

Smokeprimer

A Guide to successful
Smoke Generation
in model aeroplanes

© Copyright 1994

**MZ-Modellbau
Kalbacher Hauptstrasse 57
60437 Frankfurt
www.mz-modellbau.de**

All rights reserved.

No copying or reprinting is allowed without the written authorisation of
MZ-Modellbau

11th edition 2005

Introduction	4
Smoke Systems and Model Aeroplanes	5
Different Smoke Systems	6
Choosing the right Model	8
Choosing the right Motor	10
Non Return Valve	10
Exhaust System	11
The right Tank	13
Electric Power Supply	15
Permanent Installation	16
Mobile Installation	17
Enough Heat ?	18
Tubing	22
Smoke Fluids	23
The right Moment	24
Range Testing	25
How much Fluid ?	26
Intelligent Smoke Control	27
Let's start Smoking	28
Airshow with Smoke	29
Problems and Solutions	30
Ten safety Rules	31
Technical Data	33

Introduction

This is a summary of tips and tricks as well as an introduction into all possibilities of generating smoke in model aeroplanes.

The primer is also an instruction for our

“Super Smoke Pumpe VI” the latest product of 16 years of continuous smoke-system development.

It was based on the booklet “smoke success” from Albert Tejera, written in conjunction with many model pilots which did participate in developing the “Super Smoke Pumpe VI”.

Special thanks to Ed Gizzo, Dave Patrick from Carl Goldberg Models, Don Aliffi from Gulf Stream Air Video Inc. and Egon Becker from Airmix Video.

Also thanks to Charles Kuitenbrower from Somoso Products, who assisted in translating this booklet, and to all the airshow pilots who have tested and presented our “Super Smoke Pumpe” successfully over the years.

We, from MZ-Modellbau are constantly looking for new ideas and tips to improve our products. Therefore we are interested in any of your experiences and ideas. We will add all new tips in the next issue of the Smoke Primer.

Axel Maurer

Smoke systems and model aeroplanes

Basically there are two different ways of smoke generation in model aeroplanes.

1. Pyrotechnic

Especially for sailplanes and small motorplanes you may use pyrotechnical means. MZ-Modellbau carries a variety of coloured smoke generators to be ignited either manually or electrically. Self-manufacturing of such articles is very dangerous and prohibited. It may only be done by authorised personnel.

2. Smoke Fluid

A special fluid is sprayed into the hot exhaust of the model motor. There it vaporises and creates dense, white smoke.

In all cases you need a reliable system to pump the right amount of smoke fluid into the exhaust.

The secret of dense smoke is to heat up the smoke oil as much as possible.

Gas engines of 30cc and up produce enough heat to operate without any extra preheating.

Smaller engines and especially glow-fuel engines need to have some pre-heating of the smoke fluid.

Later we will show you, how to build those pre-heaters yourself.

Different smoke systems

There are various ways to feed the smoke fluid into the exhaust system.

All systems might work perfect, even when there are major differences in the way how they work.

Pressure systems

Those systems use either the pressure from the crankcase or from the muffler to feed the smoke fluid into the exhaust.

They are very light weight, but are mostly difficult to install.

Many mechanically servo-operated valves and tubes are necessary. It is very difficult to adjust the flow rate, and the systems are often leaking, causing major damage to the inside of the model.

When using gas engines you cannot use the crankcase pressure, because it might interfere with the carburetor pump system.

Never use an external pressure tank. This is dangerous, because any leakage will make your fuselage to be filled up with smoke fluid, damage the model and will cause a high fire risk, even on the ground.

Unpressurized systems

Unpressurized systems use an active pump to feed the smoke fluid into the exhaust.

Some Systems use oscillating pumps, either driven by vibration of the motor or by the varying crankcase pressure.

These systems sometimes do interfere with the carburetor pump of the gas engine. Again the installation is complicated like the pressure systems. Major tubing and installation as well as mechanically servo-operated valves are necessary.

Another disadvantage is the limited flowrate, that restrict those systems to smaller aeroplanes. In bigger planes it is only suitable for very light smoke at full throttle.

Another method is the use of an electric pump. Due to its high flowrate it provides especially big planes with enough fluid for dense white smoke.

Therefore you need only very little tubing and installation is straight forward.

Our “**Super Smoke Pumpe VI**” is a complete system with a durable electric pump, a specially developed electronic flow control on-off switch. All in one case.

With minimum installation time you will have maximum reliability. All in all with a weight of only 125 g.

The electronic flow control switch works with every AM, FM or PCM radio.

Its unique intelligence and special internal program guarantees instant dense smoke when switched on.

Choosing the right Model

If you are looking for the perfect model for your smoke system, you need to think about this:

Choose a model with a voluminous fuselage. There you have space enough to install the smoke system including the fluid tank. In small planes you might have to install the smoke tank outside. Ideal are giant aerobatic planes.

Especially those for 3D-Flight. But slow flying Old-Timers also perform well with the smoke system.

If the model is very heavy itself, you should think about a smaller smoke fluid tank, not to get too much takeoff weight.

The airspeed has the greatest influence on the amount of the visible smoke. Absolutely perfect are models with very low speed with high engine power. They leave lots of smoke at short distance – that's what spectators want to see.

The best smoke system has no effect when the model is very fast at low power. So it will leave only a thin smoke-trace.

The faster you fly, the less smoke you will see.

The choice of the propeller is critical.

Use a great diameter and a low pitch. Then you will have low speed and most power. So you can fly aerobatics slow and powerful.

Use this formula for selecting your propeller:

Power = 2 x pitch + diameter

(example: use 24 x 10 instead of 20 x 12)

As long as you leave the power constant, you can use different props to find out the right combination of propeller, motor and model.

Some covering materials may not be resistant against your smoke fluid.

Remember, that the smoke fluid is not burned off in your exhaust, but only vaporised. So the fluid might hit parts of your model. Our experience tells us, that 2-component car paint is absolutely resistant as well as good quality iron-on foil. If in doubt, ask the manufacturer or make some tests before use. Sometimes a longer exhaust tube helps spraying the fluid away from the model.

