One Owner's Tips & Tricks for Operating and Maintaining a Sting Sport (Light-Sport) Airplane

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Preface

Background: *In October 2010, after my first 20 hours of flight training in a 2005 model Sting Sport light-sport airplane (LSA) at Lodi, California, I knew I was "hooked" and decided to take the plunge. I purchased a 2007 Sting Sport (now called "Sting") with 250 hours. I finished up my flight training in it, took my check-ride and earned a Sport-Pilot Certificate in June 2011. I've been flying her "peddle-to-the metal" ever since. With the Hobbs meter recently eclipsing 1,700 hours, including the 1,450 I've flown her, I decided it was time to memorialize some of the operations and maintenance tips I've accumulated during my relatively brief (4+-year) journey into aviation and Sting ownership. Below are my first 44 tips. I will be updating and expanding these over time–as long as I am flying! Please forward corrections or comments to me at:* ***drdehave@hotmail.com.***

Disclaimers:
1. *These are my personal observations–things I (or one of my mechanics and I) have done or learned. They may or may not be applicable to your make and model of Sting–or other LSA–and should not be construed as recommendations. Many of these were originally posted by me on the discussion forum at SportPilotTalk.com.*
2. *This document is neither a product of, nor fully endorsed by, the manufacturer (TL Sport Aircraft) or the North American Distributor (SportairUSA) for the Sting LSA. However, some of the elements (asterisked) were reviewed and concurred with by Bill Canino, President of SportairUSA. As further concurrences are received, updated editions of this document will be produced.*
3. *Before adapting anything herein to your situation, do consider all other relevant* ***official*** *information, including (but not limited to) the Sting Maintenance Manual; Master Equipment List (31 Nov 2012), Sting Owners' website; Pilot Operating Handbook; and various Rotax documents and videos (Rotax-Owner.com).*

1. *Shutting Down the Rotax 912 Engine.** To avoid excessive wear on drive-train components the engine should be shut down "softly," without a loud "slap" or any kick-back. This in turn necessitates that the engine idle speed be pulled down to about 1,800-1,850 rpm (Rotax *"General Operation Tips*," E-Learning video recommends 1,800 rpm idle). When ready for shut-down, I pull the throttle slide back to idle and let it stabilize a few seconds (rpm should gradually diminish). Also, I turn off all electronics and switches, except the main power and both ignitions (commonly referred to as "mags").

To shut down, I turn one mag off and let the engine rpm stabilize again (few seconds) at the lower level; I don't rush it (unless the gearbox is "hammering"). Then I turn the second mag off and the engine stops. Lastly, I turn off the main power switch. (I wait until *after the mags* are off, to prevent uncontrolled electrical power, due to loss of the voltage regulator.) *If the engine does not stop softly, I look first to adjusting idle speed down, especially if it's more than 1,850 rpm (hot, static).*

One final trick I use is to alternate the order of the mag switches on each successive shut-down. Instead of the right one first, I go with the left one, then vice versa. Alternating mags like this provides a "mini-mag" check, to confirm operation of each ignition module.

2. ***Correct Idle Speed is also Essential for Good Landings.**** Shut-downs are not the only time I've found idle speed to be important; for me it is also key to consistently good landings–without bounces and go-rounds! I prefer to fly the final approach at 60 knots (slightly faster than the POH recommends) with a 500 fpm descent and throttle at idle (which, at this airspeed, gives about 2,000-2,250 rpm, because the prop is being driven by the forward motion). By about 20-30 ft AGL, I've let airspeed decay to about 50 knots. Then, just before flare and touch-down, I pull the throttle back against the "hard" cockpit idle stop (*see* #3) again; idle then usually diminishes to about 1,800-2,000 rpm, depending on conditions. For me, at the moment of touchdown, anything much above 2,000 rpm greatly increases likelihood of a bounced landing. Thus, I have another reason to ensure my idle speed (hot, static) is correctly set at 1,800-1,850 rpm. If you're having more bounced landings than you think you should, check *your* idle speed.

3. ***A "Hard" (Metal) Cockpit Throttle-Stop is Needed for Idle Position.**** Rotax recommends "hard" fore (full open) and aft (idle) stops for the cockpit throttle slide. On my 2007 Sting, these were presumably provided by the "cut-out" for the throttle slide within the carbon-fiber base housing it. The problem is, when pulled back to idle, the slide handle can and does gradually "cut" into the rear carbon fiber functioning as the stop. Therefore, we installed a "hard" *metal stop* here, instead; an *adjustable* hard metal stop (on many Rotax 912 applications) would have been even better! A photo of the hard metal stop placed in my Sting appears in my forum post on this topic at *SportPilotTalk.com*. Without a hard metal stop for the idle position, the engine-mounted carb levers (at the idle adjusting screws) can and do become bent over time, from pulling hard (with leverage) on the throttle at idle. This is a common malady amongst several Stings I have observed.

4. ***Set Idle Speed Correctly!**** Setting idle speed involves much more than just simple adjustments to the idle stop screws on the carburetors. The Bowden throttle-cable adjusters and cockpit hard metal idle-stop also factor into the equation. With a properly adjusted idle, the cockpit throttle slide abuts firmly against the hard metal stop (#3); at the same time, each of the two idle stop screws (one per carb) should *just barely be making contact (0.002")* with their stops. Otherwise (i.e., the screws are in "hard" contact with the stops), the pilot's "leverage" when pulling the throttle slide back, can still bend the carb levers. Your mechanic should be well-versed in how idle speed is set, adjusted and maintained in the Sting–and not going directly to simple screw adjustments at the idle stops. I've run into one Rotax tech who *did* think it was that simple!

