

SECRET "SMOKE SUCCESS" TIPS

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INTRODUCTION

This is a collection of tips, tricks and in fact a complete tutorial introducing you to proven techniques for producing awesome smoke from your R/C airplane. The information in this text was collected from our own research and experience as well as advice from many modelers over the months of developing the SIMPLE SMOKE PUMP. Our special thanks go to Ed Izzo, Dave Patrick of Carl Goldberg Models, Don Aliffi of Gulf Stream, Air Video Inc., and Randy Dewberry of AMP for their contributions.

TME was the first to combine an electronic switch with a heavy duty pump and we have had many years to perfect our system. Before our simple smoke pump was introduced, anyone that wanted smoke had to put together a series of pumps switches, wires or valves and hope they could get it all to work. We are proud to say that All other "Smoke Pumps" came after we showed the way. This book started the ARS "Almost Ready to Smoke" bandwagon.

We recommend that you read through this entire book before you proceed to install your smoke system. We believe all the information to be as accurate as humanly possible. Please use caution when handling, installing and using your smoke system.

We at TME are always looking for new ideas and techniques for improving the quality of smoke. If you have any smoke oil formulas or preheater tips that you would like to share, call or mail in your ideas to TME. We may include them in future printings.

I OVERVIEW

Lets get right down to the basics in smoke production. Model airplane smoke systems create smoke by delivering a blend of oils to the hot exhaust of a model engine within the cavity of its' muffler.

Apart from having a good delivery system that is reliable and simple to maintain, the real secret of thick powerful smoke is simply getting the oil very hot! Even gasoline engines, which by far put out the most dense clouds of smoke, produce thicker and denser smoke by using special smoke mufflers. Smoke mufflers usually have built in pre-heaters. Later we will present some ways for you to save some money by showing you how to make your own smoke oil preheater.

DELIVERY SYSTEMS

There are several types of delivery systems that are available to the modeler. All types can be made to work very well, however, there are trade-offs in terms of size, weight, and complexity between systems.

Lets break down the systems into two basic types; pressurized and non-pressurized systems.

PRESSURIZED DELIVERY SYSTEMS

Pressurized systems rely on either crankcase pressure or storing muffler pressure to provide the energy to move the smoke oil to the muffler. While most installations work very well and can be very light in weight, they are the most complex to install. Pressurized smoke

systems require engine or muffler tapping, lots of plumbing, 4 way valves, a check valve, a servo and pushrod to operate. Special care should be taken with pressurized systems. Should too much unregulated pressure build up it may result in smoke oil tank or tubing failure possibly creating an awful mess. Sometimes certain combinations of engine, muffler and placement will not provide enough pressure. The result in this cases is inadequate smoke.

NON-PRESSURIZED DELIVERY SYSTEMS

Non-pressurized systems use active pumps to move the fluid out of the tank and into the muffler. Some systems use crankcase pressure only to provide energy to the pump. These systems work very well but may not work in combination with fuel pumps using the same crankcase pressure. These systems are about as complex as the pressurized systems requiring a valve, servo and pushrod as well as good amount of plumbing. However some users have reported insufficient volume at high throttle for large gas engines with these pumps.

Another way of making a non-pressurized system is to use an electric pump. Electric pumps have been used to provide the very high volume of smoke fluid consumed by gasoline engines. These engines can produce very thick dense smoke. Typically while electric pump systems greatly simplify the plumbing, they are usually more complex to wire. Also, since the pump draws quite a bit of power, it is normal to use a separate battery pack to provide power to the motor. This pack is usually wired to a switch that is then turned on and off by a servo. A wheel collar around the tubing or a remote flow valve is usually used to adjust for proper flow. All these elements can add weight and complexity.

Another consideration when putting together an electric system is the electrical noise generated by the motor brushes. Soldering filter capacitors to the motor case and across the motor terminals usually reduces the R/F interference to an acceptable limit. This technique is common and mandatory in electric powered R/C cars and planes to maintain maximum range.

