

Exhaust technology

Next to the cylinder, the exhaust system is the most important deciding factor in the power characteristic of your motor, which means it should be chosen very carefully. A motor that is setup to do quarter mile sprinting requires a very different exhaust system to one that has been put together for touring purposes. A system that provides the ultimate kick on a FALC tuned V50 would be totally out of place on an original PK setup.

The function of the exhaust

Basically the exhaust is responsible for emptying the cylinder of burnt gases following their successful ignition – the pressurised gases are released so enabling a fresh charge of fuel mix to replace it. The more effective this transfer of gas is, the greater the volume of fresh gas to replace it becomes, so increasing the potential performance of the motor.

Basic varieties of exhaust systems

The whole purpose of the motor setup should be taken into consideration when deciding which exhaust type is to be used: An expansion chamber system is designed to be most effective in the so called 'power band' or to enhance the performance of the motor in combination with the layout of its particular cylinder, the transfers and the exhaust porting inside a certain area of rpm. The more performance orientated the exhaust is, the more limited the choice of cylinder with suitable exhaust timing becomes. An original Vespa motor would be more restricted than enhanced with a full-blown expansion chamber system. A maximum performance cylinder that operates at high revs would not be able to perform properly with an OE PIAGGIO exhaust. Once the cylinder and exhaust system have been successfully combined you can take care of the inlet side of the motor, with a suitable carb and manifold upgrade. Here also it is basically a case of 'horses for courses'. A 35mm flat slide carb. with a multiple petal reed valve manifold is a bit too much for an original cylinder and a standard carb will not really help a performance racing cylinder kit to reach its full potential.

Alongside **original exhaust systems** that do not make use of the resonating effect, but instead deliver a more constant performance, are acoustically inconspicuous and are suitable for everyday road use, there are two types of expansion chamber exhaust systems available.

Touring exhausts closely resemble the original exhaust unit and through light modification, can ensure an optimal torque output that can be fully exploited. **The SIP Road** possesses a hand-welded, multi-segmented downpipe that serves as the diffuser cone of an expansion chamber.

In racing, rev orientated **expansion chamber systems** are used, that use the timing of the exhaust pulse to enhance the existing power available. These are available in various shapes and forms:

With so called **right-hand** exit systems the silencer is situated behind or underneath the motor. The inclusion of a sparewheel does not represent a problem. The main body of left hand exit systems is positioned to the left of the rear wheel. They owe their high performance output to the larger volume possible in their construction.

The so called **'down and forward'** runs the main body of the exhaust to the left of the small frame motor's rear wheel. The silencer is mostly 'hidden' beneath the running boards.

Racing exhaust SIP Performance Curly



original exhaust system Vespa PX200



SIP Road for Vespa PX200 with diffuser (extends into the body!)



right-hand exhaust system

'Curly' exhausts stand out with their voluminous expansion chamber segments. modification to the frame is necessary if you wish to fit this exhaust type to the following models: V50 special V5B3T/ Elestart/PV and the ET-3. All PK models require modification to the side panel to make the 'Curly' fit properly.

The exhausts mounted to reverse cylinder setups also promise a decent amount of power. The cylinder, in this case, is **rotated 180°** so that the exhaust outlet faces towards the front of the scooter. The creativity involved in the construction of exhaust systems is almost limitless and with craftsmanship and a little patience many pipes can be reworked and altered to fit your particular needs. Every type of exhaust system has its advantages as well as drawbacks.



