



**SUNNEN PRODUCTS COMPANY**

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## Air-Cooled Two-Stroke Engine Cylinder Honing

### A New Approach to Accuracy



### Executive Summary

Honing is an abrasive machining process that is the "best kept secret" at many small engine manufacturers, whether the end product is a chainsaw, grass trimmer, blower, hedge trimmer, or other type of outdoor power tool. Sunnen has developed technology for small two-stroke engine honing solutions that help manufacturers meet the 2011 EPA standards for reduced emissions. These solutions improve the engine durability and power output. Simply put, honing produces a more accurate cylinder – a better overall product – for lower cost!

Honing improves cylinder performance by producing more uniform and controlled bore geometry, size and surface finish. Honing improves straightness, cylindricity, and roundness. It corrects taper, bow, barrel shape, tight spots and other geometric errors better than boring or reaming. It's ideal for correcting bore geometry after Chrome or Nikasil™ plating processes. Honing consistently produces surface finish to specifications. With its self-sharpening abrasive tooling, honing eliminates tool condition and wear as a manufacturing variable.

Honing is used after the plating process to correct bore geometry problems and plating buildup at interruptions in the bore. The secret to good bore geometry lies in the honing tool design, the abrasive selection, the coolant, and the honing machine feed system control. And with today's CNC controls, honing is a true production process – fast, low-cost, highly consistent, easily automated, and requires no special skills or touch.

Leading outdoor power equipment cylinder manufacturers rely on Sunnen honing systems, including Stihl, Mahle, Homelite, and Kolbenschmidt. The following article provides details.



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## Application Summary – Chainsaw & Grass Trimmer Engine Cylinders



Sunnen Products Company has '**cracked the code**' for production of small engine cylinders! The production process for small engine cylinders has remained relatively unchanged for many years, although technology advancements in honing have yielded drastic improvements in production cycle times, geometric bore quality, and surface finish in recent years at several manufacturers. New developments in honing tooling, abrasives, and machines have improved the size control and bore geometry of the small engine cylinder. These developments help to overcome the challenges that are common with these types of cylinder bores, such as blind bore designs and large interruptions in the bore for exhaust and intake port designs. Of particular importance, and key to the success of the Sunnen solution, are the advancements in the honing tool and abrasive design.

Two-stroke engines have several advantages over four-stroke engines. Because they don't have valves, they are lighter. Since every stroke is a power stroke, they produce significantly more power per cubic centimeter. Finally, they operate in any orientation because there are no oil flow issues as with a four-stroke engine. Aluminum is typically used for the cylinder body for its light weight and good heat transfer properties. The aluminum cylinder bodies are machined and the cylinder bore is plated with chrome or Nikasil™. *No matter the composition*, all plated materials can be honed with the proper choice of abrasive and honing coolant. By choosing the honing stone bond and grit size properly, any imaginable surface finish requirement can be achieved!

The cylinder body is cast with cooling fins on the outside to help dissipate heat. The intake and exhaust ports in the cylinder bore and the uneven wall thickness of the casting make machining the bore difficult. In addition, the bore is blind and plated with a wear-resistant material such as chrome or Nikasil™. The uneven wall thickness, large port openings, blind bore design, and plating issues have caused many problems in the honing operation until today. **Sunnen has the solution!** With the proper choice of machine, tool, abrasive, and coolant, even the most difficult cylinder bodies are successfully honed on Sunnen equipment to within 5 to 10 micron tolerances. Honing is performed in a two-step process, consisting of a roughing step followed by a finishing step. The roughing step provides the bore geometry and the finishing step provides the surface finish.



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## **Two-Stroke Chrome or Nikasil™ Plated Engine Cylinder Application Application Case History**



In the grass trimmer or chainsaw engine cylinder application, most manufacturers' main goal is to improve the bore geometry in the combustion zone of the cylinder bore. The roundness specs are typically 5 to 15 microns for the cylinder bore, with the tightest specs called out in the combustion zone of the cylinder. Better geometry in the combustion zone improves the sealing capability of the piston rings and transfers the maximum amount of energy to the crankshaft, improving performance.

The cylinder body is typically cast from an aluminum alloy with good tensile strength properties. The strength-to-weight ratio of aluminum is a good choice for mechanical properties but the wear properties are not suitable for the combustion chamber. In most cases the cylinder bore is plated with chrome or Nikasil™ to provide the necessary performance. Cylinder diameters typically run from 30 to 50 mm (1.2 – 2 inch). The cylinder lengths run from 45 to 70 mm (1.8 to 2.75 inch). The aluminum casting is machined prior to the plating step. Machining provides the mounting holes and flat surfaces to attach the cylinder to the crankcase and the intake and exhaust connections. The sparkplug hole is drilled and tapped and the cylinder bore is bored to the size required prior to plating.

After the plating operation, the bore diameter becomes smaller and the roundness and straightness become worse. Honing is used after the plating operation to provide the correct bore size, geometry, and surface texture. The honing machine can be equipped with automatic air gage feedback to control the diameter of the rough honing and finish honing steps. Size can also be controlled manually by an operator monitoring the process. Typical results follow:



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### **Work piece Details:**

Diameter:	35 mm
Length:	65 mm
Plating:	Chrome or Nikasil™

### **Honing Results:**

Roughing:	75 to 100 micron (.003 to .004 Inch)
Cycle Time:	20 to 25 seconds
Finishing:	20 microns (.0008 inch)
Cycle Time:	15 to 20 seconds
Roundness/Straightness:	5 microns (.0002 inch)

The key to achieving good bore geometry comes from a combination of honing machine, honing tool design, abrasive selection, and coolant. Sunnen provides the *“best total solution”* for customers – supplying all the components in a turnkey solution. The tool is custom designed for each engine cylinder configuration to provide the best geometry possible. The unique problems associated with blind bore honing can be largely eliminated with the proper tool design. Long-life honing tools provide good value and performance, minimizing the cost per bore of the operation. A typical Sunnen honing tool for two-stroke engines designs is shown below.





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## Summary

Two-stroke chrome or Nikasil™ plated engine cylinder applications come in a wide variety of sizes, lengths, and tolerance requirements. Sunnen has developed both vertical and horizontal honing solutions for this application. A complete turnkey two-spindle vertical honing system with automated loading, unloading, servo driven rotary index table, and air gage feedback can be supplied by Sunnen. A single-spindle vertical or horizontal solution is also available. Flexible solutions with easy setup and quick changeover are our specialty! Sunnen Products Company has the solution!

## Sunnen Products Company – a brief history

Sunnen Products Company is the world's largest vertically integrated producer of honing machines, abrasives, tooling and coolants. A leading supplier of technology for small engine manufacturers, the company was founded in 1924 in the U.S. by Joseph Sunnen, a man who was truly ahead of his time in many ways. His initial creative genius was geared toward the repair of automotive engines to improve the productivity of the automotive repair shops of his era. Over the ensuing years Joe sought to improve the performance of industrial products using the honing process. This work led to the development of honing tools, gages, machines, and processes capable of yielding bore accuracies of ten millionths of an inch ( $\frac{1}{4}$  micron), in a production environment!

With more than 600 employees worldwide and global Sales & Service through 50 distributors, Sunnen has become a leader in fully automated flexible honing systems for medium to high-volume production. Standard products are also available from the extensive Sunnen Honing Supplies catalog for high, medium and low-volume production. With manufacturing control of its own abrasives, tooling, coolants and machinery, Sunnen Products Company is ideally positioned to offer "***the best total solution***" to its customers. No matter what the production requirements, Sunnen has a solution for you – ***all from one supplier!***