5. ***Gradual & Smooth Throttle Application During Take-Off.**** Videos on YouTube where pilots flying Rotax 900-series-powered machines jam the throttle forward like they're in a race continue to amaze me. I prefer to slow it down. My rule-of-thumb is 4-5 seconds to smoothly go from idle to WOT (wide-open-throttle) on take-offs. To help restrain myself, I used to count, "one thousand one,..." Also, sometimes (depending on conditions and location, including if I'm in the mountains) I will gradually and smoothly apply power up to about 4,000 rpm, quickly scan the EIS for anything problematic, and then advance throttle more rapidly to WOT.

6. ***Loss of Partial Power During Take-Off–What to Do!**** It is not uncommon for specs of dirt or tiny pieces of rubber to make their way to the bottoms of carburetor float-bowls. This can happen from disturbing (i.e., removing or replacing) fuel lines, dirty fuel, or a dirty gascolator. Often, such debris just lies harmlessly in the bottom of the float bowl. However, sometimes, such as during WOT on take-off, a piece is sucked up into the main-jet opening; this may block or reduce fuel flow, causing a partial (i.e., one carb) loss of power. This has happened three or four times to me during 1,450 hours (2,600 take-offs) in the Sting. I have learned not to panic. I just lower the nose (if I'm airborne) and reduce throttle. This usually causes the offending piece of debris to fall back down into the carb float-bowl. Then I divert back to the airport, or climb gradually, until I've got enough altitude to make the return. Every loss-of-power situation is different, but relaxing the throttle is sometimes a useful option.

7. ***How to Remove Debris from the Carburetor Float-Bowls.**** If I suspect debris in a carburetor float-bowl (partial loss of power on take-off, or rough-running engine), I remove both bowls for inspection and cleaning. Unfortunately, "dropping the bowls" is complicated by the Sting's two carb drip pans; the carbs must both be pulled out of their sockets and back clear of these pans, before the float-bowl can be removed. I've had to do this twice, at remote mountain airports, to get back home! The procedure is not too daunting, once you've done it. Nonetheless, you may want to just relay these instructions to a competent mechanic–as opposed to trying the procedure yourself. Whatever *your* "druthers," here are step-by-step instructions (I carry a copy with me in the airplane):

A. Move throttle slide (cockpit) to WOT, to relieve cable stress.

B. Remove carburetor retainer spring.

C. Remove 10 mm nut and washer atop the carb retainer arm.

D. Loosen phillips screw on the carb flange clamp.

E. Lift carb retainer up enough to allow the stud to be moved away below.

F. With side-to-side and up-and-down motion on the carb, pull it out of the rubber socket.

G. Once the carb is free, position it for access to the float-bowl on the bottom.

H. Remove float-bowl retainer spring-clip using a flat screw driver on the pry-points.

I. Remove float-bowl, then lift the two floats straight up and set them aside.

J. Now, with unobstructed access to the bowl, clean it out (compressed air if you have it; debris pieces may be tiny!).

K. Reverse the process and put everything back together. Use a new float-bowl gasket (I always carry at least two with me) and seat it fully up into the grove, before reinstalling the bowl. Also, be sure both floats are properly repositioned and you haven't bent the float bracket. Run the AUX fuel pump to fill the carb bowls with fuel.

L. With care in these steps, the carb linkages (still attached as before) should not have been disturbed. Thus, you shouldn't need the carbs balanced to get back home!

8. ***Clean the Gascolator Frequently & Regularly!*** The gascolator is primary defense between dirty (or water-contaminated) fuel and the carburetors. During one brief period early in my Sting ownership, I didn't sufficiently respect this fact. Although I was regularly inspecting the glass bowl (older Stings had the glass gascolator; newer ones [and Sportair's *recommendation*] have a metal one) during pre-flights and *thought* it and the screen *looked clean,* I failed to actually remove and clean it for more than 50 hours. This nearly ended in trouble! I was amazed that the screen was almost totally blocked with debris when I finally cleaned it! Part of the problem is that the Sting's gas tank(s) are composite, so they are continuously shedding composite debris, some of which makes its way to the gascolator.

Cleaning the gascolator (i.e., the older glass ones) is easy (*see* MM). Loosen the wing-nut, drop the bowl, then clean the bowl, spring, screen, and plastic washer atop the bowl, using compressed air and a clean, lint-free rag. I've found reinstallation is trickier. First, I fill the bowl with clean fuel (to minimize the air-bubble in the top of bowl on start-up), then I place the clean spring and screen in the bowl, place the plastic washer atop the bowl, then carefully fit the bowl and washer up into the housing. I make sure to "seat" it correctly in the grooves (i.e., for plastic washer and top of the screen). With the wing-nut re-secured, I run the engine 5-10 minutes with the AUX fuel pump on, or until any air bubble in the top of the bowl completely disappears. I check for leaks while it is running and after shut-down. These are just *my supplemental tips* to consider. We must all read and follow the MM instructions first and foremost. Anyway, I now clean my gascolator religiously, every 25-30 hours, depending on conditions–even if it *looks clean* during pre-flights. (Refer also my *Aircraft Safety & Performance Tips* video on YouTube.)

9. ***Liberally Drain the Fuel Sump Before First Flight of the Day!*** I used to drain fuel from the sump into one of those "test tubes" before every first-flight of the day. You know–the kind that you "push up" against the sump drain valve, for a fuel sample. I avoid this now. First, when I push up–then "softly" release–that valve regularly, it soon starts leaking. Then, I find I either need a new one or a new rubber O-ring and someone who can replace it. Second, I find it hard to *see* debris (especially *composite* debris) in those test tubes.

Now, I prefer a wide-mouth mason jar–either quart- or pint-size. I *lock* the sump valve open, then drain a jar-full, all the while moving a wing up-and-down for tank agitation. This really draws debris out! Once a jar-full is drawn, I unlock the sump valve and let it "snap" back to the closed position, then observe a few seconds to make sure it's not leaking. In my experience, snapping it back to the closed position depresses the O-ring sufficiently to keep it from leaking. (Refer also to my *Maintenance Tips* video on YouTube.)