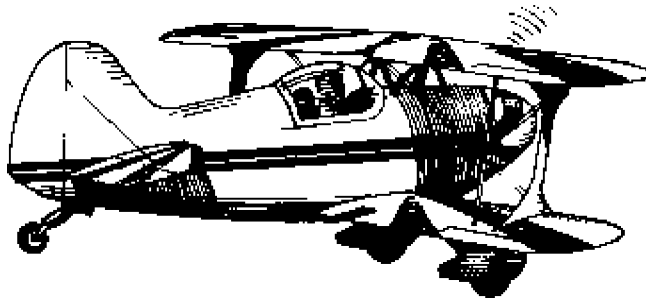
An exception to the normal electric pump setup is TME's "Simple Smoke Pump". (You new this was coming, didn't you?) TME has developed a lightweight electric smoke pump that plugs into your receiver just like a servo! This greatly simplifies the mounting and plumbing of your system. It eliminates all wiring, has a built in RF filter, and provides the safety of a non-pressurized system in a very compact lightweight package.

If you don't already own one and would like more information on the Simple Smoke Pump contact TME at 813-968-9510.

In conclusion, all delivery systems when tuned for optimum flow produce great smoke. But then again, the real secret to impressive smoke is simply lots of heat. We cannot over emphasize this. The best delivery system will not produce any more smoke than your muffler can smolder with heat.

SELECTING THE IDEAL AIRPLANE AND COVERING FOR SMOKE

If you haven't selected an airplane yet, here is what to look for to improve your chances of installing a successful smoke system. Look for airplanes with a large wing area and spacious fuselage. With smaller .40 size airplanes you may be limited to large boxy trainers or you will have to mount the pump and/or tank externally.



Of course a scale aerobatic airplane just begs to have a smoke system installed. I'm sure you already have one in mind, just make sure that it will handle the extra weight of the smoke system. Remember, that a fully fueled model could weigh up to a pound more than its dry

weight. Add it all up and see if it makes sense. You may, if necessary, simply decide to limit your smoke tank size.

We have noticed in our testing that a slow flying model at high throttle gives the appearance of thicker and more pronounced smoke. This is in direct contrast to a model that zooms about the sky like a rocket at only mid throttle. The faster the model flies, the longer the smoke trail appears and logically the thinner the smoke is perceived. Therefore you can understand that selecting the right propeller also can improve the quality of a smoke system.

When experimenting with propellers remember not to change the load to the engine. That is, if you go up in pitch, go down in diameter. A good rule of thumb is to use the following formula. $Load = 2 \text{ times } PITCH \text{ plus } DIAMETER$. Whenever you make changes make sure that the load number stays the same. Be careful not to slow down your top speed too much, if your flying a mere 5 m.p.h. faster than the stall speed you won't have much room for wind gusts or banked turns. The name of the game is to experiment until a suitable compromise has been reached.

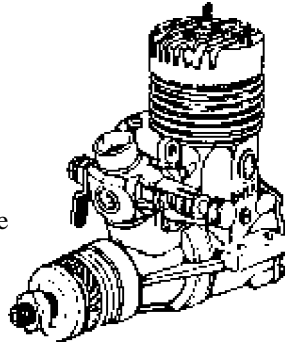
Also be cautious when selecting your film coverings and paints, especially the low temperature films. **Some materials are not compatible with the smoke fluids you will use.** Run your own compatibility test and divert heat and oil away from your plane as much as possible. In extreme cases you may want to make a deflection shield out of lightweight aluminum or tin to protect the model from direct hot spray.

In general, polyester films such as Monokote, Ultracote and 21st Century should work fine. Stay away from polypropylene film coverings and the low temperature films. Read the film manufacturers' instructions or call them if in doubt.

Clean your model often when using your smoke system. Inspect for seepage near control surface hinges frequently. Smoke oils may eventually loosen the hinges causing you to lose control of the model.

SELECTING AN ENGINE

2 Cycle Engine



Gas engines will provide the most awesome smoke, 4 cycle engines are second best while 2 cycle non ringed engines are the next best choice. The important variable here is heat. More heat equals more smoke. Generally the larger the engine displacement, the more heat energy is created.

Therefore for small 2 and 4 cycle engines, some form of preheating the smoke oil is mandatory to improve the visibility and the persistence of the smoke. We'll get into pre-heaters later.

THE SMOKING MUFFLER.

If you are not purchasing a commercial smoke muffler for your engine then you may want to drill and tap your existing muffler. In this case you will need to purchase a pressure fitting at your local hobby shop. Make sure you tap the muffler at a point closest to the exhaust from the engine.