Clean your model after every flight and inspect the model before every flight.

Your smoke fluid may attack the glue you use for your hinges.

Choosing the right motor

The most important point in choosing the motor is the exhaust gas temperature. Basically gas engines do have the highest exhaust gas temperature. Four-stroke engines perform also very well. Last are the famous glow engines. There you need smoke fluid pre-heating.

As a general rule, the bigger the motor, the more smoke you get. Engines of 45 cc and up produce as much smoke as you know from full size planes.

In large motors with more than one cylinder, you may use only one exhaust for smoke production. If you like, you can use a V-connector to inject smoke fluid in several exhaust mufflers. Small 2-stroke and 4-stroke motors need a pre-heating system to ensure enough smoke generation, and to enlarge the duration time of the smoke. You will be introduced to several systems within this brochure.

Non Return Valve

Normally you do not need any checkvalve when using the “**Super Smoke Pumpe VI**”. Only in very unlikely cases the use of a non return valve between pump and exhaust muffler might be necessary to prevent exhaust gas pressure to enter backwards via the tubing into the pump and smoke fluid tank.

When using a V-connector for two mufflers, there might be the necessity of two non return valves, each right in front of each muffler.

Exhaust Systems

Large Mufflers are ideal for the smoke system. Here the heat stays long enough to vaporise the smoke fluid and to produce dense smoke.

Injection should take place into the main chamber. If the muffler has more chambers use the 2nd. For injection you need not use a special nozzle. The exhaust gas has enough power to vaporise the smoke fluid.

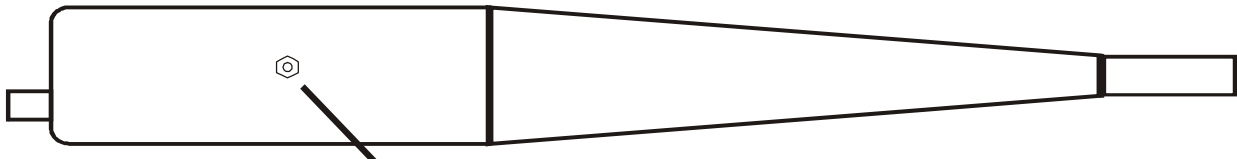
Tuned pipes outside the model are not ideal, because the gas is cooled from the outside within the pipe. If you use tuned pipes, you need to install them inside the fuselage or in a special tunnel.

Never use Tuned pipes made of fibreglass.

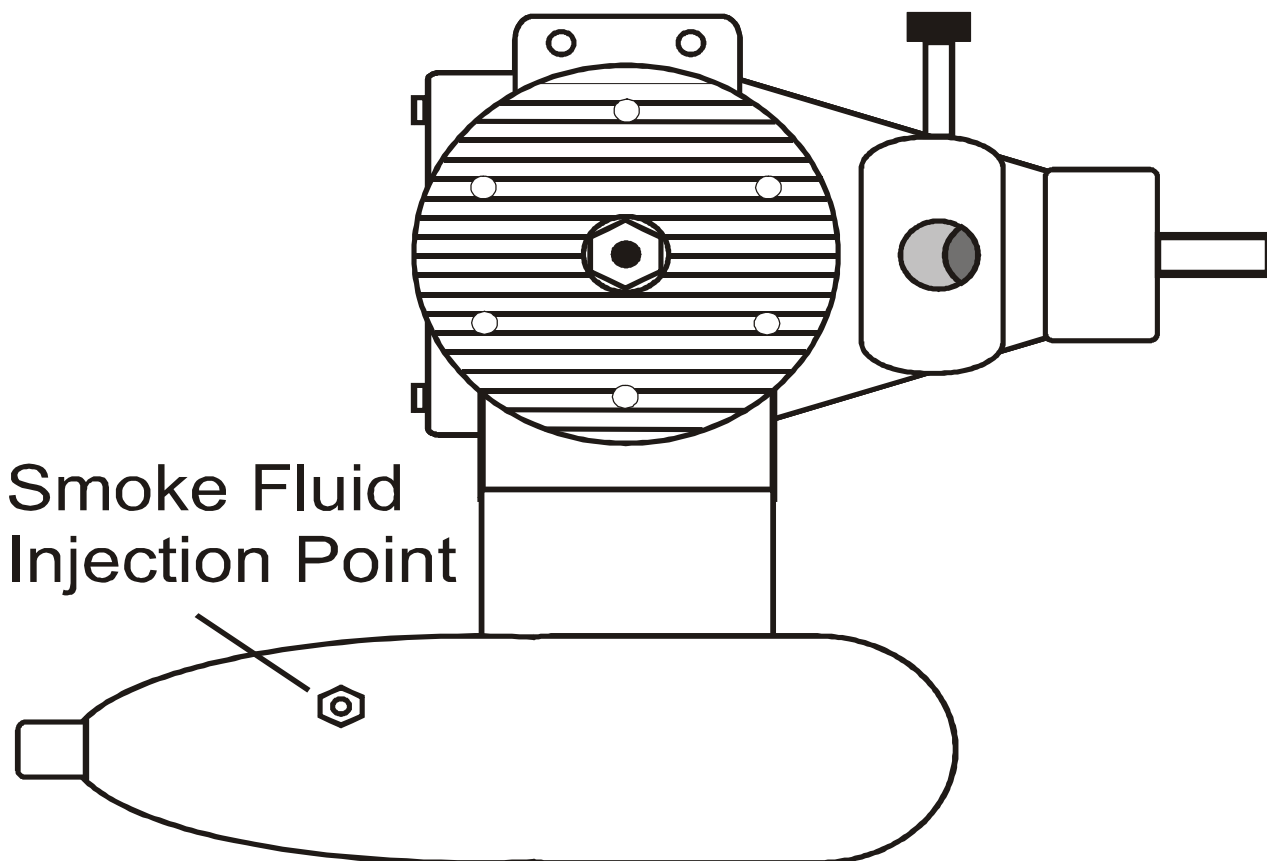
The ideal point of injecting the smoke fluid is at the rear of the tuned pipe, into the first muffler chamber.

