THINGS YOU REALLY NEED TO KNOW…
THAT NO ONE EVER TELLS YOU

Like any other mechanical and social activity, model flying has its own technical and behavioral "secrets" that more experienced model pilots take for granted. In fact, most of these "Old Pros" take so many things as just the "way it should be done" that they forget that newer pilots *really don't know these great truths.*

Explaining some of these "great truths" is what we are going to attempt here. In this and in future articles, we'll cover tuning your engine, battery management, starting techniques, landing gear setup, fuel selection, transmitter dual-rate setup, radio range checking, throttle setup, field rules, field etiquette and dozens of other topics. For now, it might be best to start at the front of the airplane and work towards the rear. That means its time for:

ENGINES

Today's model 2-stroke engines, especially those in the .25 to .61 cu. in. displacement range are nearly works of art. While incredibly difficult to design, these engines are simplicity itself to operate. If the glow plug is working and there is the proper ratio of fuel/air mixture in the combustion chamber, the engine WILL start. There are no other requirements. Well, someone does have to rotate the propeller, but that is the only extra thing that is required. If the high and low-speed mixture controls are properly set and the fuel is good, the engine will always run until the tank is empty.

So why then, is it so difficult to get the engine running reliably? Maybe it is poorly set mixture controls. A two-stroke model engine is fuel/air mixture dependent. That is, nearly its entire operating system depends on having the right fuel to air ratio. Properly setting these mixtures requires just a little understanding of how the mixture controls are designed to work in sport engines.

MIXTURE SETTINGS

The high-speed mixture control, called a needle valve since the section inside the engine tapers to a sharp point (photos 1 and 2), meters the amount of fuel that flows into the carburetor *at high speed*. For most practical purposes, the mixture setting determined by this control has little effect on the engine's actual mixture until the throttle is opened more than 40% or so. Therefore, do not use this control to set the engine's mixture below half throttle.

Photo 1 Photo 2

Instead use the idle, or low-speed mixture control. There are two types of idle control as shown in photos 3 and 4. The most common is the separate screw or small needle. But the second, “air bleed” type is also common. Both work effectively, but only at throttle settings below 60%. Therefore, do not use this control to set the high-speed mixtures.


Photo 3 Photo 4

As seen in photo 5, the idle mixture screw does not even *touch* the fuel inlet jet until the throttle approaches the mid-range. As the throttle approaches mid-range in photo 6, the idle mixture needle is just beginning to contact the fuel inlet jet. It cannot have an effect until contact is made.

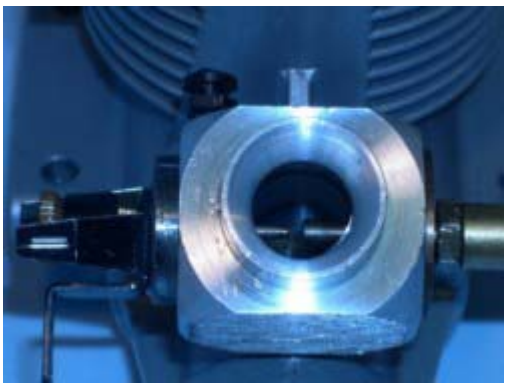
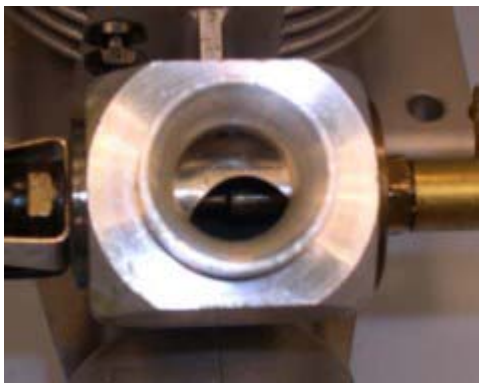

Photo 5 Photo 6

Notice that the HS needle works down to 40% throttle while the LS needle works up to 60% throttle. The mixture ratio for throttle settings between 40% and 60%, called the “midrange,” are affected by both controls. Fortunately, if both controls are set properly for extreme high and low speeds, the midrange usually works out.

Always set the High-Speed mixture first. Open the HS needle to the number of turns recommended in the engine’s instruction book. If that is not handy, open the HS needle 31/2 turns on most sport .40-.61 engines. This should be a very “rich”, lots of fuel but little air, mixture that will allow the engine to start and run without damage. Open the throttle fully, while the airplane is firmly held in position by a helper. Start the engine.