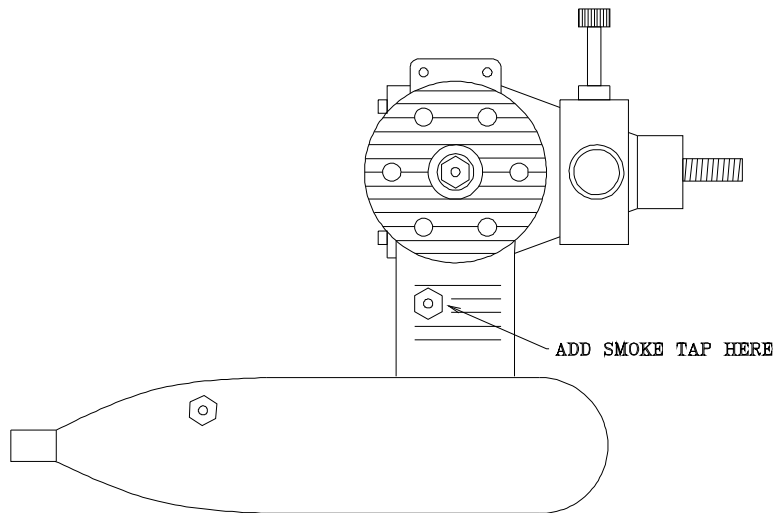


FIGURE 1. -2 CYCLE MUFFLER TAPPING

The idea is to inject the hot oil at the hottest possible place. Heat is not the only reason to tap at the neck of the muffler. **When you tap at the narrow part of a muffler you are tapping at the point of highest velocity and therefore the lowest pressure.** This is very desirable for a smoke system. Tapping at the large part of the muffler provides the highest pressure. This is where pressurized *fuel tanks* are usually hooked up. Too high a back pressure can cause smoke systems to act erratic or not work well at all. We will present some more ideas later.

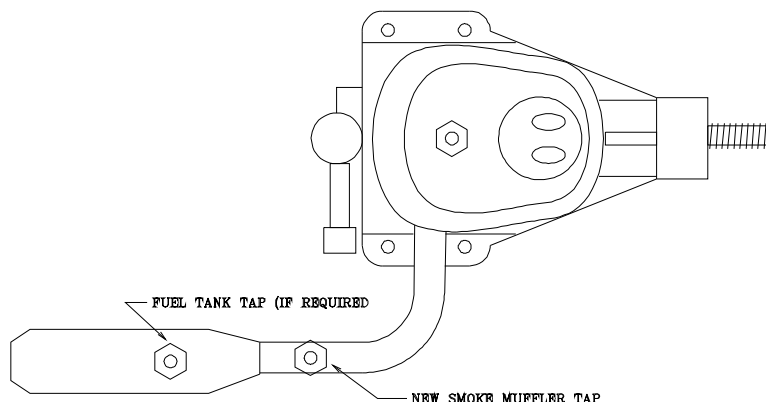


FIGURE 2. - 4 CYCLE MUFFLER TAPPING

SELECTING THE RIGHT SIZE TANK

Small 2 and 4 cycle engines will consume smoke fluid at a rate of about 1.5 to 2 oz. per minute. The larger gas engines can consume smoke fluid at a rate of 3 to 6 oz. per minute.

Remember that smoke production is best when used for effect and will typically be on for less than half of your flight. Therefore a 4 oz. tank can yield 2 or 3 minutes of smoke for a .40 sized airplane while imposing a minimum weight burden. A 6 to 8 oz. tank will be optimum for .60 to .90 2 cycle engines. Of course, bigger, is better, but remember that you will be adding weight and filling up space in your model airplane.

You will need to replace the tubing in the tank with neoprene or special gas tubing for maximum life. Add wire ties around the tubing to insure it will not slip off. Don't forget that a leak in your model can make a horrible mess, so please don't take any shortcuts here that you may later regret.

		BURN RATE		
		2oz./min	4oz./min	6oz./min
SMOKE TANK SIZE	2oz.	1 min	0.5 min	20 sec
	4oz.	2 min	1 min	40 sec
	6oz.	3 min	1.5 min	1 min
	8oz.	4 min	2 min	1.33 min
	10oz.	5 min	2.5 min	1.66 min
	12oz.	6 min	3.0 min	2 min
	14oz.	7 min	3.5 min	2.33 min
	16oz.	8 min	4.0 min	2.66 min
	18oz.	9 min	4.5 min	3 min
	20oz.	10 min	5.0 min	3.33 min
	22oz.	11 min	5.5 min	3.66 min
	24oz.	12 min	6.0 min	4 min.