Never inject straight into the header.

There might be a slight powerloss when switching on the smoke system at high rpm. This is not harmful, as long as you ensure, that the smoke system is switched off under half throttle. Else there might be the possibility of aspiration of smoke fluid from the exhaust side into the motor at idle. This could lead to an engine failure during flight.



Smoke Fluid Injection at Tuned Pipes



Smoke Fluid Injection Point

Glow engine with muffler

The right tank

The right size of the smoke fluid tank depends on the size of your motor and the expected smoke duration.

Small motors use 50 to 70 cc per minute, big gas engines use up to 300 cc per minute.

Please remember that smoke is a special effect that is used in certain phases of the flight only.

In no case it should be switched on for long phases or for the whole flight. This is boring for the audience.

Plan the tank volume to suite for 2 – 4 minute smoke effect.

So a 15cc motor needs a 150cc tank, for 30 cc motors you should use a 200 to 300 cc tank. Motors with 60cc to 150 cc need a tank volume between 500cc and 750 cc.

Remember the bigger the tank, the more weight you have to carry.

How much smoke time do I have?

Motor	15- 30 cc	ab 60 cc	Turbines
flow	100 ml/min	250 ml/min	> 600 ml/min
100 ml	1 min	-	
150 ml	1,5 min	-	
200 ml	2 min	-	
300 ml	2,5 min	1,2 min	
500 ml	5 min	2 min	
750 ml	-	3 min	1 min
1000 ml	-	4 min	1,5 min

Almost all available tanks without rubber seal may be used as a smoke fluid tank.

Tin or Aluminium tanks are the best, when you do not want to smell anything of the smoke fluid when stored. Some plastic tanks might leave some bad smell through the wall.

All tubing must be manufactured from gasoline resistant material.

Silicone tubing must not be used.

Best is the special tubing from MZ-Modellbau

Order No: MZ-110601.

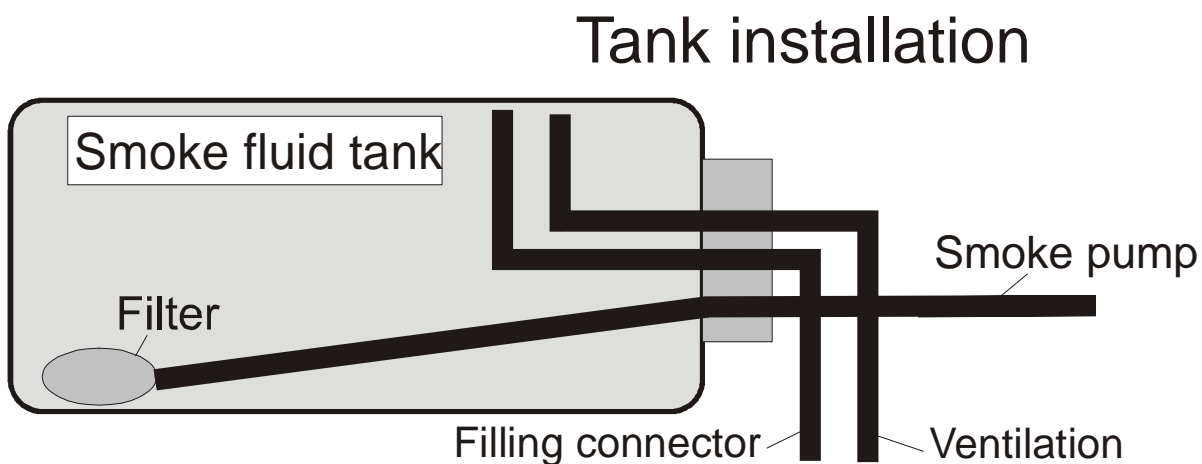
All connections must be secured with metal clamps to avoid sliding off.

The smoke fluid tank should have the following connections:

- filling connector
- ventilation connector
- smoke pump connector

Because the tank will not be pressurised, you must not close the filling and ventilation connector airtight.

To prevent the system from leaking during transport, you should think about closing the fill and ventilation connectors for transport.



Electrical Power Supply

With the “**Super Smoke Pumpe VI**” you can choose either to use a separate 4-cell battery or the receiver battery for the operation.

For normal use a battery with 400 mAh will last for about 30 minutes safe pump operation. Charging of this extra battery may be done with a separate V-cable. For this kind of operation the switch at the pump must be in mode “extra battery”.

A lot of giant scale planes use two receiver batteries with an electronic separation device. Here you can safely operate the “**Super Smoke Pumpe VI**” out of one receiver battery. So you do not need any extra battery. Just slide the switch at the pump into “receiver battery” position.

The disadvantage of this method is, that possible electronic interference may reduce the range of your transmitter, and the receiver battery will be run down faster.

The internal electronic switch of the “**Super Smoke Pumpe VI**” cuts all the power from the pump automatically.

In addition to that feature you may switch the pump completely off. This is very helpful, when you want to test your radio and servos in the model, and want to prevent the smoke system from unwanted operation.

Permanent Installation

The smoke fluid **tank** should be installed near the centre of gravity, so as not to influence the flight performance of your model.

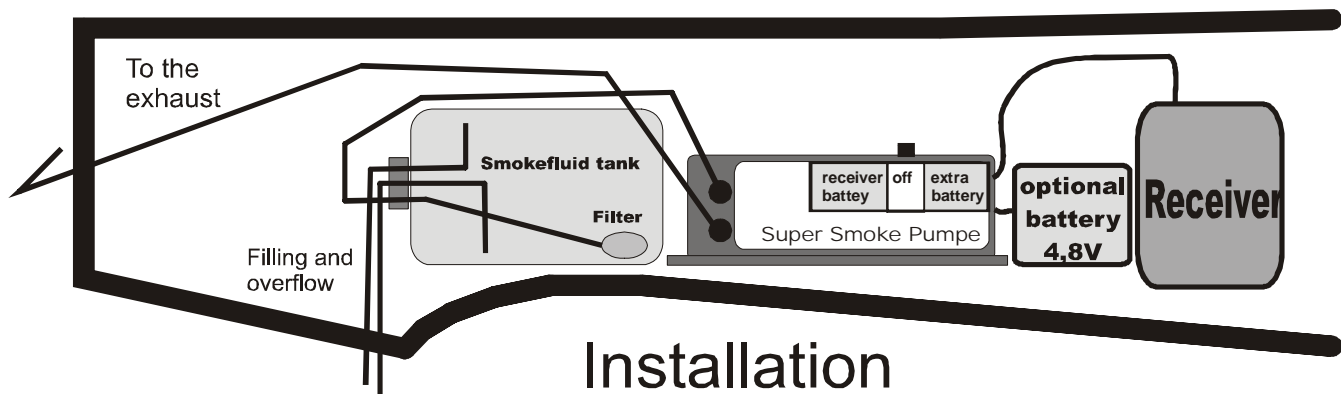
In smaller models you might install it inside the canopy.

