*Phillip Lockwood*

# Keeping Cool

## Choosing the best coolant for your liquid-cooled Rotax engine

Rotax recently released two service bulletins* requiring some Rotax 912, 912S, and 914 owners to change their coolant to Evans NPG+ waterless engine coolant. This has unleashed a firestorm of questions from Rotax 9-series owners, making it the hot topic for this month's article.

The number one question is, "Do I need to change to the Evans coolant?" The answer depends on the design and capability of your aircraft's cooling system and the recommendation of your kit or airframe manufacturer. Evans waterless coolant does offer some significant advantages over conventional coolants, which we will highlight later in this article. If I were inclined to sensationalize, I could make an argument that would compel 90 percent of you to switch, whether you need to or not. However, sensationalism isn't my style, so here are the facts with just a little dose of insight.

The 9-series engines come from the Rotax factory with two VDO cylinder head temperature (CHT) probes. One is located in cylinder No. 2 and one in cylinder No. 3. Monitor the hotter of the two cylinders in your installation. The normal CHT range should be between 167°F and 230°F. *This is new information.* In the past Rotax only gave a maximum temperature, *redline,* of 300°F for the 912 and 275°F for the 912S and 914. These maximum temperatures remain unchanged provided you make the switch to Evans waterless coolant. There is no alternative; it's Evans NPG+ or Evans NPG+. End of discussion.

If you continue to use a 50/50 blend of conventional antifreeze coolant with the 0.9 bar (13 psi) radiator cap that most 9-series engines are equipped with, *then you must re-mark your cylinder head gauge with a new maximum temperature redline of 115°C/239°F.*

| Radiator cap | Maximum permissible cylinder head temperature (CHT) |
|---|---|
| 0.9 bar / 13 psi | 115°C / 239°F |
| 1.2 bar / 17.5 psi | 120°C / 248°F |

A new 1.2 bar cap is now available; when installed it allows for a maximum CHT of 248°F. The higher pressure increases the coolant boiling point. The new cap will become standard equipment in 2005.

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If your CHT never approaches the new 239°F temperature limit, then you could continue to operate with the coolant you have been using. DEX-COOL has been the conventional coolant of choice in North America.

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Here are a few tips for those continuing to use a conventional water-based antifreeze.

- Only mix it with distilled water (available at every supermarket). Avoid tap water because the chlorine and minerals usually found in tap water can cause corrosion within your engine.
- Unless your climate requires the most extreme freeze protection, *mix at a 50/50 ratio* of coolant and water. Higher ratios can cause jelling of the coolant, which can lead to other serious problems.
- *Never exceed* the coolant manufacturer's maximum ratio; in the case of DEX-COOL, the ratio is 60 percent coolant and 40 percent water.
- Rotax recommends changing coolant every 200 hours or two years, whichever comes first. Although DEX-COOL is supposedly good for five years, Rotax still recommends changing every two years. If your coolant mix is already 5 years old, cash in your chips and change it.
- Those who see a *maximum* CHT of 239°F or higher should be changing to the Evans NPG+.

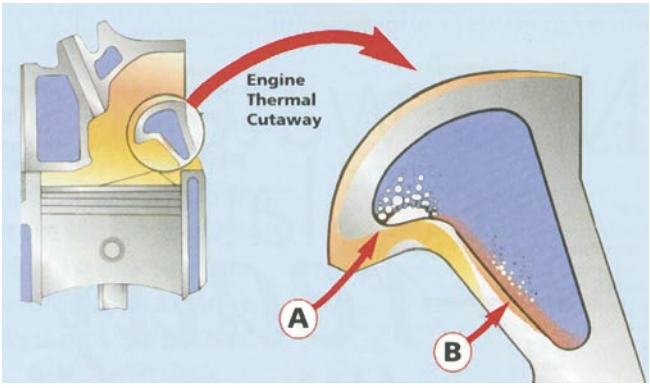
## Evans NPG+ Waterless Coolant


As we said earlier, Evans NPG+ waterless coolant offers some significant advantages over conventional coolant. It has a zero pressure boiling point of 375°F compared to just 255°F for most 50/50 water coolant mixes at 15 psi. It remains liquid down to –40°F, at which point it simply thickens and contracts slightly but never actually freezes. It is designed to last the life of the engine, and although Rotax has not changed its two-year/200-hour change recommendation, perhaps with experience we will see the extended intervals Evans promises.

Evans also claims its ethylene-glycol-based product contains an alcohol dehydrogenase (ADH) enzyme inhibitor reducing its oral toxicity. Even so, Evans NPG+ coolant and its Post Drain Prep Fluid (which I will discuss later in this article) must be disposed of in the same way as other ethylene-glycol-based coolants.

Evans coolant weighs the same as conventional coolant, so no change in weight and balance is required.

The key attribute of NPG+ is its high boiling point, which helps avoid hot spots that can form in the 9-series cylinder heads when the coolant boils "locally," creating small pockets of vapor hindering heat transfer as depicted by arrow A in the diagram below. Arrow B shows how a similar hot spot will continue to be cooled effectively when using Evans NPG+.




The 9-series heads are made of a heat-treated aluminum alloy. If the head is overheated, the aluminum will soften and warp. Experience has shown that when operating with a conventional coolant/water mix, at CHTs approaching the maximum limit, portions of the head may become hot enough to damage the head after many hours of prolonged high temperature exposure.