The engine will be running very rich, with raw fuel “spitting” from the muffler end (photo 7). The engine’s exhaust sound is low pitched and unsteady. While still at full throttle, slowly rotate the HS needle clockwise, into the engine. The engine will begin to speed up.

Photo 7

The sound will change to a steady, higher pitch. If the HS needle valve is turned too far clockwise, the mixture becomes too lean, too little fuel and too much air. Remember that the fuel also lubricates the engine. Not enough fuel means engine damage, quickly with no chance to appeal. If the mixture is set too lean, the exhaust note takes on a sharp, angry sound, steady but lower in pitch than the “peak” setting. The engine actually begins to slow down and you may hear a buzzing sound. This is detonation and it is trying to put a hole in your expensive piston.

If you went too far and the engine is now running lean, turn the HS needle counter-clockwise until the engine speeds up and then starts to slow again. This is the proper mixture setting. With muffled engines, getting the mixture correct by sound takes experience and is still difficult. There is a better way.

For about $30, buy a model tachometer (photo 8). It will last you the rest of your modeling career and save you hundreds of dollars in engine replacement and repairs. The “tach” also lets you get the most out of your engine without nagging worries about durability.

Photo 8

Using the tach makes setting mixture controls too easy. Once the engine is started and running at full throttle, rotate the HS needle clockwise and watch the rpm’s increase. At some point, the rpm’s will start to decrease. Turn the HS needle counter-clockwise until the engine is turning at peak rpms again. THEN RICHEN THE MIXTURE UNTIL THE ENGINE IS TURNING 4-500 RPMS LESS.

This is very important. Once in flight, engine rpms increase as the propeller unloads, and a slightly richer mixture is required. Even more important, in vertical climbs, engine fuel draw is reduced and less fuel flows into the engine, leaning the mixture. Never set the high-speed mixture less than 4-500 rpm “off peak” unless your engine is equipped with a fuel pump. Few sport engines are.

Once the HS mixture is set, stop the engine. Reconnect the glow plug driver, start it again and reduce the throttle to a high idle, around 3,000 rpm. Use the transmitter’s idle trim lever, set all the way up to reach this idle rpm. Leave the glow plug driver connected for now. Watch the rpms. If the engine slows down, the idle mixture is too rich. If it speeds up, it is too lean. Adjust the idle mixture control accordingly.

This is tedious because you must stop the engine each time to adjust the idle mixture. Do not try this adjustment with the engine running. The screw slots are small as seen in photo 9. It is *guaranteed* that the screwdriver will slip off the vibrating screw head and into the spinning prop. This will surely ruin the prop, and possibly your whole day, as you may be spending quality time with your local hospital emergency room.

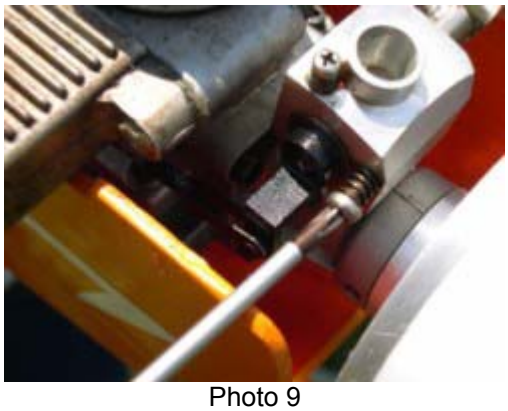

Photo 9

Make small adjustments with the idle mixture control. A little goes a long way here. Use only one-eighth turns at a time. Restart the engine, run it at full speed for a few seconds to clear the lower crankcase of fuel (there is a lot of fuel buildup here as we'll see later on in this article) and then reduce the idle back to3,000 rpm.

Continue making adjustments until the engine rpm remains steady. Then lower the idle speed, again with the trim lever, to 2,600. Repeat the process. Once the engine maintains 2,600 rpm, make the final reduction to 2,300-2,400 rpm. Your trim lever should now be at the halfway point. Readjust the idle until the engine maintains this low rpm. Remember to "clear" the engine at high speed after each adjustment.