For Fun-Fly models or trainers some people install it under the wing with rubberbands.

The **smoke pump** should be installed near the engine and far away from the receiver to prevent interference of, coming from the motor inside the pump.

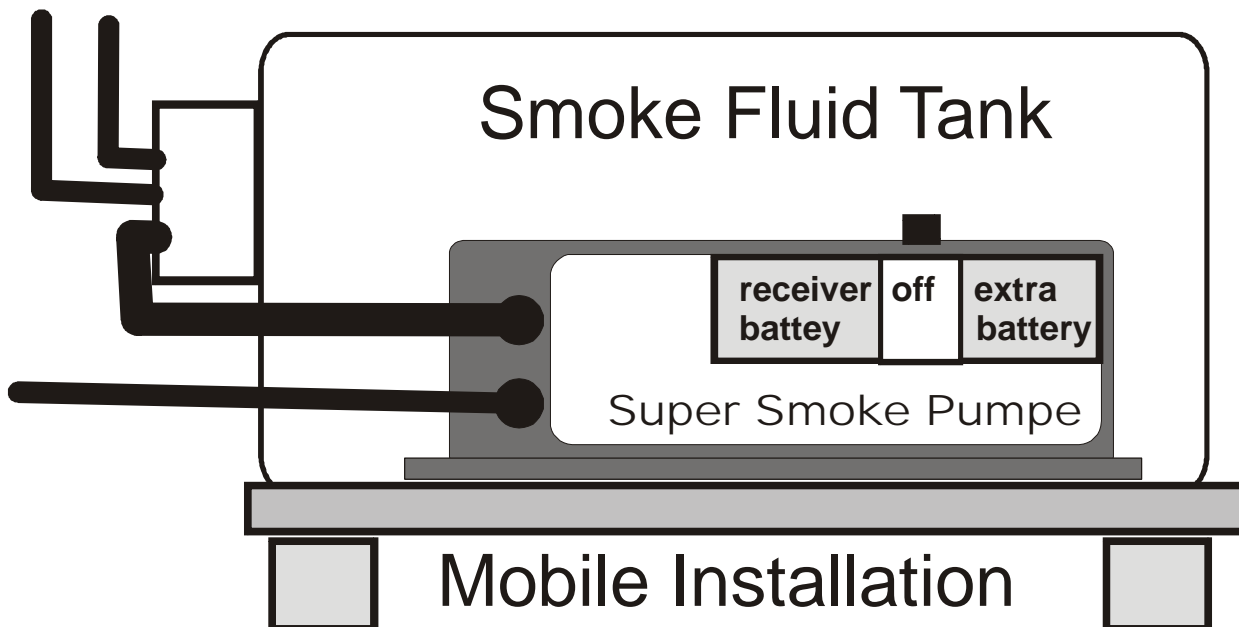
To make the pump resistant against vibration, use rubber pieces or wrap in foam to fix the pump inside the model.

Tank and pump should be placed approximately on the same level.



Mobile Installation

You can install one super smoke system into several models. Dave Patrick showed this version during the TOC in Las Vegas. The complete system is installed on a piece of plywood, that might be installed into several different models in a few seconds. Therefore you need enough space inside your fuselage near the center of gravity.



Enough Heat?

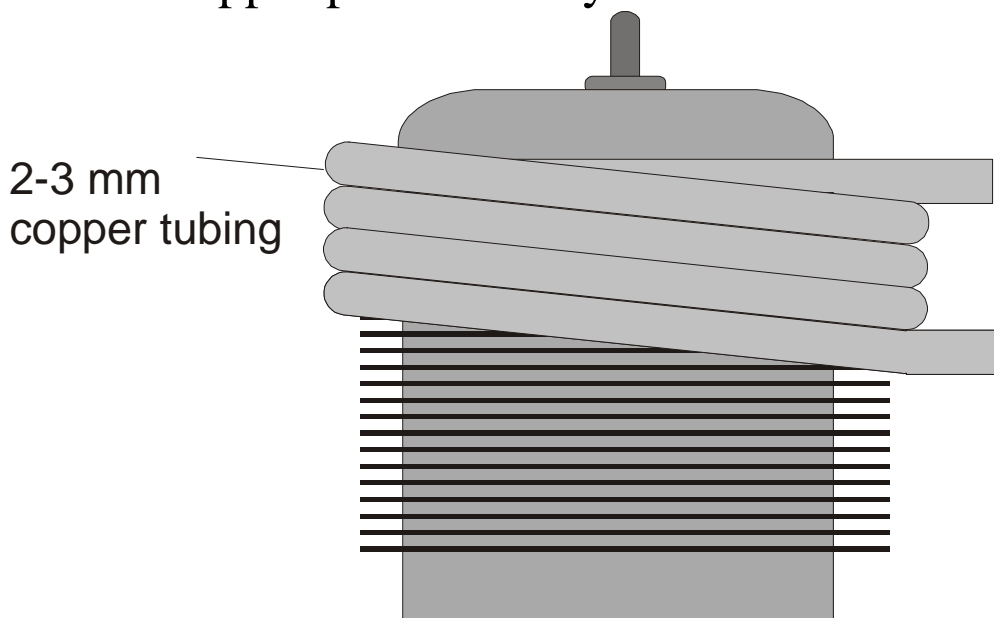
Ask any Airshow-Professional for his secret to produce dense smoke. The Answer will always be: a good smoke system and plenty of heat !!!