10. ***Using Mo-Gas to the Extent Possible.*** You no doubt know there's a conundrum over which type of fuel to use. On one hand, E10 (10% Ethanol) unleaded auto (Mo) gas *may* pose risks of delaminating composite structures (i.e., the Sting's fuel tanks). (Certainly, fiberglass boat-owners have suffered demonstrably with such issues!) On the other hand, leaded Av-gas *definitely* creates a number of engine- and gear-box-related problems for the Rotax 912 engine. I have "paid the price" (in lead-related repairs) for the first owner of my airplane running 100 LL *exclusively* over the first year (250 hours) of operation of my airplane.

I'm a Mo-gas convert, with no obvious composite problems yet, "knock of composite!" I use Av-gas only when I have to, on my longest trips (which isn't very often, thanks to having the auxiliary wing tanks). I do buy all my premium Mo-gas at one nearby high-volume station, where I'm betting the high turnover of fuel lessens chances of getting volatized gas with diminished octane. Diminished octane (<91) poses the threat of "detonation," which is bad news for the Rotax 912 engine. If I could, I would certainly be buying *non-ethanol*, unleaded Mo-gas, but here in central California, the nearest source is 100 miles away. (I am, however, considering a 200-gal utility-trailer-tank, for fuel runs, though.) If you opt for the Mo-gas route as I have, I recommend getting several *Jaz Jugs* (5.5 or 15.0 gal, wide-mouth) to carry it to the airport and a *Mr. Funnel Fuel Filter,* for pouring it into your tank(s)**.** Meanwhile, let's pray the national switch from leaded to unleaded *aviation fuel* comes sooner rather than later.

11. ***Monitoring Coolant Level at the Overflow Bottle During Pre-Flights.*** I used to follow the recommendation–to open up the metal coolant tank during pre-flights, to check coolant level. I have stopped doing this. After a few dozen times, the radiator cap on the tank invariably starts to fail to seal properly. This leads to a leak, loss of pressure and the need for a new pressure cap–and that's an $80 part (I always carry a spare one)! I've found it sufficient for most routine pre-flights, with a properly functioning, *stabilized* Sting cooling system, to just monitor coolant level in the overflow bottle on the firewall; this is done with a cold engine, before first flight of the day.

Nevertheless, anytime the cooling system is "broken-in-to," for example, when we flush and replace coolant, replace a coolant hose, or work on the cylinders or heads, I know that *re-stabilization* may take a few days. When re-filling, I begin by filling the coolant tank, then I add about ½ bottle of coolant to the overflow bottle (my 2007 has the small-sized bottle). Next, Rotax says to "run the engine briefly," which I interpret as "about 30 seconds," after which I check (re-fill to same level) the bottle and tank again. Then I'm ready for a more extensive ground run, although I have found it better to take a short flight, then "put her to bed." The next morning, with a cold engine, the level in the bottle should have dropped or it may be empty (either of which indicates the system is functioning properly). I replenish at the bottle, up to at least the MIN mark printed near the bottom. I then continue flying and doing this again each morning, until the level, cold, has *stabilized* in one place (assuming similar temperatures). I prefer the stable (cold) point near the MIN mark; I mark it prominently, with a magic marker. This mark is what I check on pre-flights, with a cold engine. With the relatively small bottle being used, a stable point (cold) much higher than the MIN mark, invariably results in coolant expansion out the top of the bottle during flights on *hot days*. If this happens, I know I'll be cleaning dried coolant off the bottom of the fuselage.

12. ***Manage Radiator Air-Flow Seasonally with the Radiator (Heater) Shroud.*** The Sting has a heater shroud which covers almost one-half of the left rear side of the radiator. A hose connects from it to a heater duct, to provide cockpit heat in winter. But even if cockpit heat is not needed, the shroud, which restricts airflow, may still be needed to ensure engine oil temperatures aren't too low (Rotax says normal operating temperature is 194-230 F and that at least once a day 212 F should be achieved) during cold weather. On the other hand, in warm or hot weather, you want the shroud off, to maximize cooling and keep engine temperatures from exceeding upper limits. For me, here in central California, a good rule-of-thumb for springtime is when I start having (and flying in) upper-70s-to-low-80s (F) or higher, days, it's about time to remove the shroud for the season. In fall, flying with temperatures below this level, indicates the shroud should go back on. Also, I know it's time to remove my shroud if my hottest CHT, or oil temperature, reaches or exceeds 230 (F) degrees, before I get to 1,000 AGL on climb-out. These are just *my* guidelines to be aware of. Every airplane and local weather situation is different. Set up your own rules for managing your heater shroud.

13. ***Control Excessive Engine Temperatures through Hottest-EGT Management.*** As stated (#s 11,12), I believe the first line-of-defense against high oil temperatures and CHTs is to have the *radiator shroud off* and a *full, stabilized cooling system*! But, I've also discovered a second defense, if and when engine temperatures start soaring (or the red warning light has already started flashing): managing the hottest-EGT reading via the EIS. First, I reduce AOA (if climbing) and throttle back, until I find the "sweet spot," where hottest-EGT drops rapidly (i.e., 5-8 seconds) by at least 25-50 F degrees (or more). I move the throttle around (usually down, but sometimes up) and select the *RPM* that gives me the greatest drop in the hottest-EGT! Usually, this "sweet spot" exists around 4,500- 4,700 rpm. I hold it there and I soon see engine oil temperature and CHTs dropping dramatically too, in response to "less work" (thus less heat) the engine is doing. And if throttling down does not yield a sweet spot, I always remember to try going up. I've found the hottest-EGT sweet spot to be a very effective way to help manage high engine temperatures in hot weather.