TECH TIP



down & forward exhaust system



"curly" exhaust system



left-hand exhaust system

Exhaust construction

Manifold

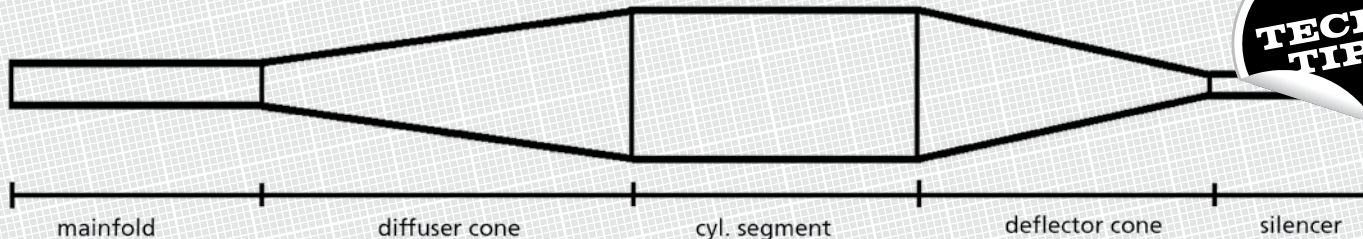
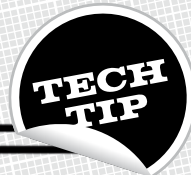
Ideally the downpipe should be 10-20% larger in section than the exhaust port. This area increases quadratically in relation to its radius (twice the radius means 4 times the area, $A=\pi r^2$). The length of the downpipe can be determined according to its diameter. If you choose a length 6-8 times larger than its diameter, you will be left with a relatively narrow power-band. For a less peaky, broader power delivery the downpipe should be between 9 and 12 times longer than its diameter. Take care when calculating the length of your downpipe and be sure to include the length of the exhaust port and stub to your formula.

Most racing exhausts use springs to fix the downpipe to the cylinder and the expansion chamber segment ensuring a solid, yet flexible, fixing. The downpipes on small frames, COSA II and T5 models are attached to the cylinder using threaded studs. The OE PIAGGIO exhausts are fixed to the large frame Vespa cylinder stub using a clamp.

Warning: The outer diameters of the different exhaust outlets are not identical. The 200cc motor for example has the following different sizes on offer: OE PX200 Ø 44.7mm, PINASCO 215 Ø 44.7-45mm (conically shaped), POLINI 208 Ø 44.4-44.5mm, POLINI 210 Aluminium Ø 44.3mm, MALOSSI 210 Ø 44.3mm. This means that a pipe, that fits a MALOSSI stub perfectly, is a very tight fit on an original cylinder and consequently if the pipe fits the original cylinder, it will be too large for the MALOSSI. Due to this lack of uniformity, high end manifold downpipes that are equipped with an O-ring exhaust gasket are only designed to fit one type of exhaust stub. If the clamp holding the exhaust to the cylinder is overtightened the exhaust stub outlet or the manifold itself could be cracked. If the exhaust is damaged in this way and the seal is no longer intact, it could lead to the motor overheating and a loss of power. We can provide a solution in the form of our range of exhaust stub gaskets (e.g. part no 13014000) for the PX 200.