With the “**Super Smoke Pumpe VI**” you have purchased the best powerful smoke system. Now you need to get the right heat. Gas engines produce the most heat and do not need any special pre-heating. Smaller Glow-engines need to have a smoke-fluid preheater to get good smoke.

Basically there are three possibilities to pre-heat the smoke-fluid:

1. Cylinder head

The heat of the cylinder might be used to pre-heat the smoke-fluid. Just wind some copper tubing with 2-3 mm diameter around the upper part of the cylinder head.



Pre-heating at the Cylinder Head

Caution! Do not cover too many cooling ribs. This might lead to local overheating of the cylinder head and may damage the motor.

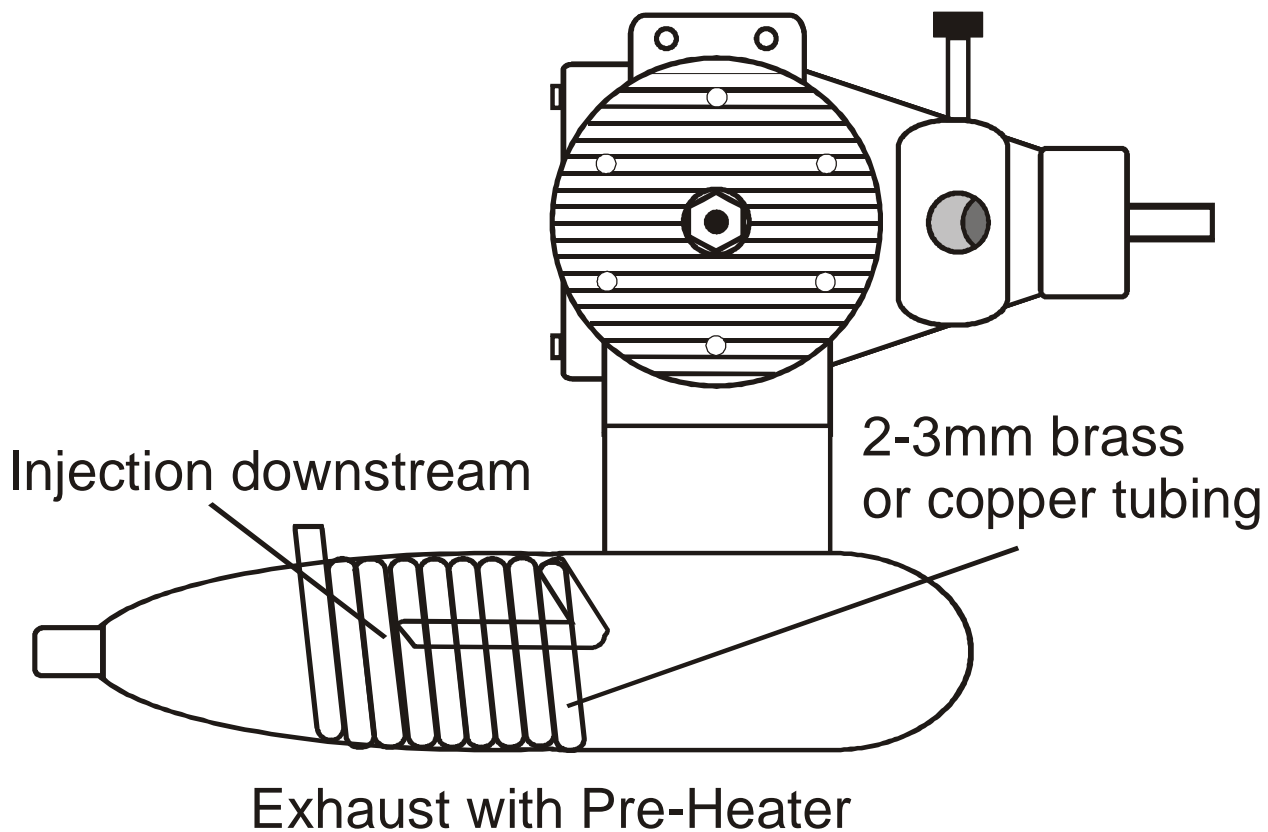
If you notice during test runs, that the smoke starts strong and then gets rapidly thin, the reason might be, that you have not enough windings, or the contact to the cylinder surface is not good enough. If necessary, you may combine this method with other methods for pre-heating.

2. Special Smoke-Exhaust

There are some very well designed smoke exhaust mufflers in the market. They include copper coils inside for optimized pre-heating of the smoke fluid.

If your muffler is big enough and can be opened, you might install the pre-heater yourself.

Just wind some copper tubing with 2-3 mm diameter over a round piece of wood. The outside of the spiral should be about 2 mm bigger than the inside diameter of the muffler. Then drill a hole inside the muffler for the entrance of the tube. The other side of the tube must be bent, to face the outlet of the muffler. It must not face the motor. This could lead to smoke fluid back flowing back into the motor.



Now insert the copper spiral inside the muffler. You can fix it with some high-temperature-resistant (red) silicone. This method suits small glow engines. Gas engines do not need such pre-heating systems.