14. ***Don't Overlook the Air Deflector "Flaps" on the Radiator.*** Although I may be diligent about coolant level (and stabilization), radiator shroud, and hottest-EGT management, if I'm still getting excessive engine temperatures, I know there's another possible culprit. During pre-flights, I always check the flexible "flaps" attached to the bottom of the radiator that fit into the lower air duct of the lower cowling. They can become bent, broken or just plain worn out (mine were)! Without the proper flap fit inside the lower cowling air duct, cooling efficiency is reduced. New radiator flaps can rather easily be built, I've found, using a piece of 4" rubber crown molding from a hardware store, pop-riveted to the sheet metal base attached to the radiator. When we did this, a dramatic improvement in engine cooling was immediately observed–and has been enjoyed ever since!

15. ***Taxiing "Attitude" Affects Engine Cooling.*** From taxiing my airplane to 2,600 take-offs, I've seen engine cooling–and heating–issues, first-hand. For example, taxiing long distances and taxiing with a following wind both dramatically increase engine heating. Also, sitting with engine running and wind from behind increases heating, while facing into the wind improves cooling. I always try to use such nuances to my advantage. Thus, if it's a cold day and I want to get engine oil temperature up to take-off minimum faster, I look for a longer taxi route with following wind or "hold" in a following wind. Also, if I know there's a long line of airplanes at the run-up area on a hot day and I'm facing a mile-long-taxi with following wind, I don't hesitate to forego my start-up and launch until the crowd disappears. Otherwise, I know I may be seeing excessive engine temperatures (and EIS warnings) before I get to 1,000 AGL!

16. ***Reducing Ignition "Drop" & Drop Variation during Ignition Tests.*** I've found two simple things that dramatically reduce both "drop" and variation between the two ignitions in my airplane during ignition testing at the run-up area. First, I always point the nose and propeller directly into any wind. Second, I do run-ups with engine oil warmed up to at least 128 F degrees (instead of just the recommended 120 F minimum). I was (and continue to be) impressed by how much smaller and more stable those RPM drops become with just these two little tricks! (Refer also to my *Aircraft Safety & Performance Tips* video on YouTube.)

17. ***Composite Cracks Not Worth Fretting Over!*** Sting owners have been known to "freak out" when observing the first cracks in their airplanes. Yet most of us will, sooner or later, end up with some. Fortunately, my cracks so far have just been cosmetic paint cracks and not composite structural issues. The first place cracks occurred on my airplane was underneath the wings, where the flaps are attached using small hinges. During construction, these hinges require filler around them to create a smooth surface for painting. After the paint is applied, cracks may develop, especially if "stressed" by exceeding the flap speed limits! Although on my airplane it looked like the hinges were breaking away from the wings and flaps, it was determined to be just the paint cracking. So I no longer fret over these cracks, but I *do watch my flap speed limits* carefully, now, just as the POH advises!

Another place cracks appeared on my airplane (and three other Stings I know of) is along the leading edges of the wings and the centerline, along the bottom of the fuselage. These were also determined to be paint cracks, related to paint-and-filler issues, at the joint where two composite "halves" are mated together. I've found that paint cracks along wing and fuselage joints tend to appear after flying in cold air. This may be because the paint and filler contract and expand at different rates in response to cold (and warming).

At any rate, in my experience, paint cracks at the flap hinges, wing leading edges, and bottom centerline of the fuselage, were found to be nothing to fret over. But don't take my experiences as gospel. Investigate thoroughly any cracks in your Sting's paint to verify they are benign.

18. ***Starting the 912 Engine.*** My engine became easy to start flawlessly, every time, once I learned how! I have to use the choke for every "cold" start. (Remember: This is not a "choke" in the traditional sense [of an operational butterfly valve]; this choke is simply a fuel enrichment device [i.e., delivering raw fuel]). I fully engage the choke, with the throttle at idle. As soon as the engine fires, I start smoothly exchanging choke for throttle; I do this pretty quickly, over about 2-3 seconds, after which the choke is then fully closed and idle is at a smooth level (2,000-2,200 rpm, according to Rotax) for warm-up (colder may necessitate higher rpm). Starting a warm or hot engine has always been trickier for me, especially at higher altitudes. But I rarely need any choke. Rotax says "hit the starter, while gradually applying some throttle." But what works better (to prevent flooding) for me is to just barely crack open the throttle and hold it there when hitting the starter button. Once I got the hang of "cracking it" just enough, it has always started easily, without flooding. Exceptions do occur when my carburetors are not in balance.

19. ***The Main Battery is Short-Lived.*** My Sting has the YTX9-BS battery; unfortunately, I rarely get more than about 200-300 hours and a few months of service from a new one. However, this model (YUASA) is inexpensive, available for about $60 or less on the internet. So I always have a spare one on hand, ready to go *when* (not *if*) my battery starts going bad. For me, indications of eminent failure are: (a) the prop spins noticeable slower when starting; and (b) the "low battery" warning light starts coming on intermittently, but increasingly, especially when taxing long distances with the strobe, landing, or taxi lights on. When these signs start appearing, I usually just install the new battery–and order another one to replace it on the shelf.

20. ***Be Sure Your Pants are on Tight!*** I'm talking about main-wheel pants! Each one is attached with two screws (to pant bracket) and one bolt (to axle). I can verify that these fasteners can and do come loose–probably due to extensive vibration they endure. This can lead to a wheel pant "wrapping" around a tire and wheel, which tends to create God-awful noise, embarrassment, and danger, depending on when and where it occurs. I once watched one get "wrapped" on the runway in front of my hangar, I nearly wrapped one myself on another day, and I know of one east-coast Sting owner who has a lighter wallet after a wrapping incident. The moral to this story is that now, I get down there, with a screw driver and wrench once in a while, and check those very important wheel-pant fasteners!