Once this is set, remove the glow driver. Make any final adjustments. Your engine should idle at 2,400 rpm for at least 60 seconds with little or no change in rpm. The last step is to check the engine's transition; it's acceleration from idle to full speed. Let the engine idle for 20 seconds, then move the throttle lever to high speed. The engine should accelerate without hesitation. If the engine slows then accelerates, the idle mixture is slightly lean. If the engine stumbles, then accelerates, it is too rich. Make final adjustments with the IDLE MIXTURE CONTROL, not the HS needle.

Mixture controls need to be reset only if fuel, propeller or field elevation changes. Weather variations usually do not require adjustments unless they are extreme. Most model pilots fly at temperatures between 50-90 degrees and humidity levels from 50% to 80%. This range is not extreme enough to require much mixture change. Probably one "click" of the HS needle would help from one of these extremes to the other, but not enough to be really worth the bother for sport flying. So try to leave the mixture settings alone if you can.

GLOW PLUGS

Glow plugs come in two types: with and without idle bars (photo 10). Both plugs work well in muffled engines. Idle bar plugs provide a slightly more consistent idle, especially for engines mounted in the inverted position. However, idle bar equipped glow plugs reduce the engine's top rpm by 2-300 rpm.

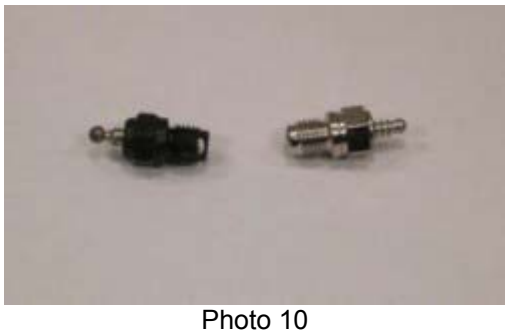

Photo 10

Glow plugs also have something called a “heat range” that measures the temperature of the glow element during operation. Frankly, for sport engines using nitromethane levels of 10-20%, this is probably irrelevant. Since the heat range is not readily available information, it is best to forget it for now and use the type plug recommended by the manufacturer. Once the pilot moves on to racing, competition flying or ducted fans, then is the time to worry about heat ranges.

One very important point to know is that glow plugs can need replacing *even though the engine still runs*! Like all things mechanical, glow plugs wear. The glow element still glows when connected to the glow driver and the engine still runs, but the plug may be worn out. Look closely at photo 11. You can see that the last coil of the element is not lit, a sure sign of a worn plug. The first operational indication of a worn plug occurs during idle. The engine starts smoothly, and idles well. As soon as the glow driver is disconnected, the idle slows by 2-300 rpm. This is the signal to replace the plug.

Photo 11

If not replaced, the next operation to go bad is the engine’s transition. No matter the mixture settings, the engine stumbles during acceleration as if it were too rich. Next, the idle becomes unreliable and the engine sometimes quits at low throttle settings. Once this starts the pilot starts changing the perfectly good mixture settings. Sometimes this is of temporary help, but makes matters worse because now the settings are off and the plug is still bad.

Change the glow plug the first few times a well set idle slows dramatically when the driver is removed. You will save yourself a lot of headaches if you do.

STARTING THE BEAST

If today’s model engines are wonders of technology, why is starting sometimes a problem? Even though it has fuel and a new glow plug, the stupid thing won’t start? Nothing! Not even a “kick” or a pop anywhere. Keep turning it over with an electric starter until the city lights start to dim, but still you get nothing. A Wonder of technology, you say? Hey Editor, come closer and I’ll show you a wonder!

We all feel that way when our engines get stubborn. But even when it is being its most difficult, your engine is telling you, no it’s shouting at you, exactly what its problem is. So, lets take the starting procedure one step at a time and note how your engine identifies every possible problem along the way.

The fuel tank is full. Disconnect the fuel line from the filling tube. Does some fuel run out the airplane’s fuel line when the pressure line, now filled with fuel, is raised vertically? It should. The engine should never have to work hard to pull fuel into the line to the carburetor. If the tank is full and under slight pressure from the filling process, raising the filled pressure line should be enough to cause fuel to escape out the carburetor line. Of course, this is for two-line systems.

If there is a separate fill line, a three-line system, you should see fuel flow to the carburetor during filling. In three-line systems, make sure the throttle barrel is completely closed before filling. If not, enough fuel can flow into the engine during the filling process to flood it. Flooding is bad for easy starting.