FIGURE 3. TANK SIZE VS. TIME CHART

SELECTING A LOCATION

It is best to try installing the system near the CG so that you don't have to add weight to re-balance the airplane. The smoke fuel tank may be installed in the canopy to conserve space in smaller .40 and .60 size airplanes.

II. SMOKE OILS

MAKING YOUR OWN BREW

There are several formulas that have been used successfully and will be presented here. TME is constantly updating their web site with the latest formulas suggested by other modelers. For an up to date list check out the web site at www.TMEnet.com



WARNING

Please handle all these materials with extreme caution and observe the respective manufacturers warnings.

Diesel oil No. 2

Kerosene

Diesel & kerosene 50:50

Diesel and Automatic transmission Fluid 50:50

Diesel and small amount of butyl carbitol (used by clothes cleaners)
no more than 30% butyl carbitol

Diesel & Concrete Form Release Oil 50:50 (obtained from construction industry goes under the name of Corvus Oil, EXXON Unuius-15, SONOCO 222, Corbisol.)

Lamp oil

COMMERCIALY AVAILABLE SMOKE FLUID

The best commercial smoke fluid we have tested is the Super Dri formula by MDW. This fluid is clear and produces dense, lingering smoke, even with preheated .40 size engines. It is convenient and very economical. Check your favorite hobby store or mail order supplier for availability.

III. GETTING ENOUGH TEMPERATURE

Ask anyone that produces thick dense smoke from their model airplanes what the key to their system is. What you'll hear is that a good delivery system combined with lots of heat is the key. If you've purchased the SIMPLE SMOKE PUMP you now own a smoke pump that is capable of delivering smoke fluid at a very high rate. So lets concentrate on getting the oil hot.

With gasoline or large 4 cycle engines you will get the most heat. Pre-heaters and/or smoke mufflers will offer a significant improvement. But with smaller 2 cycle engines you will have to preheat the oil to get acceptable smoke. We will discuss three different ways of doing this; they are; head coils, smoke mufflers with internal coils, and external heaters attached to the existing muffler.

HEAD COILS.

You can make a simple head coil by purchasing some soft 1/8" copper tubing and wrapping it around the non finned portion of your engine head. The smoke oil source will go to one side of the coil. The opposite side of the coil gets a length of tubing that in turn goes to the tap on your muffler. Make sure that the copper tubing is tightly coiled around the engine head. You can use some steel wire or automotive hose clamps to hold the tubing firmly against the head.

CAUTION: Do not cover the air cooling fins on the engine. Even though the smoke fluid will cool the engine while it flows through the tubing, it will not cool your engine at all when the flow stops.

When testing the effectiveness of this system you may notice that the smoke is very dense when initially turned on but thins out after a few seconds. This means that you either don't have enough mass (in the form of coil length) or that the thermal coupling to the engine is poor.

If necessary, remember that you can combine these techniques to increase the heat of the smoke oil.

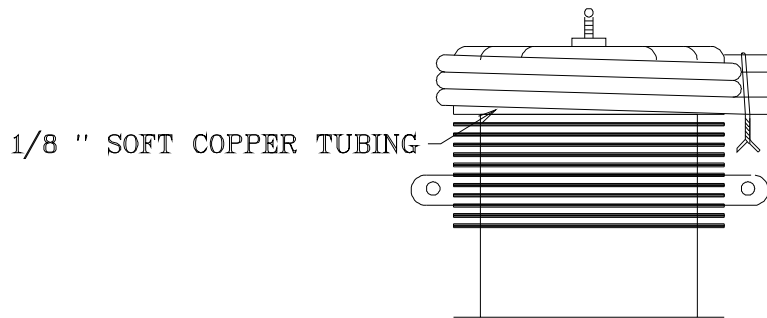


FIGURE 4. - MAKING YOUR OWN HEAD COIL

SMOKE MUFFLERS

There are some very good commercial smoke mufflers available for your engine. Slimline, for example, makes a range of smoke mufflers for a variety of engines. These commercial mufflers provide a coiled tube on the inside of the muffler to force the fluid to stay in the hot exhaust longer. This is really just another form of preheating.