21. ***Apply Torque Seal for Safety!*** Early on, I purchased several tubes of Torque Seal paint (several colors) and marked every fastener I could find, except a few (e.g., wheel pants) avoided for aesthetic purposes. Torque Seal helps me to quickly spot fasteners that are coming loose (i.e., a "break" in the paint). So far it's worked close to a dozen times for me in 1,450 hours; a few of those "paint breaks" could have eventually led to a "bad day" for me and the airplane.

22. ***Secure the Open Canopy with a Bungee!*** My experience is that sooner or later, a gust of wind will grab the opened canopy like a sail and try to rip it off! It's not if, but *when*. Once this happens, the canopy may be "sprung" and fail to ever close properly again. One preventive measure I employ is to carry a long bungee cord (~36") at the ready. I drilled a hole in the top middle of the cardboard seat-back structure and hooked one end there. I let the cord rest on the rear deck. Then, whenever I open the canopy in a following wind–or leave it open and unattended–I hook the other end of the bungee to the rear canopy handle.

23. ***Don't Close the Canopy Tightly in Direct, Hot Sun!*** This fact becomes obvious once you make the mistake! The Sting's bubble canopy, buttoned down in a hot sun is like a magnifying glass and it can melt stuff! Just ask the first owner of my Sting, who damaged two GPS antennas and scorched the cloth fabric on top of the panel that way. Whenever I leave, but remain within "watching distance," I always use my bungee cord (appropriately shortened) to keep the canopy open a few inches for air circulation and temperature control. If more security is desired, I go ahead and lock the canopy down, but ensure my fabric cover is over the top for solar protection.

24. ***Keep an "Arrow" Near Your Prop!*** "Propping" the Rotax 912 in the wrong direction (i.e., opposite normal engine travel) can potentially lead to engine damage. Nevertheless, once, one of my mechanics–a Rotax-certified veteran–started reverse propping, until I yelled loud enough to scare us both! Now, I maintain a prominent "arrow" decal, on the upper cowling near the propeller, pointing to the "correct" direction of travel. I figure it may save somebody (i.e., me or a mechanic) from an inadvertent mistake, which could lead to an even worse day for me.

25. ***Changing the Engine Oil & Filter.*** The MM describes oil and filter changing. However, I've discovered nuances (based on my 38 oil changes over 1,450 hours) to keep in mind:

> **A.** Not all 3.5 quarts of old oil can be removed from the engine. At best, I can drain and replace 3 quarts. But I don't get this much, unless I "burp" the engine, after running it up to temperature (>128 F) and shutting down. I wait 10-15 minutes after shut-down, then burp it several times in succession, pausing briefly (15-30 s) between. This gets most of the oil out of the engine and into the oil tank, for removal;
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> **B.** First steps are to change the oil filter and remove and inspect the magnetic drain plug. I wait a few (~5) minutes for these to drain. I put the new filter on and replace the drain plug, and button them both up. I still do pre-fill the new filter with oil (1-2 ounces), although this is no longer necessary, after Rotax introduced its new filter a few years ago;
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> **C.** Next, I remove the oil tank, just as described in the MM. I know I can forget trying to get at the drain plug on the bottom of the tank, unless I invest in a trained monkey with tiny hands! Also, I never attempt a shortcut of "sucking" the old oil out of the tank using a pump; this would leave "gunk," including lead, in the bottom of the tank.
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> **D.** After the oil tank is drained and cleaned, I reinstall it, and button up the connections. Then I add three full quarts of fresh *Aeroshell Oil Sport Plus 4* oil. If I've followed the guidance so far, including "burping," before filter and drain-plug removal, three quarts will be just right to bring the oil level to the middle of the flat spot on the dipstick–exactly where it should be (*i.e., the next morning, at ambient air temperature, not right now!).*
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> **E.** Finally, I like (my preference; you decide) to doubly ensure the system is fully primed. First, I slowly pull 50 prop blades ("burping" is heard), then after a few-minute pause, 50 more. Then I "dry-crank" (ignitions OFF) the engine for 10-12 seconds. Finally, I fire her up for the ground-run and leak check. But only the next morning, with the engine cold, do I check the oil level on the dipstick (after burping) and top off the tank, if needed! But I've never needed to yet; it's always been perfect, following these procedures!

26. ***Cold-Weather Engine Starts Call for Pre-Warming.*** If my hangar isn't heated and the engine will be started in cold weather (<35-40 F), I know pre-warming is advisable to reduce start-up engine wear. Several factory-made heaters are available for use on the Rotax 912; and if I was dealing with *really* cold (frequently below freezing), I'd definitely fork for one. However, for milder winter conditions that I have, I simply bought two inexpensive engine heating pads on Amazon. On cold mornings, I clamp one to the gearbox and one to the oil tank; an hour or two later, the engine is warm as toast when it's first cranked over. (Refer also to my *Aircraft Safety & Performance Tips* video on YouTube.)

27. ***Avoid Throttle-Back Harmonics (TBHs)!*** When reducing throttle, high-frequency vibrations may be felt in the rudder peddles. The cause is the propeller developing "harmonics," due to load changes. That's why I call it "throttle-back harmonics" (TBHs). My experience is that TBHs are related to type of propeller (also make and model); whether I am in descent; my rate of descent; relative wind direction and speed; my airspeed; and how quickly I pull the throttle back. I don't know all the nuances, but I do know (from having to replace many expensive parts) that TBHs are *bad* for the airplane! When ignored, they cause exhaust tubes to crack, muffler-bracket arms and muffler springs to break, cracking of engine rubber blocks, and added wear-and-tear on drive-train components. Fortunately, TBHs are also relatively easy to control and prevent. Just change either the throttle setting, angle of attack, direction of travel, rate of descent, or airspeed, right away. I have learned to quickly make whatever change is necessary to prevent and/or make TBHs disappear! I believe most folks quickly learn these control and prevention tricks too, for *their particular airplane*, once they recognize and focus on the problem. And here's another tip: If TBHs appear suddenly–or suddenly get worse–I always begin troubleshooting the carburetor synchronization and/or pitch of the three propeller blades, first (Refer also to my *Aircraft Safety & Performance Tips* video on YouTube.)

