REMANUFACTURING

PLATED ENGINE CYLINDERS

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No discussion of plated cylinder bores is complete without understanding why and where the process came from. Long before the Nickel Silicon Carbide (NiSC) composite coating was invented, chrome was the coating of choice. It was used in aircraft, diesel, and chain saw engines in the 1940's, 50's and 60's. Snowmobiles and motorcycles began showing up with chrome-plated bores in the late 1960's and 70's. Chrome plating used in engine bores is very durable because of it hardness (69 -72 Rc) and low coefficient of friction. It has one major drawback for engine use in that the coating is not **oleofilic**. What we mean by this is that oil will not "wet" the surface. Thus many different techniques from sand blasting to special honing, to the Laystall process (lapping operation) were employed to develop an oil " wetable" surface. In recent years environmental problems with chrome plating and a difficulty in obtaining compatible rings (cast iron) has caused chrome to fall out of favor.

Lacquer is used to protect the cylinder during the process of removing the damaged plating with acids & caustics. Aluminum tape is then used to mask the head surface during the replating process to protect the areas that are not to be coated.

Consequently the search for a better coating began.

In the early 1960's a composite coating of nickel and silicon carbide was being experimented with in the United States. The new coating caught the eye of the billion dollar+ German company, Mahle. They spent over ten years of engineering and developing the process, trademarking the name **Nikasil**. This composite coating has many advantages over chrome in that the surface is oleoflic due to the silicon carbide. It is also very wear resistant, retains its hardness at much higher temperatures than chrome, and it is compatible with all ring packages. In addition, it is environmentally friendly to produce. The major disadvantage is it's rapid failure due to ingestion of dirt. This problem is eliminated by use of modern air filtration.

Honda uses this coating through a licensing agreement with Mahle. Mahle also supplies Nikasil to Rotax and Polaris for their domestic built engines. Another company that has developed their own version of the coating is Nihon Parker in Japan; Polaris Fuji, Suzuki and Yamaha use this version of the coating.

Nickel Silicon Carbide (NiSC) has

many names including Nikasil, Ceramic Composite, NiCom, or Apticoat. All these coatings are basically the same, a two-phase composite of silicon carbide and nickel, which is electrolytically co-deposited. A good analogy is to think of the coating as concrete. The nickel is the cement and the silicon carbide the stones. The nickel is used to hold the silicon carbide particles in place just like cement in concrete. As you can see by the photomicrograph the dark spots are the silicon carbide particles which are very fine and evenly dispersed. The nickel shows up as the lighter area and as seen holds the silicon carbide in place. Above the coating you see the running surface and below is the aluminum casting. Silicon carbide has proven to have been an excellent choice for the running surface of the composite coating because of its hardness and wear resistance. Silicon carbide is used in grinding wheels and is close to diamonds in hardness.

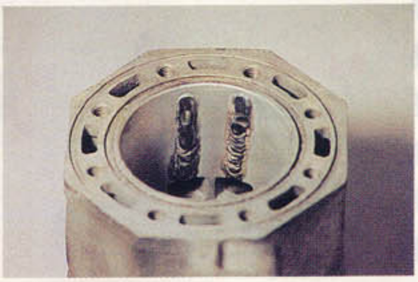
It is important to understand some of the advantages and disadvantages of the NiSC. There has recently been some discussion in regards to the higher initial cost and repair expenses of these coatings in comparison to the traditional cast iron (steel) bore cylinders. While a Nikasil cylinder is more expensive, the advantages outweigh the disadvantages in high performance applications. We have found an average increase of 2% to 4% horsepower over cast iron due to increased lubricity of the coating. The low coefficient of friction, and the natural olyeoflic nature of silicon carbide achieve this. Heat transfer is also greatly improved, up to five times better than a pressed in steel sleeve. In addition, the wear resistance of NiSC was tested against cast iron and found to be 10 times better. There are few disadvantages, especially when the coating is done properly. But when a poor job is done, peeling, bubbling, and abnormal buildup around the ports can occur.

When an engine suffers a piston seizure, the likelihood of having to repair the cylinder is far less frequent with a NiSC cylinder. With an iron bore it is more common to find damage and therefore boring and honing to the next oversize is required. It is fairly infrequent to be able to simply "clean up" the iron bore and install a new piston and rings. With a NiSC bore, the aluminum from the piston can be dissolved off using Miriatic Acid. Once the bore is clean, you can install a new piston & rings and you're back in business. However, the cheaper over-boring process will most likely fix the iron bore. The problem arises if stock sizes must be maintained for racing or the cylinder has been over-bored so many times that pistons are no longer available. Then fixing iron bore cylinders becomes quite expensive. Another benefit to the NiSC bore is the ability to repair it many times and still maintain original specifications. Repairing a race cylinder 6 or more times is not unheard of.