Some ultralights and light aircraft have marginal engine cooling while on the ground; this is a common problem with many pusher designs. In this situation the 9-series Rotax engines have an advantage over engines with air-cooled heads because even with minimal airflow through the radiator, the coolant takes some time to heat up, allowing time to taxi and take off without worry of overheating. Once in flight the cooling system functions normally.

On aircraft with marginal cooling on the ground, prolonged running time on the ground, especially on hot days, can lead to a boil-over with large quantities of hot coolant being expelled from the cooling system. This is why it is especially important to check your CHT gauge while taxiing and before takeoff. The use of Evans NPG+ with its ultra-high 375°F boiling point should help avoid a volcanic eruption-like cooling system boil-over.

## Signs of an Overheated Engine

The 9-series cylinder heads are normally quite durable and last through several overhauls unless they are overheated to the point of becoming soft. If you think your engine may have been overheated and would like to know what to look for, here are some of the telltale signs:

■ If the black plastic-like substance in the center of the CHT sender has melted allowing the brass connector pin to fall out, the head is toast. This is the most ominous sign.

■ The valve cover begins to leak oil and does not seat properly when using the standard O-ring.

■ The aluminum coolant socket located on the underside of each cylinder head may begin leaking where it is pressed into the head.

■ The pushrod guides, also located under the cylinder head, may also leak oil at the point they are pressed into the head.

■ The cylinder head bolts suddenly become loose.

■ The rocker arm shaft is jammed in the head and will not rotate or slide.

■ The valve guides have shifted from their correct position.

■ The ultimate test is a hardness check, which requires removal of the head. These hardness checks can be performed by Lockwood Aviation Repair or any facility FAA has approved to perform checks of this type. An engine that has had an overheated head will usually keep on running, but it will exhibit the serious problems listed above until the damaged heads are replaced. In addition, the engine will begin to lose power as the compression drops because of losses in valve train performance.

### Which Coolant Should You Use?

Aircraft manufacturers can perform their own tests and make a recommendation on which coolant should be used based on their aircraft's cooling system design and capability.

If you are going to make the change to Evans NPG+ waterless coolant, you should know a few things.

■ First the obvious: *Never remove your radiator cap while the engine is still hot; you could be burned by escaping coolant.*

■ Evans NPG+ does not transfer heat quite as well as water-based coolant, so your engine will run a


little hotter than with a conventional 50/50 mix.

■ Even though the overall engine temperature may be slightly higher, engine heating will be more stable and consistent because of the elimination of vapor pockets that can allow damaging hot spots to build up in your cylinder head. If the temperature gets really hot, you are much less likely to face a boil-over because of the 375°F boiling temp of the Evans coolant.

■ It is important to eliminate all of the water from your cooling system prior to adding the NPG+. Unless you are filling a new radiator/cooling system, you will have to clear the cooling system with Evans Post Drain Prep Fluid. The instructions that come with it are clear.

■ Even though Evans states you can use a zero-pressure radiator cap, Rotax feels it is important to continue running the 9-series cooling system under pressure and recommends continuing to use a pressurized cap.

■ Evans NPG+ coolant comes with a decal for the radiator cap warning not to add water to the system. We have made up a plate (part no. NPGPLT, $.50 each) that can be riveted to the radiator cap to give the decal a good surface on which to adhere.

## No Change for 582 Engines

There is no information from Rotax regarding switching to Evans NPG+ coolant in the 582 engine, so it's best to stick with the conventional coolant at this time in these two-stroke engines. However, the rule of mixing 50/50 conventional antifreeze and distilled water are the same as stated previously in this article.

*The service bulletins are SB-912-043 for the 912 and 912S or SB-914-029 for the 914 turbo. All Rotax service bulletins can be found online at *www.rotax-owner.com* or *www.Rotax-aircraft-engines.com*. The most up-to-date manuals for Rotax engines are available online and offer a great deal of information. Don't be fooled by the date on the cover of the manual online because revisions are continuously being made; the cover isn't changed unless the entire manual is rewritten. Owners who keep paper versions of their Rotax engine manuals can print out the revisions and update their copies.

*Disclaimer: The information in this article is the opinion of this author and has not been reviewed by Rotax.*



Each month in Power ON, **Phillip Lockwood**, president of Lockwood Aviation Repair (lockwood@digital.net, www.lockwood-aviation.com), will address common Rotax engine maintenance or operation issues. In addition, readers are invited to send their questions about various alternative engines to our panel of engine "answer men" or to editorial@eaa.org, or

■ For HKS engines, write **Dana Persiani**, danapersiani@yahoo.com.
■ For 1/2 VW engines, write **Bill Bronson**, onehalfvwguy@worldnet.att.net.
■ For Corvair engines, write **William Wynne**, WilliamTCA,@aol.com.
■ For Subaru engines, write **Don Bouchard**, dbouchard@earthlink.net.
■ For Hirth engines, write **Matt Dandar**, rpe@bpsom.com.
■ For (non-Rotax) two-stroke engines, write **Torello Tacchi**, tacchi88@bellsouth.net.

We'll reprint questions and answers of interest in upcoming Power ON columns.