Time to start. Connect the glow plug. Many glow starters have a feature that shows if the glow plug is working. Such lights or gauges only show if the glow plug element is intact, not if it is good enough to use (photo 12). One nice thing about the Pro Driver on the left is that the lights indicate whether the engine is flooded or not. Two to four lights mean all is well. Five or more lights indicates that the engine is flooded with raw fuel.

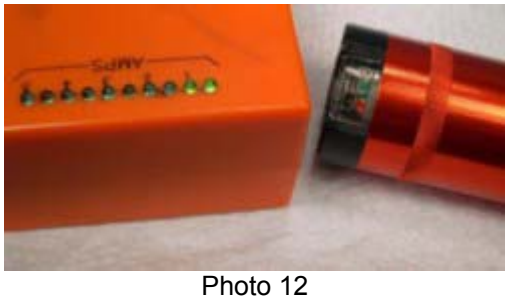

Photo 12

Having a glow driver that gives some indication that the glow plug is at least lighting is better than killing yourself trying to start with a truly dead plug. Check to see if the glow plug passes this test before trying to start the engine. Otherwise, you may flood the engine attempting to start with a completely dead plug.

If this is the first start of the day, your engine may need a little priming. This can be done one of three ways. First, close the throttle, then fill the carburetor's air intake space above the closed throttle barrel with fuel. Open the throttle and let the fuel into the engine. Never add more prime if this doesn't work.

Or you could open the throttle all the way, make sure the glow plug is disconnected, and rotate the propeller while holding your finger over the throttle barrel air intake (photo 13). Be sure your hands are clear of the propeller arc. Remember that the propeller will also bounce backwards after you flip it. Make sure to reduce throttle before starting the engine.

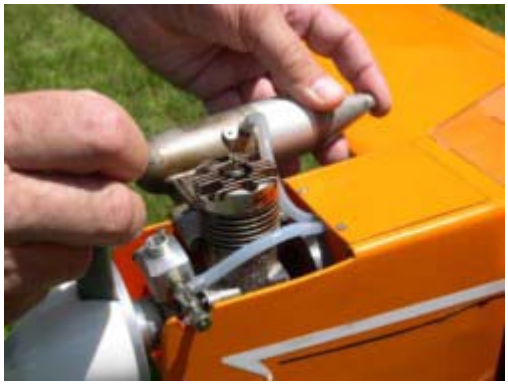

Photo 13 Photo 14

The third way is to hold your finger over the muffler outlet, set the throttle at starting position, and flip the propeller a few times (photo 14). Some pilots use an electric starter to rotate the propeller with this method. This is an excellent way to get some fairly impressive striped scars on the inside of your forearm. Hand rotate the propeller, use a chicken stick, or have another person hold their finger over the muffler outlet from behind while you use the electric starter.

If the engine has already been run, there is almost never a reason to prime it as lots of fuel always remains in the engine's lower end and will power the next start. A good way to tell if the engine has the proper air-fuel mixture in the carburetor is to connect the glow plug. HOLD the propeller ***firmly*** and then slowly rotate it clockwise until you feel a "bump" in the prop. Make sure you are holding the propeller firmly so it doesn't start out of your hand.

If you get the bump, the engine will start. If you have primed the engine or it has been running already that day, and there is no bump, the engine is probably flooded. Another sign of flooding is the propeller's suddenly getting hard to rotate completely. It seems to stick just *before* its usual compression point.

If this happens, do not use an electric starter. The engine may have an hydraulic lock. This means that liquid fuel is in the combustion chamber. Severe engine damage will occur trying to rotate an engine through hydraulic lock. Clear the engine before attempting to start. Remove the glow plug and its copper washer, and then disconnect the fuel inlet line. *Stand out of the way of the glow hole* and hit it with the starter. Ole' Faithful lives again in your model engine! After the fuel fountain subsides, replace the glow washer and plug.

Leave the fuel inlet line disconnected. Connect the glow plug and start the engine. If the glow plug is good, (you did remember to check its glow when you had it out of the engine right?) the engine will start. It will run for a lot longer than you might think; probably about 30-45 seconds or more, just on the fuel still in the lower crankcase. After the engines stops, connect the fuel line, do not prime, and start the engine. There is more than enough fuel still inside to get it running again.

If your engine floods frequently and starting is difficult, then the *power supply* to your glow plug driver is weak. Glow plugs which are not completely dead, but still not good enough to use, will start an engine if their power supply is strong. Remember, weak glow plugs manifest themselves by ruining the idle, not the starting procedure.