outlet MALOSSI 210cc



Body

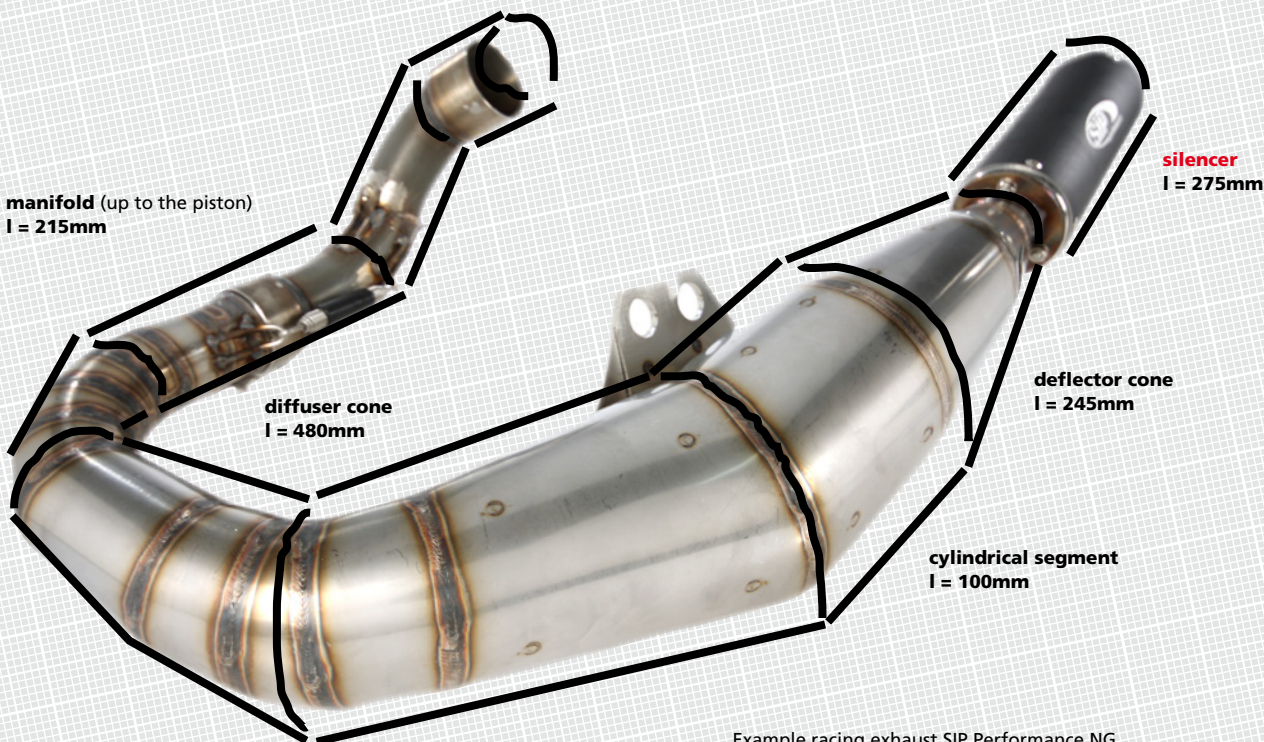
The body of the standard exhaust is divided into several compartments with an integrated silencer unit. In contrast to the conically shaped walls of an expansion chamber exhaust system no 'real' resonance effect is created within the standard exhaust. Nevertheless a certain amount of pressure is maintained within the compartments of the original pipe, that is necessary for adequately filling the cylinder with a fresh charge of fuel. To control the 2-stroke motor with the help of an expansion chamber exhaust system allows a decidedly modified resonance (more power) at a pre-set part of the rev range (power band). This level of performance is limited though and brings with it worse performance at lower revs, or when the engine is 'off the boil'.

Expansion chamber exhaust systems are constructed using many segments of pipe, the most important being conical. The main difference to a normal exhaust is a calculable supercharging effect that these conical segments produce: following the exhausts manifold, gradually widening conical segments are used, so allowing the escaping gases to accelerate as they expand. This part of the system is called the 'diffuser cone'.

While the general shape of the system has a relatively minimal effect on its power characteristics (see 'Curly') the angle at which the opposing cones (diffuser and deflector) are arranged has a direct effect on the width of your power band when torque is at its maximum value. The wider the diffuser cone becomes, the more the gases will expand, so producing a smaller but stronger power band. The more extreme the angle the cones open and close at, the stronger it sucks the gases away from the cylinder, with a more aggressive effect on overall performance. Theoretically, the potential

performance of the motor should also increase, but regrettably, the Vespa motor was never conceived to act as a high performance race motor unlike certain other 2-stroke motor designs. This means that you cannot automatically expect more performance the fatter the exhaust, when a more conservative, slimmer item, could actually do a better job. Between the two conical segments there is a cylindrical segment. It should not be too short with a length of between 20 and 40% of the total length from the diffuser cone segment to the end of the cylindrical segment. It should then have a diameter of 2.5 times the average cross sectional area of the pipe. Theory and practice are very seldom identical however and especially with the more potent exhaust systems available for Vespa some things that work on paper do not always work out so well in a real world situation.