28. ***Monitor the Engine Rubber "Blocks!"*** Whenever the cowlings come off for a pre-flight or other formal inspection, I examine the six engine rubber mounting blocks carefully. I look for cracks in the rubber. Cracks are serious and here's why. Bolts which *appear* to go *through* these blocks *do not go through these blocks*! Thus, when a block cracks all the way through (i.e., in half), the engine is no longer attached to the engine mounting frame at that point! When engine rubber blocks are found to be cracking, we go into replacement mode pretty quick!

29. ***Remove the Engine Cowlings Regularly for Pre-Flights!*** There is a "dead" 2005 Sting rotting in a field at a small California airport; this is the Sting I took my first 20 hours of flight instruction in. Because the cowlings had 50 or so screws and not just a handful of "cam-locks," the owner rarely removed them for pre-flight inspections. They often stayed on for 50 hours at a time, and when they did come off, there was usually plenty of "stuff" needing attention. When I purchased my Sting, I vowed not to repeat this inspection lapse. Today, I *never* fly more than 3-5 hours without pulling the cowlings off for a thorough inspection! Doing so has resulted in at least a dozen issues being detected and fixed before they became potentially serious. Whether it's screws or cam-locks, the time it takes for a look inside is always worth it in my book!

30. ***Know Essentials of "Burping" the Rotax 912 Engine.*** When I began my aviation journey a little over 4 years ago, burping my Sting's engine was often an exercise in futility. So I examined the subject carefully and made my "burping video" (Sting Flight; YouTube). I will only repeat two key points here. First, to burp the engine quickly (1-5 prop pulls) before the first flight of the day, just *pre-burp it* 10-15 minutes *after the last flight of the previous day* (or last time flown)! Second, if you believe it makes no difference whether you check the engine oil hot or cold, try a comparison. Burp it and check the oil cold, noting exactly where the level is on the dipstick; then, go fly it, land and check (burp 10-15 minutes later) the oil again, hot. You will be surprised how much the hot oil has expanded in volume. That, in turn, may lead you to agree with my point-of-view: always checking engine oil cold to better detect *subtle daily* changes in oil *volume*.

31. ***Know Tire Management Essentials!*** Looking back (based on what I know now) to my first year of flying, I was lucky not to have had a landing or take-off "incident" involving a "bad" or blown tire. Then I educated myself–and produced my tire mounting and balancing video (Sting Flight; YouTube). I will only reiterate three of the most important points, here:

A. Use a new tube with every new tire! (Because the old tube has *stretched*)

B. Use plenty of talc on the tube and inside the new tire! (So the tube fits evenly inside, without folds or creases)

C. Before installing (under load) the new tire and tube on the airplane, inflate it, then let it "grow" unloaded, overnight–or for at least 12 hours! (To avoid "flat-spotting and bumpiness)

Stings may use either aircraft tires or utility-trailer tires. Mine has always had utility-trailer tires. I'm on my 28th set of main-gear tires, averaging a little over 100 landings per set; of course, the nose-gear tire lasts much longer. I've tried many different (within specifications) utility-trailer tires. My current favorite is the *Kenda Loadstar*. However, the heaviest and stiffest tire (much like the *original Sting tires*) available (but also the *most difficult to mount*), is probably the *Carlisle Sport Trail*. Utility-trailer tires can be purchased on the internet for about $22-30 each, plus about $8 for a (Firestone) tube! However, when I purchase tires, I take care to ensure they have the correct DOT specifications: 4.8/4.00 x 8 Load Range C, 6-ply rating, high-speed, with 745 lbs (339 kg) maximum load at 90 psi (*note: 30 psi inflation, per the MM*);

32. ***"Fixes" for Anomalous EIS Readings.*** My Sting has the Grand Rapids Engine Information System. Several times in 1,700 total hours, it has gone slightly "bananas," flashing periodic anomalous warning lights and/or errant engine readings. When troubleshooting such problems, I follow these steps:

Step 1-Search (continuity tester) for a defective ground connection to the offending sensor(s). In addition, un-bolt and clean the main ground wires bolted to the top of the engine (two places; several wires). Once, just *removing oxidation and corrosion from these ground connections to the engine resolved an errant EIS issue.*

Step 2-Search for a bad wire, especially a bad female spade-foot connector, attaching to the involved sensor. Even when I haven't found any obvious problem with a spade-foot, I have, on occasion, soldered on a new one, anyway–and that resolved anomalous readings! Also, once, a couple drops of engine oil on a spade-foot, where it attached to the sensor (from a nearby leaking valve cover) was causing anomalous CHT readings.

Step 3-If a bad ground, lead-wire or spade-foot to the sensor are not the issue, only then do I start focusing on the sensor itself. One trick is to switch wires going to same-type sensors. For example, if one CHT is acting badly, I switch its wire to the other CHT and see if the problem stays with the sensor or follows the wire. This helps me find the *real* issue.

Despite the various errant EIS behavioral issues I've experienced, only once did I have to replace any sensor–the fuel-pressure sensor, about 700 hours ago.