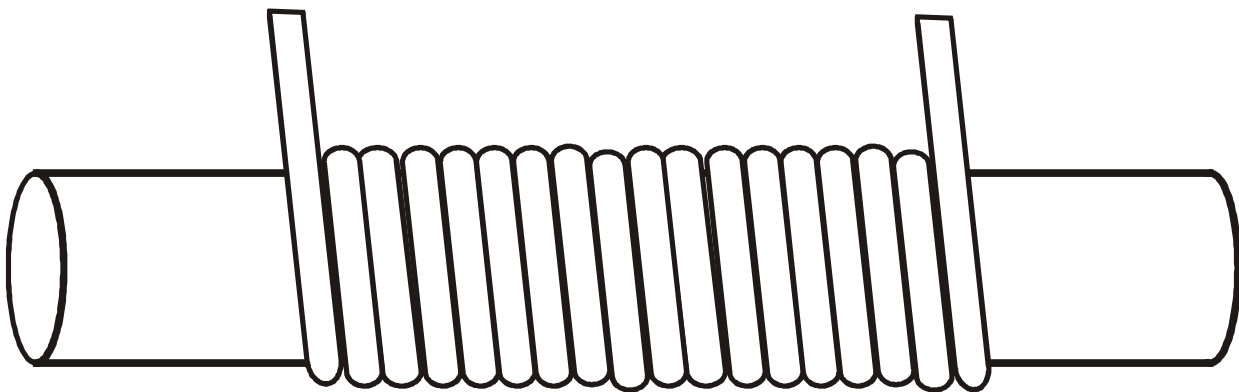
3. External Pre-Heating

Especially for gas engines or tuned pipes the external pre-heating system is a common method.

Wind at least 10 times 2-3mm brass or copper tubing around a piece of wood. The spiral should be a little smaller than the exhaust tube (or header). Then slide it over the header and fix it.

Then drill a hole for the injection nozzle. The Pre-heater will be connected with the nozzle by using neoprene tubing.

Please note, that the direction of injection must be downstream, not towards the motor.



External Pre-Heating

Tubing

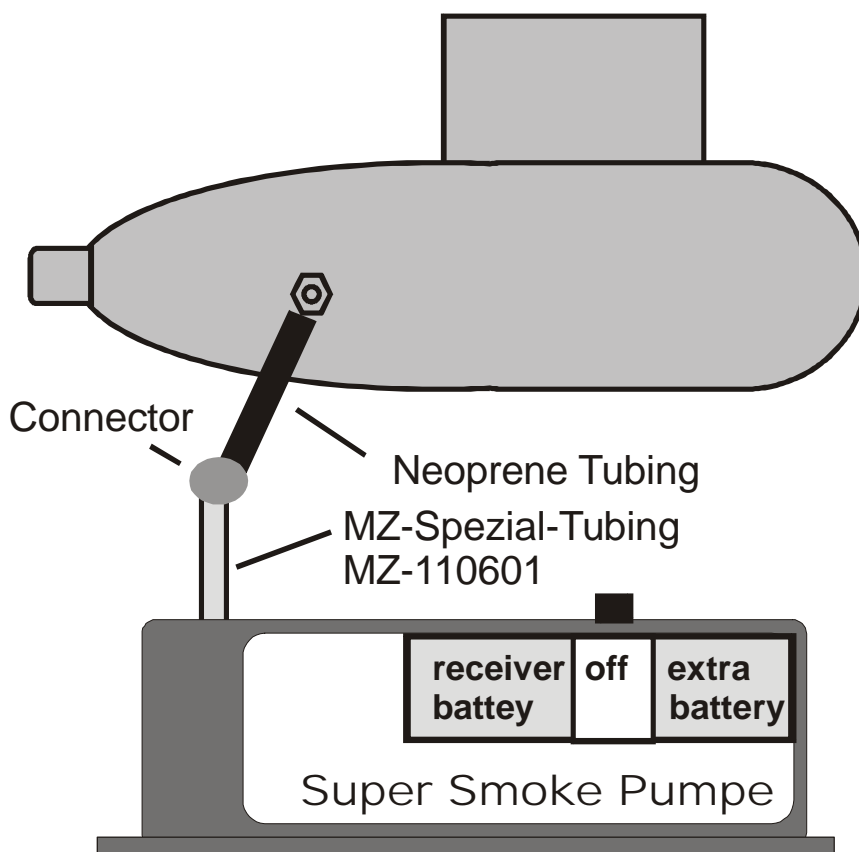
Smoke generation is done mainly with smoke fluids made of paraffin oil.

Normal silicone hose does not withstand these fluids.

Black neoprene hose is ideal for smoke fluids. The disadvantage is, that you cannot see the fluid inside, and the tubing lasts only 2-3 years. It has to be exchanged then.

Since many years MZ-Modellbau sells the special tubing MZ-110601. This transparent tubing is resistant against all aromatic fluids you may use, and it lasts many years.

Because the special hose is sensitive to heat, it must not be used direct at the exhaust. Therefore we include a piece of neoprene tubing and a connector.



Smoke fluids

Several mixtures are tested for good results in smoke systems.

Caution !!

All these fluids are flammable and toxic.

Do not mix or handle without good ventilation.

Do not drink or inhale vapor.

Do not smoke while handling.

Store the fluid so that children can not reach it.

1. MZ-Special smoke concentrate & lampoil 40:60
2. MZ-Special smoke fluid, flavored readymix
3. MZ-Special smoke concentrate & kerosene (A1, JP4)
4. MZ-Special smoke concentrate & Diesel

Especially mixtures No. 1 and 2 produce the most dense and durable smoke. Kerosene alone gives only grey smoke that vanishes quickly.

Also you would not like the smell of diesel and kerosene on your model, especially during transport in your car.

Important Notice!!

To make sure that no dirt is entering the smoke system, only use well filtered smoke fluid. Dirt may damage your smoke pump.

The Right Moment...

If you have installed the “Super Smoke Pumpe VI” correctly, it should work without any problems.

When the smoke fluid is heated up enough, you will experience awesome smoke. If there is not enough heat, some of the smoke fluid will not vaporize and exit the exhaust still as fluid. When you reduce engine power, this effect will be even greater. If you inject smoke fluid during idling, it might get aspirated by the engine. That may cause even an engine failure.

Therefore you have to make sure, that the flowrate of the “Super Smoke Pumpe VI” is adjusted correctly, and the system is switched off at less than half power.

As a user of a **programmable computer remote control**, it should be no problem to set the “ON” position of the smoke system to half throttle. It is advisable to combine this feature via the mixture program with an extra switch.

Then you may select with the switch the smoke system “armed” and it will be activated when you have more than half throttle.

If you use a **non programmable radio**, you might switch the system on by an extra switch or linear channel. During the flight you must not forget to switch off the pump when reducing the throttle towards idle.