If your muffler has enough room and you want to make your own, you can experiment by taking 1/8 inch soft copper and forming it around a wooden dowel. Just make sure that the dowel diameter is less than 1/4" of the available inside dimension of your muffler. Drill a hole in the back half of the muffler for one end of the coil. The other end should be as close as possible to the engine head. The "Red Hi-temp" silicone should be used to steady the coil in the muffler.

Just make sure that the exit point of the smoke fluid is either pointing in the same direction as the exhaust gas flow or is less than 90 degrees to the exhaust flow. Otherwise the blast from the exhaust may work against the flow. Another way is to have the tubing come back out of the muffler. A small piece of neoprene tubing can be used to connect from this point to the muffler tap at the neck of the muffler.

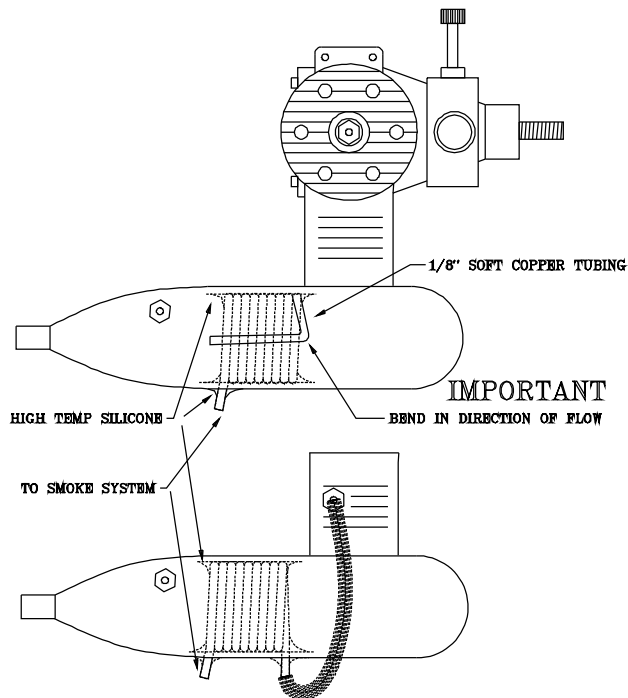


FIGURE 5. - MAKING YOUR OWN SMOKE MUFFLER

3. EXTERNAL PREHEATERS

Another good way to preheat the oil is to pass it through a pre-heater that is attached to the exhaust of your existing muffler. A silicon or neoprene tube and plastic ties or automotive hose clamps can be used to secure it to your muffler.

You can easily construct one by obtaining a piece of brass tubing about 1/2" in diameter and cutting it to about 3" to 4" length. You will then want to wrap soft 1/8" copper tubing around the larger tubing to make a coil. Either braze the tubing together or use an automotive hose clamp to insure good contact and maximum thermal transfer. Now, using short lengths of silicone or neoprene tubing, connect the

large brass tube to the exhaust hole of your muffler. This will resemble what you would do to attach a tuned pipe to a header. Run the tubing from your smoke system through the preheater coil. The smoke oil should now be hot enough to run directly to your muffler tap.

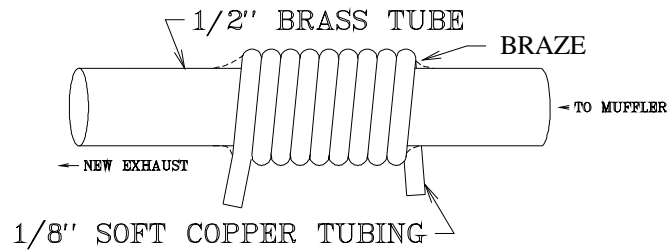


FIGURE 6. - MAKING YOUR OWN HEAD COIL

If you don't want to go through the hassle of building your own external preheater you may want to purchase one from American Model Products. They will sell you their preheater from their smoke system separately. It attaches in much the same fashion as the one we described above.

IV. WHEN TO TURN ON AND WHEN NOT TO

Only two things can occur to the smoke oil that we are sending to your muffler. It will either smolder and vaporize into smoke, or it will just get hot and pass through your muffler. We have stressed that you must preheat in order to fully convert the smoke oil to smoke. However, when we throttle back we also reduce the heat and the exhaust velocity in the muffler. This in turn causes much of the smoke oil to pass through as a liquid.