We haven't said anything yet about the high-speed (HS) mixture control needle. Yet isn't that what everybody starts to mess with as soon as starting becomes difficult? Yes it is. And no, they shouldn't have been moving it at all. The HS has almost no effect below half-throttle. It is called the "high-speed" mixture control because it only works at *high speed.* Unless it is open 2-3 times more than it should be or nearly completely closed, in which case it floods or starves the engine, moving the HS needle means nothing for starting.

Even the idle mixture control has little effect on starting. As long as the idle mixture is somewhere in the right range, not 200-300% off either way, it will allow the engine to start. It will not allow a good idle, but will permit starting.

So now the engine is running. But it will not transition from low to high speed and will not idle for more than a few seconds, even with the glow plug connected. Well, what do you expect when you go messing with mixture controls while trying to start? Everything is messed up now and the engine will not run long enough to get anything reset as described above.

Don't despair yet. Even this too can be fixed. Just the high-speed mixture needs resetting. First, make sure the engine is not flooded as we already discussed. Clear it if it is. Then reposition the HS needle back to where the manufacturer's instructions first set it when the engine was new. If you do not remember this setting, close the HS needle and then open it 3 ½ turns. Start the engine and follow the setting procedures already described.

ELECTRIC STARTER TIP

Sometimes, the battery used for an electric starter begins to get weak. Or the starter may not have enough power to turn a larger engine. In these cases, the starter rotates the propeller up to the compression point and then everything stops. Now what?

There is a way to get this to work. But first, MAKE SURE THE ENGINE IS NOT FLOODED. Clear it if it is. If you know for sure that the starter is the problem, do the following. First, rotate the propeller by hand clockwise until it stops at the compression point. This provides the starter time to accelerate to full speed before the propeller hits the next compression point. The momentum usually carries the propeller through the compression point and the engine starts.

If this still does not work, try a tip from long-time Pattern competition pilot, Joseph Lachowski. Remove the glow driver, and then rotate the propeller clockwise back to the compression point. Continue slowly rotating the propeller to the middle of the compression point and leave it there. Reconnect the glow driver. Keep your hands clear of the propeller when you do as it may "bump" over when the power is added.

Now use the electric starter. The extra acceleration time while the engine is "coming off" the compression point provides extra momentum and the starter will rotate the propeller through the next compression part of the engine's stroke. If it does not, either your starter battery or the starter itself is too weak to fly that day.

THE DAY'S FLYING MAY BE DONE, BUT YOU AREN'T, YET.

You have had a great flying day. No problems and everything went just as well as you can possibly imagine it could. It's now time to pack up and head home. Get out the Windex® or 409® spray cleaner, clean the gunk off your airplane and put it in the car. Right? You know it's not right or we wouldn't be asking you this question.

Remember how your engine ran without the fuel line connected in some of the above scenarios? That was because fuel remained in the engine's lower areas. A lot of fuel is still there. Our fuel contains alcohol and nitromethane. During storage, the alcohol in the fuel attracts moisture. The nitromethane combines with this moisture to create a mild, but potent nitric acid. This acid and moisture combination can attack the steel parts of your engine, usually the bearings, and cause rust.

To prevent this, start your engine one last time. Leave it at idle with the glow driver connected. Carefully remove the fuel inlet line and let the motor run dry. Once it stops, make a few more starting attempts. It usually takes three starts to remove most of the fuel. Now drain the fuel tank. Leave the fuel inlet line disconnected and also disconnect the muffler pressure line to prevent fumes from reentering the engine during storage. If you wish, you can plug the disconnected fuel lines with 4-40 bolts, but it is not necessary.

Disconnect the glow driver and open the throttle all the way. Using a small bottle like the one in photo 17, add about 5-6 drops of Mobil 1® synthetic oil, or equivalent synthetic motor oil. Rotate the engine by hand a few times to distribute the oil into the bearings. Then close the throttle barrel completely. Now you are ready to clean the airplane and pack it all up until tomorrow. Use this procedure along with proper mixture settings and your engine bearings should last hundreds, maybe thousands, of flights. Photo 18 shows a 19-year old Enya engine still running on its original bearings after more than 1,500 flights on four different aircraft.

Photo 15 Photo 16

The next article in this series will cover fuel selection, tank location and propeller choices. We'll also include radio battery management and range checking.

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