Range testing

Before the first flight with the installed “Super Smoke Pumpe VI” you need to test the actual range of your radio.

Place your model on the ground, switch on the radio and walk away from the model until you recognize the first signs of radio interference (AM/FM servo noise, PCM/IPD Fail Safe or no reaction to input).

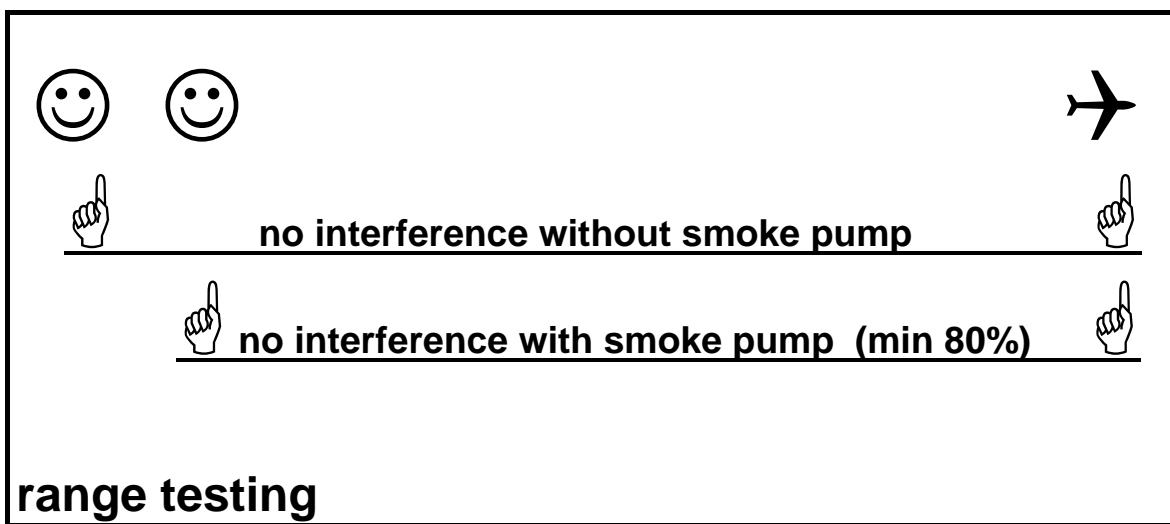
This measured distance now is your reference distance.

Now switch on the Super Smoke System VI and walk towards your model. There might be a slight reduction in range, despite careful interference suppression.

With at least 80% of the reference distance, your radio must work without any disturbance.

Otherwise you have to change the place of installation. The pump must be as far away from the receiver as possible.

Repeat this test from time to time. Never take off with any disturbance in your radio.

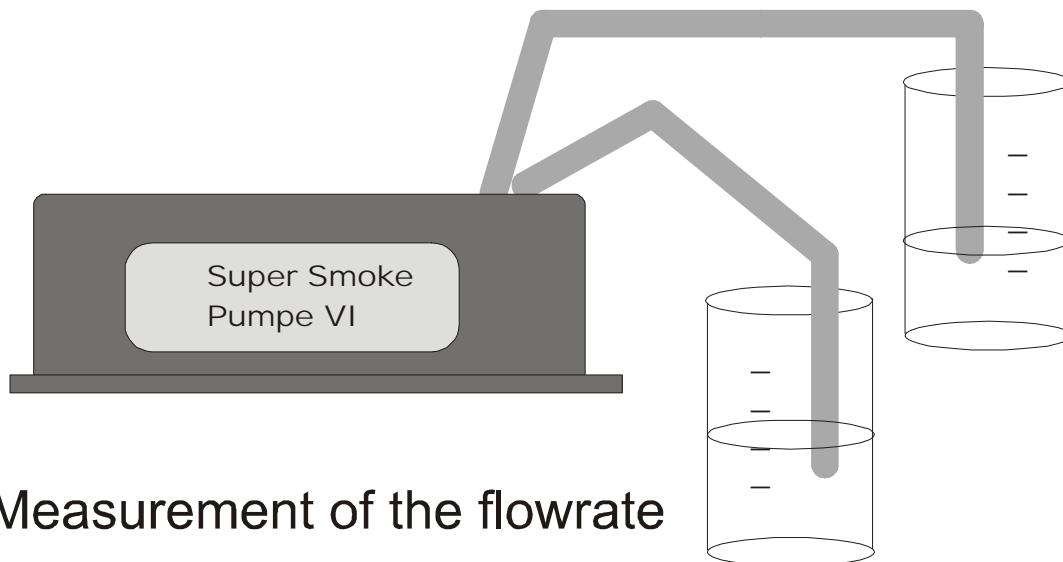


How much fluid?

To adjust the right flow of smoke fluid, you have to make some tests.

First you adjust the “Super Smoke Pumpe VI” to the flow from chapter “the right tank” according to your model and motor.

Therefore you use the system to pump smoke fluid into a calibrated glass. After one minute you stop the pump. Now you have measured the exact flow rate.



With a proportional channel or your computer radio you may now adjust the system to the exact rate you need.

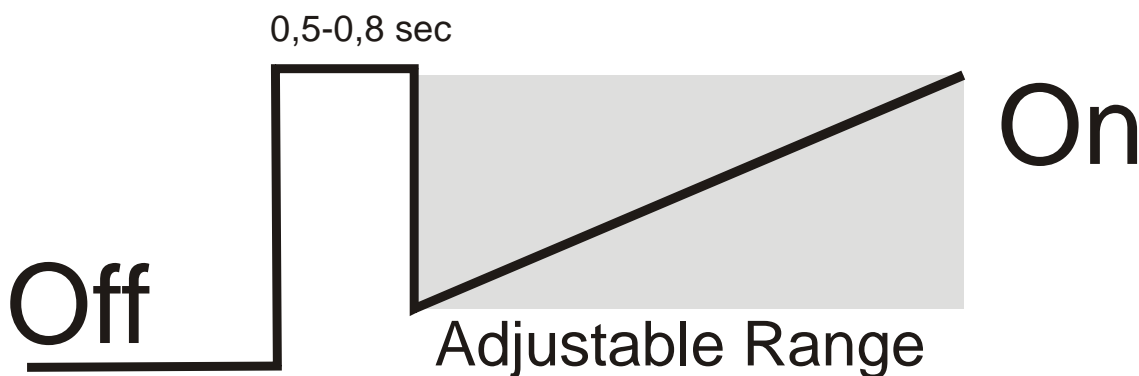
Intelligent smoke control

The Super Smoke Pump VI has a specially developed speed control.