33. ***Common TruTrak Auto-Pitot Issues.*** My Sting has a single-axis TruTrak auto-pilot slaved to a Garmin 396 GPS. It's always worked, but never to my satisfaction. "Hunting" excessively for direction, on NAV (to a waypoint), was one issue. A few months ago we decided to look for a solution and ended up dramatically improving the auto-pilot's performance! First, we went into the set-up menu for the ADI unit; two or three of the factory's "recommended settings" were out-of-bounds, so we re-set them per the TruTrak manual. Next, we set both the ADI and the Garmin to the same (highest) baud (data) rate, because they were paired at a lower rate. Then, in the Garmin we discovered a "data rate" control menu set to "auto" and changed that to "ON." The improvement in auto-pilot performance after these adjustments was dramatic. Apparently, the ADI and GPS just weren't "talking" correctly to each other, before the changes.

Also, for a long time, I didn't know something else integral to TruTrak ADI operation. Care must be taken that the airplane *does not move and turn*, until the GPS locks onto a position, and the ADI window changes from flashing "- -" to "OFF." Otherwise, correct operation is impaired.

34. ***Best Management Practices When Disturbing Fuel Lines.*** A few years ago, there was a flurry of activity, as everyone focused on Rotax's (and thus many LSA manufacturers') 5-year rubber replacement mandate. Some went along, kicking and screaming. Others of us, saw the value and did it willingly–but had some dangerous, close calls as a result! What happened is that a few mechanics were using pretty sloppy practices during rubber change-outs. Thus, some of these jobs resulted in debris being introduced into fuel lines and from there it made its way to carburetors. That in turn eventually resulted in several of us experiencing partial losses of power during take-offs; I had three or four of these myself, including a dangerous one!

As a result, some of us (including a well-respected Rotax mechanic) developed *Best Management Practices (BMPs)* for 5-year rubber replacement on the *SportPilotTalk.com* forum. Do a search there, if you want to review the associated "thread." Anyway, I'm pretty sensitive now to keeping debris out of the mix, when fuel lines are disturbed or replaced. So here are our BMPs, which I like to have my mechanic *review* before beginning work on any of my fuel lines:

A. Bulk fuel-system lines should be stored only in clean, enclosed containers and never open and exposed, such as on a shelf or the floor; and

B. When old lines are removed, all open fuel-system orifices should be capped or plugged, immediately; and

C. New fuel-system lines should be double-flushed with air and/or gasoline just prior to installation; and

D. All cuts should be made only with the sharpest of instruments, to avoid ragged edges and cutting debris; and

E. Any fire sleeves through which fuel lines are to be inserted should be cleaned and flushed, and fuel lines pushed through them capped, during the insertion process; and

F. After fuel system hose replacement and engine test-run, shut down, remove fuel hoses at the carbs and drain some fuel through for flushing action, with particular focus on the 1/4-inch line from the fuel pump.

35. *Is the Garmin's Internal Battery Toast?* My Garmin 396 has always had start-up issues. If the airplane wasn't flown for a few days, it needed 5-15 minutes to lock onto a position. And this often required first selecting "*Start w/out Internal Battery*" in the pop-up "*Poor Satellite Reception*" Menu. Recently, I discovered why: The internal lithium, rechargeable battery was toast! (This tiny, 3V coin battery allows the unit to "remember" where it was when last shut down.) It would only start working after several minutes, after drawing enough of a charge from the main 396 battery. The internal coin battery is just a $2 battery (Digi-Key PN P044-ND), but Garmin charges $200 to install one. We installed one (following pictorial directions available on the internet), which required miro-soldering the two tiny leads. With the new internal battery, my Garmin 396 locks a position almost immediately now–just like my Garmin 695–and that means the TruTrak ADI also becomes "live" almost immediately too.

36. *De-Bugging Today is Easier than Tomorrow.* My favorite bug-cleaner is Rain-X 2-in-1 Foaming Glass Cleaner + Rain Repellent. What I didn't know for a long time was that even with this great cleaner, removing all the insects from the airplane after the last flight of the day is *way easier* than letting them stay on until tomorrow–especially during hot weather.

37. *Lemon Water is Just as Good as Plexus!* Initially, I was paying $20 or so per can of Plexus, for cleaning the plastic canopy and wing-tip covers . Then, for about 1,000 hours I was a Lemon Pledge (furniture polish) fan. More recently, I found something simpler and cheaper than either of these: two tablespoonsful of fresh-squeezed lemon juice in a spray-bottle (quart) of cool water. Lemon-water is my go-to cleaner now, and the canopy is cleaner than ever! I still break out the Plexus occasionally, however, to quickly polish out any light surface scratches.

38. *Be Careful If You Tape Your Joints!* I'm a believer now! I think you can indeed *slightly* increase airspeed by taping up all exposed joints–especially those big, ugly gaps between wings and fuselage–to ever-so-slightly reduce drag! I tried the recommended white vinyl electrical tape, except I left it on too long (>90 days) and when I finally pulled it off to replace it (due to soiling), it pulled a lot of paint off, too (fortunately, on the undersides)! I know now if I tape my joints I must change it frequently (~30 days). But I'm still "smarting" pretty good from the missing paint, so I've stopped doing this. Besides, I go fast enough, anyway, with my new DUC Swirl propeller (#40)!

39. *Gas Tanks Full or Empty When the Airplane's Not in Use?* I'm torn about the best answer to this question. It would seem that empty tanks during cold, damp weather is a bad idea due to the (water) condensation issue. And for a long time, I did keep full tanks when the airplane was grounded for bad weather or repairs. But recently, I've discovered there is much more debris coming out during pre-flight sump-draining, when the tanks have been stored full versus empty (i.e., and filled just before flight). Also, I worry about loss of octane rating from full tanks, since the fuel system is not a truly "closed" system. So, my answer is "I don't have a clue!" and if anyone can offer some educated advice, I would welcome it.

