be idled at a minimum of 2000 rpm or slightly better, to avoid gearbox 'chatter' caused by backlash of the gears.

**Belt Drive:** Smoother, quieter, and turns the same direction as the crankshaft. Older belt drive systems used a series of 'V' Belts to absorb and transmit the power to the prop. With this system, when one belt loosened, there was no way to tighten a individual belt and a lose of power to the prop resulted. Newer systems use a Cogged Belt, and are very reliable. However, belt drive systems can impose large amounts of side loads to the crankshaft, (causing premature bearing and crankshaft failure) if tightened too much.

### 5) Which direction do I need?

All props are viewed as if you are sitting in the cockpit. We will assume your engine is a Rotax.

For a tractor engine, belt drive, prop rotates left hand.

For a tractor engine, gearbox, prop rotates right hand.  
Pusher engines, belt drive, prop rotates right hand.  
Pusher engines, gearbox, prop rotates left hand.