The deflector cone deflects part of the pulse of gases produced by the diffuser cone and when calculated and assembled correctly, this pulse should reach the exhaust port just before it is closed by the piston to force any fresh charge of fuel that maybe escaping, back into the cylinder. The better these conical segments are setup in relation to each other and the general requirements of the motor, the better the resonating effect and the elasticity of the power delivery will be. The deflector cone is usually about half the length of the diffuser cone. The problem with expansion chamber systems remains though, that outside of this specific band of engine rpm, fresh fuel charge is lost through the exhaust port after the piston has opened the transfer ports to allow a fresh gas mix to replace the spent charge. This loss leads to less fuel being ignited and counter productive power-loss.



Example racing exhaust SIP Performance NG

A recent trend amongst sprint racers has been the use of thermal isolation tape wrapped around the body of the exhaust. Unlike more normal road systems, this helps keep the exhaust at a higher temperature due to the fact that hotter gases flow faster, the gas exchange is also accelerated with less reverse pressure.

Silencers

While the standard exhausts have the silencer unit integrated into their body, with expansion chambers, they are a separate part of the design. The diameter of the end-pipe should be at least a half to two thirds of the diameter of the downpipe/manifold and around 10-12 times longer than it is wide. The better designs of exhaust have bolted or riveted silencers, which can be removed to replace the silencer wool. The silencing abilities of the unit are determined by its outer diameter and general dimensions, the amount of holes, the length of the internal pipe and the silencer wool or amount used. The silencer wool is usually made of heat resistant steel wool or a fibre glass material. If the motor is running a little rich, the wool will become soaked with oil. If, on the other hand, the motor is running leanly the wool will be burnt away and the pipe becomes louder (in both cases). This is why the replacement of the silencer wool should be done at every major service of your motor. Always wrap or stuff the silencer gently while replacing the wool, never too tightly. To avoid trouble with German vehicle inspectors and the police, the exhaust should not be louder than when it left the factory where it was produced. According to German law, vehicles generally, should be constructed to be as quiet as the technology allows from the year in which they were built. This means the older your scooter, the louder it can (legally) be (produced before Sept. '83 – 84 dB, Sept. '90 – 83 dB, Sept. '95 – 82 dB and from Oct. '95 just 80 dB). Discrepancies of even 1 dB are not tolerated and if the exhaust becomes louder over time, it is seen as the owners responsibility and not the manufacturers. To discover the true volume of your exhaust it will then be tested (at your cost) by the local vehicle inspector. At the road side it can be roughly measured with a suitably setup microphone. A tolerance of 5 dB is possible. If your scooter is too loud though, it can be impounded for further testing.

Wider section tyres, sparewheel and main stand

Large frame exhaust systems are described in the catalogue as being compatible with wider section tyres when you can fit tyres (110/120/130 section) without any modification or extra spacers etc. Standard exhaust systems are always compatible with wider section tyres. Some, although not all, expansion chamber exhaust systems require re-welding to enable a wider section tyre to be used. It is much more complicated to use wider section tyres in combination with an expansion chamber on a small frame VESPA and should not be attempted without the use of a properly equipped workshop and/or the advice of a professional mechanic. Systems qualify as sparewheel compatible when, after the exhaust has been mounted, the sparewheel can be attached plug-and-play style. Other, non fully compatible exhausts, can be helped by slightly altering the position of the sparewheel using spacers between the wheel and the frame. The tyre should not be able to come into contact with the silencer. With, in some cases, very slight modification the OE PIAGGIO main-stand can almost always be retained when combined with an expansion chamber exhaust system.



Special silencer wool POLINI with steel wool core



Interior view of standard Vespa PX 200 exhaust system