If we continue to send smoke oil to our muffler at low throttle, it can no longer fully vaporize. Unvaporized smoke oil will collect in the muffler and possibly be drawn into the engine. This will either just cause your engine to cough a little bit or it can stop your engine. Just as important, the collected smoke oil may become a fire hazard.

The desired visual impression also suffers below about 3/4 throttle. So therefore we want to remember to shut off the smoke system whenever we throttle back. If you want to make sure it's off at low throttle and you have a computer radio, then you can program the radio to do this automatically.

PROGRAMMABLE RADIO MIXING TIPS

A programmable radio can help you by not allowing your smoke system to dump smoke oil into your muffler at low throttle. The goal is to provide mixing such that no smoke oil flows at low throttle regardless of the smoke switch position.

First, the assumption here is that you have a smoke system that comes on precisely at a certain threshold. This usually pertains to electric smoke pumps activated by some sort of switch. Smoke valves driven by servos may have some in between states whereby a small amount of smoke oil is going through the system. Therefore with those systems you are encouraged to experiment with mixing but be sure that you have reached the goal before flying.

Since all programmable radios are different we will only generalize

the procedure for all radios. We also will give an example in programming the popular Futaba 7UAF series.

What you want to do is mix the output of the throttle stick to the "smoke" switch. Adjust the mix direction so as to push the "smoke" switch to the off position as your throttle gets lower.

The smoke switch will be disabled unless the throttle is above a certain point. By leaving the TX's smoke switch ON all the time, you will in turn experience an automatic smoke turn on when approaching full throttle. This way you can merely nudge the throttle to full whenever you want smoke and back off to turn the smoke off. Your hands will never have to fumble to turn on the switch again.

Either way the choice is yours. Both methods are available to you at the same time! All you have to do is use the little mixing trick we have described above.

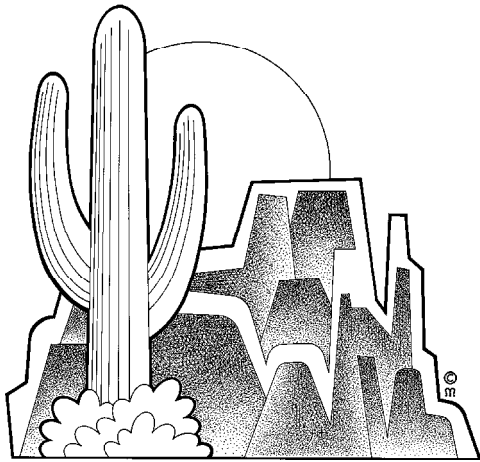
7UAF PROGRAMMING

Lets assume you are enabling the smoke with channel #5 not reversed. You would then perform the following steps. (Note: Substitute your channel # if you are not using channel 5 in the example below)

1. GO to PMX1 or PMX2 menu.
2. Set channel 3 to MAS and 5 to SLV
3. Enable mixing (MOVE cursor off INH and turn P.MIX switch ON)
4. Move throttle stick full up and set to +50%.
5. Move throttle stick full down and set to +100%.
- 6 Turn the smoke switch (channel 5 GEAR) to on.
7. Go to the ATV menu. While moving the throttle stick up and down, adjust ATV % (percent) for channel # 5 until the pump turns off at the desired throttle setting.

V. THE SKY AND YOUR SMOKE

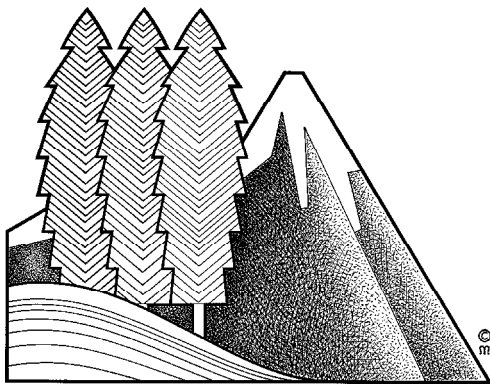
Now that you've come this far, and you're smoking up a storm, you show off your airplane to all of your friends and they're not that impressed. What's wrong? Well the final factor influencing the appearance of your smoke, is the background that you're displaying your smoke against.