40. ***The DUC Swirl Propeller for Speed Plus Performance!*** Several makes and models of propellers are allowed on Stings. About 650 hours ago (June 2013) I switched from a Woodcomp SR-200 to a DUC Swirl Inconnel propeller. This has been the most satisfying mechanical change I've made to my airplane since purchasing it! Speed increased by a solid 5-10 knots, climb performance improved, and fuel economy has been as good or better than before, at the same engine RPM. Smoothness in straight-and-level flight is just awesome and I can fly her all day at 120 knots indicated (if I wanted to)!

The conversion (on my 2007 model) necessitated three parts: the DUC three-blade propeller, DUC hub, and 6 slightly longer M8 (1.24 x 140 mm) attachment bolts. The original spacer, spinner, and spinner backing plate were used; however, six new 8 mm holes did have to be drilled in the backing plate (for a different alignment). As a testament to DUC quality, after I carefully set the pitch to 23.3 degrees, I flew to a nearby shop for a dynamic balance. Do you know what it needed? Nothing! It was already absolutely perfectly balanced!

Although I am quite satisfied with this propeller, it does have downsides that I keep in mind. First, it is not suitable for general STOL use, or for even *practicing traditional* short-field take-offs, where the engine is run up with brakes held to accelerate the launch. The problem is, it cavitates until it gets moving. So I always want it rolling, and then I gradually and smoothly add power during take-offs. Second, it is particularly sensitive to TBHs, especially at 4,500 ft MSL and higher, in cross- or following-winds and steep descents. Nevertheless, I can live with, and manage, these various shortcomings in exchange for the added speed and climb performance.

41. ***Know How Far You Can Glide!*** "Engine Out!" We all practice for one, but thankfully, few of us will ever have to actually make an engine-out emergency landing. Nevertheless, if the time ever comes where I loose all thrust, I'll want a "ball park" idea–fast–as to how far I can expect to glide, from where I am now. Fortunately, the Sting's 12:1 glide ratio and 70-knot "best glide speed," allows just that: The magic number is: *about* 2 nmi per 1,000 feet of altitude, if no "adverse" conditions exist. So I've made a Glide Table, with distances and times for various altitudes, and I keep a laminated copy in the map pocket next to me (get it at Dropbox.com): https://www.dropbox.com/home?preview=Glide+Distances+and+TimesSting+Sport+LSA+at+12.pdf

42. ***Re-Setting EIS Limits.*** The MM describes the procedure for setting EIS limits (Grand Rapids unit) and gives recommended values. However, after 1,450 hours, I've found that some of these limits are not conservative enough for my needs and one is too conservative, resulting in an inordinate number of (red-light) warnings. Limits I have re-set to be *more conservative* are (MM recommended; followed by my settings, bold font): Oil Pressure (psi)–92/30 vs **85/35**; Oil Temperature max (^{0}F)–256 vs **238**; RPM max–5,700 vs **5,520**; Voltage–14.8/11.0 vs **14.6/12.2**; and EGTs (^{0}F) max–1600 vs **1500** (CHTs max was left at 238 ^{0}F). In my particular airplane, I have found these changes were needed to give me *more warning* of impending trouble. For example, if I'm not warned until my oil temperature has reached 256^0, my options–and time–for remedial actions may be greatly curtailed. Another example is regarding battery condition, which, by the time the system is indicating just 11.0 volts, (engine running) the battery is essentially just about dead and unable to support my electronics!

On the other hand, I had to re-set Fuel Pressure (psi; AUX 2) *less conservatively* (5.6/2.2 vs **5.9/2.1**), because two of the new-style Rotax fuel pumps installed on my engine recently were consistently "breaking" original EIS limits by small amounts (problems did diminish over time).

Of course, I am *not* recommending that *anyone* change their EIS limits to my values. However, if you start experiencing an inordinate number of EIS warnings, or your flying style demands more "warning leeway," some EIS limit changes may be appropriate.

43. ***Use of "Living" and Dynamic Checklists!*** Lots of "stuff" has changed since the 2005 Sting that I took my first flight lessons in hit the airways. And I've found that the checklists in the POH don't always meet my needs and flying style. So I have expanded and improved them. And today, I consider my checklists "living" documents, which I can and do change frequently, as needed. My current checklist is here, at Dropbox.com, if you'd like to peruse it in improving your own Sting checklist: https://www.dropbox.com/home?preview=2013+Sting+Cockpit+Checklist+Update.pdf

44. ***Only Knuckleheads Have Loose "Knuckle-Pins."*** Recently, I was at Lodi, California (K1O3) jawboning with fellow flyers. As discussion ensued, one of them walked over to my Sting and began lifting up-and-down on the leading edge of one wing, up near the fuselage. To everyone's surprise–and my utter dismay–there was noticeable "play" and a discernable "knocking" noise, each time he lifted! The other wing did the same thing, just not as bad!

Needless to say, this got our immediate attention and here's what we learned (thanks in part to "*How to Remove/Replace The Wings*" instructions on the Sting Owners' website). Each wing has a carbon-fiber spar extending through a D-shaped opening on the wing side of the fuselage, clear across it to a socket on the opposite side of the fuselage. However, each wing also has a fore and aft knuckle-pin (similar to a ball-and-socket joint), which engages the wing root to resist twisting (which is what the "knocker" guy was doing to my wings!). And the "ball" of each knuckle-pin, which is attached to the fuselage, is *adjustable!* One turn "out" for each ball on the bad wing and one-half turn out for the other wing was all it took! The play and knocking in the wings was eliminated, and I was soon flying pedal-to-the-metal towards home, not afraid of "separating" from the wings.

Useful Links (copy and paste to browser):

Sting Owners' Support (Numerous documents and notices) http://www.sting.aero/owners/

Sting Flight (YouTube–Author's Channel) https://www.youtube.com/user/9162069934

Sting Flight (Facebook–Author's Facebook) https://www.facebook.com/pages/Sting-Flight/334060526751303

SportPilotTalk Forums http://sportpilottalk.com/viewforum.php?f=3

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