When a cylinder is received for remanufacturing most companies follow a similar routine. First the cylinder is inspected and all steel parts are removed or masked. If this is not done they will dissolve during the third stage of the operation. Next, the cylinder is cleaned to remove any dirt or paint. After cleaning, the cylinder is chemically treated to remove the old coating. Once the cylinder is returned to a clean bare aluminum bore, the cylinder is evaluated for damage. If there is no damage, the replating process begins. If there is light damage, in the range of .002 to .015 of an inch, the cylinder is bored oversize and plated back to stock with a thicker layer of the coating. If the damage is severe the cylinder is welded and then bored.

Plating the cylinder is not a process where a cylinder is dipped in a tank and then pulled out like paint. Electroplating is a process where a negative charge is placed on the cylinder and a positive charge on the anode. This potential difference causes the nickel to plate out on the surface of the cylinder entrapping free silicon carbide. When done correctly the bond between the nickel and the aluminum can exceed 25,000 psi.

This plated cylinder has damage which requires the plating to be removed.



After the plating is stripped, the gouged base metal is welded to fill in the damaged areas.

The cylinder is then bored to return it to exact specifications before replating.

Once the cylinder is replated, the process is not complete; note the extra material in the port areas.

After precision honing, the finished product is ready to return to service.

HONING CYLINDERS

Honing is the last step in the process before the final quality control check. It is also a lot more complicated than it appears. If a cylinder is not honed correctly, oil retention, excessive ring wear, loss of power or premature failure can occur. The parameters that must be controlled when honing a cylinder include size, roundness, straightness, taper, and surface finish. Surface finish can be defined by up to 10 to 20 parameters depending upon how critical the surface. Usually 3 or 4 are all that is needed. To ensure quality, precise measuring equipment is required which include dial bore gauges, setting fixtures, ring gauges, surface analysis machines, and a tally round. Feeler gauges and calipers are OK for the field, but are not accurate enough for the level of precision measuring required.

Honing accurately removes material from a bore, using abrasives to provide a round and straight bore. Normal cast iron is honed with silicon carbide or aluminum oxide stones. The problem with honing a composite coating is that silicon carbide stones will not cut the silicon carbide found in the coating. Therefore diamond stones must be used. Depth of the crosshatch, width of the plateau, speed of stock removal, and stone life are the factors that decide which stones to use.

Being in this business for over 10 years I have been asked a lot of questions. These are the top five:

"How is only the bore plated and not the whole cylinder?" This is done by protecting the parts of the cylinder that shouldn't be plated. The protection comes in two forms, masking and tooling. Masking is a process where parts of the cylinder are covered with tape or lacquer or other different techniques to protect the plating bath from coming in contact with the aluminum. Tooling or fixturing shades areas from the current so those areas do not receive any plating.

"Do I have to deglaze my cylinder when putting in new rings?" Yes and No. It isn't anywhere as near as important to deglaze a plated cylinder compared to a cast iron one. But a good brushing with a silicon carbide brush will deep clean the cylinder and help with ring seat. Never used a ball hone on a two-cycle engine! This will damage the cylinder geometry and cause poor compression. A flex hone is better but still will probably do more damage than good.

"Why does the cylinder have a different color or have pits on the outside?" These occur to the cylinder before and during plating. The cylinder needs to be clean and oxide free for the plating to adhere. This preparation process lightly (.0002 of stock removal) etches the cylinder and this changes its color. When done improperly the process can remove too much material and cause pits (not to be confused with porosity).

"What is porosity and is it bad?" Porosity occurs when gas is trapped in the aluminum when it is being poured in the molten state. When machined, these bubbles show up as small holes. This is common in castings and doesn't usually affect the strength or longevity of the casting. Sometimes, the plating process does not fill these pits. This leaves the pit showing through when honed. Small pits on the surface are perfectly functional as these pits hold oil and improve lubrication. I have never heard of a ring catching a porosity hole or causing a failure. In fact most OEM's have a spec that determines how much porosity is acceptable. Most consumers would be surprised at how liberal that specification is.

"What kind of tolerances can I expect?" A good shop should be able to hold a .0005 tolerance on roundness and taper for snowmobile cylinders. On some race cylinders tolerances can be tightened to .0002 tolerance. This is compared to some OEM specs as great as .0015".

So in the final analysis, replating can be a good option to buying a new cylinder. In the case of big bores, custom porting, and other modifications it may be the only option. If you chose a reputable shop, the quality, turn-around time and service should make getting a cylinder replated a pleasant experience. And most importantly, it could also save you lots of money. Typically replating can save you over half the cost of purchasing a new one. As with every precisely engineered product, quality shows and you should end up with a better cylinder than a new one.

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