The best smoke display occurs against either a crisp and clear blue sky or a dark thunderstorm cloud. White colored smoke will show up well in both types of skies, however, flying during a pending thunderstorm is not advisable



Alternately if you live in a hilly or mountainous regions, flying low against dark hilly trees or mountains also will provide an awesome display. Keep in mind that you still need to have good visibility so that your background looks dark and not hazy.



A dull, hazy, gray or cloudy sky provides the least contrast to your smoke and therefore produces the least impressive display.

VI. 10 Steps to Safe Smoke.



Please read carefully.

1. DO NOT USE ELECTRIC PUMPS TO PUMP GASOLINE. UNDER NO CIRCUMSTANCES SHOULD YOU OPERATE AN ELECTRIC PUMP IN THE PRESENCE OF GASOLINE VAPORS. THE MOTOR BRUSHES MAY CAUSE GASOLINE VAPORS TO IGNITE. PLEASE BE SAFE, IT'S JUST A HOBBY, ENJOY IT SAFELY!

2. Flammable liquids and battery shorts

This danger is present with or without a smoke system. Please look out for frayed battery, pump, or servo wires. Always inspect everything closely after a crash, no matter how minor the external damage is.

3. Range test your radio system with any electric pump before flying your model. Any electric motor placed near the receiver can reduce the available range no matter how well it's filtered.

4. Make sure your system is off when inspecting or installing the tubing, otherwise it may splash liquid into your eyes or model. Secure all tubing with plastic ties or wire.

5. Wait until the system is cool before refilling with smoke fluid.

6. Do not ground test except for very short intervals. Otherwise Smoke fuel may accumulate and catch fire.

7. Make sure your smoke system is off while starting or whenever your engine is running at idle. Smoke fluid that accumulates in the muffler may catch fire.

8. Angle your muffler exhaust downward and away from the airplane so that no excess smoke fluid can accumulate in the muffler.

9. Although not necessarily a safety consideration. Be cautioned that some film coverings and paints, especially the low temperature films, are not compatible with the smoke fluids commonly used. Run your own compatibility test and divert heat and oil away from your plane as much as possible. Read the film manufacturers' instructions or call them if in doubt.

10. Clean your model frequently when using your smoke system. Inspect for seepage near control surface hinges frequently. Smoke oils may eventually loosen the hinges causing you to lose control of the model.

BE SAFE & ENJOY...

VII. CONCLUSION

We at TME hope that we've cleared up much of the mystery concerning smoke production in model airplanes. We hope you have been inspired with some ideas and that you feel you can take on the challenge to experiment a little. Most of these smoke tips can be tested individually or in combinations. You may want to go for the simple ones first and then move up or combine ideas to see if you get better results. At any rate you are armed with knowledge that gives you an edge on creating some awesome smoke.

Again we want to thank the many modelers that either helped out directly and/or indirectly in preparing this manual. Good luck and "keep 'em smoking"...

Look for these other great products from **TME**

SmartSmoker

Simple Smoke Pump

An incredibly easy to install electronic smoke system that can actually exceed the demands of the largest smoke guzzling gas engines. It plugs directly into a spare channel in your receiver requiring no servos, pushrods or wiring. SmartSmoker version allows you to set the smoke oil from the TX and has a unique "Smart Prime™" circuit.

Includes check valve and clear smoke oil tubing, neoprene and a T valve for twins. Equipped with universal connectors that support Futaba, JR or the new Airtronics and compatible connectors. (SSP-SSD)

Auto-Trickle Adapter

Keeps ALL your NiCd batteries ALWAYS ready to go using your very own chargers! One adapter can convert up to 30 of your chargers into fully timed automatic trickle chargers at the push of a button. Plugs into the AC wall outlet thus requiring no soldering or connectors. Thousands in use, truly our biggest hit! Model (ATA-CX3)

Chargeminder Adapter

Like the Auto-Trickle Adapter above, the Chargeminder keeps ALL your NiCd batteries ALWAYS ready to go using your very own chargers! The great thing about the Chargeminder is that it supports all types of chargers from 3 hour to 16 hour charge rates. Its built in microprocessor circuit keeps track of the amount of time and goes to the trickle rate automatically. Model (CMD-2000)

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