To ensure an instant smoke start, the speed control is programmed to maximum power for 0,8 seconds when switching on.

Thereafter it reduces the output to the permanent flow you have programmed or adjusted (depending on the motor size you use).

The speed control has a long phase “OFF” and “ON”. This enables the system to work with all radios on the market without special adjustment.



Note:

If you switch On your radio with the switch on your transmitter for the smoke system not in complete OFF position, it will not start to run. This is inhibited by a safety circuit.

You must first switch it off, then it is activated and can be switched on subsequently.

Let's Start Smoking

Here is the Moment of Truth...

Remember that testing on ground should be limited as far as possible. Too much smoke fluid might cause a fire threat.

1. Ensure that the Super Smoke Pumpe VI is switched off at the transmitter.
2. Switch on the transmitter.
3. Switch on the receiver
4. Start your motor and warm it up for some minutes.
5. Use full thrust and switch on the smoke system.
6. After 30 seconds switch off the smoke and stop your motor. By now there is a lot of liquid smoke fluid inside your exhaust, the flow was too high.

If the smoke was not dense enough and the exhaust is dry, the flow was not high enough and you must increase it a little.

Now you may "fine-tune" the flowrate as follows:

1. Motor runs full throttle.
2. Smoke System ON.
3. Reduce Flow very slowly by using a proportional channel on your radio until the smoke is getting lighter.
4. Now your smoke system is adjusted perfectly. It should start instantly when switched on, and will stop quickly when switched off without long "aftersmoke".

Airshow with Smoke

Now you have installed a fantastic smoke System, tested and well adjusted. But for the perfect Airshow you must remember

some important tricks:

1. Smoke is only one effect for the perfect airshow. The flight profile is the major aspect for an unforgettable impression to your audience. Smoke must be used only in some special manoeuvres. Don't fly too fast.
2. The audience is expecting a perfect program. Best are slow upward aerobatics like loops, turns or torquerolls. Fly this manoeuvre until the model vanishes in its own smoke.
3. Always stay in front of the audience, never fly high over their heads. So they can see the manoeuvres clearly.
4. Do not fly in strong wind. The smoke is blown away rapidly and does not leave the intended impression.
5. Flights in bad weather or dark sky should be made only for training. The smoke cannot be seen very well.
6. Look for the right background of your airshow. Very impressive is blue sky or even a single dark cloud. Sometimes a mountain or a dark wood gives the perfect site for an unforgettable smoke airshow.
7. Maybe you will try to fly with smoke and music ?

Problems and Solutions

The pump does not run at all

- Switch or stick position at your transmitter was not yet in “off”-position
- Switch at the smoke pump in wrong position
- Receiver or external battery empty
- wrong channel selected at the receiver
- cable or connector defect
- connector in wrong receiver channel or in wrong direction
- dirt is blocking the pump, clean with smoke fluid

No smoke, but bubbles in the smoke tank

- tubing is mixed up. Pump operates reverse

Smoke stops after high g-loads (looping...)

- Tank is installed too high or too low in respect of the pump position. It should be installed almost on the same level.
- Installation of a non return valve might help.

Smoke starts not instantly or not at all

- Pressure in the exhaust is too high ; choose another point for the smoke fluid injection.
- Installation of a non return valve might help.

Little smoke, but model is covered with liquid smoke fluid

- Pre-heating not strong enough
- Too much smoke fluid injection
- Smoke pump runs continuously under half throttle

Engine failure during smoke presentation

- Too much smoke fluid injection
- Injection too close to the engine
- Smoke pump runs under half throttle, shift “off”-position towards full throttle

Receiver interference during smoke operation

- Smoke pump is installed too close to receiver, antenna or servos
- Probably electronic defect of the smoke system.
- **Do not operate during flight**
- **Send pump to MZ-Modellbau Service**

Smoke system stutters when switched on

- Normal behaviour while switching on. The Smoke system runs at 100% power for about 0,6 seconds and then reduces the flowrate to the adjusted value (see also chapter “intelligent smoke control”)

Now have fun

while “smoking”

Axel Maurer

Ten safety rules

1. Do not use the “super smoke pump VI” to pump gasoline or other combustible fluids. Despite the pump being resistant to almost all aromatics there is the danger of fire.
2. Check the wiring of your remote system carefully. Short circuits may lead to fire and explosion.
3. Check the range of your radio before each flight. All installed electric components may cause radio disturbance.
4. Secure all tubing against sliding off.
5. Refuel your model and the smoke fluid only after a cool-down period of the motor.
6. Smoke tests on the ground should be limited due to possible risk of fire.
7. Check, that your smoke system is completely switched off on the ground and during idling. Residual smoke fluid in the exhaust might get ignited .
8. The outlet of the muffler should be installed so that residual smoke fluid may drain off easily.
9. Clean your model after each smoke presentation and check all connections and hinges that were exposed to the smoke fluid.
- 10. Store the smoke fluid absolutely out of reach for children.**

Technical Data „Super Smoke Pumpe VI“

Operating Voltage:	3,8 – 6,0 V
Motor current:	max. 1 A
Weight:	125 g
Dimensions length x width x height:	88 x 48 x 30 mm
Flowrate at 4,8 V:	approx. 600 cc/min
R/C Systems:	all modern R/C like AM, FM, IPD and PCM
Order Number:	MZ-110600D

Accessories:

Order Number:

Special tubing, transparent and resistant against gasoline, diesel, kerozene and all aromatics	MZ-110601
Non return valve	MZ-110602
Injection Nozzle	MZ-110604
Super Smoke fluid concentrate 2 l enough for 6 l smoke fluid	MZ-110606

Notice