

Clean and Machine Aluminum by Combining Processes

By Doug Kaufman

Steel may still be the big dog when it comes to the content of the world's motor vehicles, but aluminum usage in cars and trucks continues to increase. Fueled by the desire to save weight, time and energy, aluminum is gaining ground with manufacturers of parts and components.

How does the use of aluminum in today's engine components impact today's engine builder/rebuilder? It's certainly not a foreign material but understanding its properties makes good business sense.

Cleaning aluminum creates special challenges for engine builders because of its corrosiveness and soft metal properties. There are several effective ways to clean this non-ferrous metal but there is no magic solution. You will more than likely have to combine several processes to get the kind of clean that you demand. The methods that will work best will depend on the volume of aluminum you're cleaning.

Jet Spray Washers

Today's jet washers have evolved from little more than a dishwasher to a complete cleaning solution. Manufacturers have improved turntables, nozzle systems, pumps and heating systems, and jet spray washers are often the starting point for cleaning aluminum in many shops. The chemical makers have stepped up, too, offering aluminum-safe alkaline soaps.

Some of the keys to remember when cleaning aluminum or any other metal in a jet spray washer is the importance of good heat. Too low a temperature may mean incomplete washing—and wasted electricity. For this reason many manufacturers have incorporated digital thermal controllers to monitor the washer's temperature.

In addition, some new machines have improved spray nozzles to deliver uniform high pressure along the entire nozzle profile.

The manufacturers of jet spray and other aqueous equipment agree that the physical properties of cleaning are the same whether it is aluminum or cast iron. The biggest difference with cleaning aluminum is in the type of chemical you use.

Cleaning aluminum with aqueous requires using a compatible chemical that won't etch or discolor the metal. Aluminum builds an oxide on it and that oxide has to be torn down chemically with a caustic agent. Most manufacturers offer a variety of chemicals for cleaning aluminum and other metals, so you should always consult your chemical supplier to decide what is best for your shop. The type of chemical you use depends on various factors like how many parts you clean, what equipment you have (and how many units), what type of metals are cleaned primarily and how dirty are the parts.

While aluminum often turns black when exposed to caustic chemicals, this coloration is just oxidation, which can be removed by a de-oxidizer, returning the metal to its attractive uniform aluminum surface.

Some chemical suppliers say a moderate to high pH (around 12 pH) is safe for aluminum and when combined with a caustic and oxidation inhibitor, can be a very effective solution to cleaning bimetal components.

It's possible to squeeze out as much cleaning power and still inhibit the attack on aluminum so that you can clean mixed metals without having to run two systems. Formulations are available that are very safe on aluminum surface and will provide a clean, bright aluminum surface but without brighteners in them. There are mixes of phosphoric and nitric acids or phosphoric and hydrofluoric acid—there's usually an acid mix that goes beyond straight phosphoric to actually bring out brightness in aluminum.

There are three types of aqueous chemicals that an engine builder needs to be aware of: 1) high caustic products that are safe on ferrous alloys only; 2) silicated, higher pH products that are multi-metal safe and provide the most cleaning and protection for aluminum; and 3) non-silicated products, which are

used mainly in precision cleaning processes. It is aluminum compatible and thoroughly rinseable but may cause some discoloration of the aluminum.

Thermal Cleaning

Heat cleaning is an effective way to clean aluminum but you should err on the side of caution when it comes to the factors of time and temperature. Many aluminum heads are made from a composite of alloys. Unless you have access to a metallurgical lab it may be impossible to know exactly what its composition is.

The key to thermal cleaning, especially with aluminum parts, is having the ability to dry oil deposits to a dried ash state. One way to do this is by using indirect flame—in other words a non-contact, convection process.

In this process, a flame heats the air, which flows around the part. This is safer for aluminum because the lack of direct flame eliminates the possibility of temperature spikes, which can cause annealing of the surface, where the aluminum loses some of its hardness. Therefore, keeping temperatures in check is critical with aluminum parts.

Media Blasters

For baked-on carbons, sometimes the only way to remove it is to blast it off with some sort of bead media. Bead media on aluminum can be challenging, however, because you may spend as much time cleaning the media out as you do cleaning.

You have to be sure that you don't leave anything behind in the cleaning process. Certain types of media are more resistant to lodging in a cavity than others. Glass bead and steel shot (specifically shapes that are more jagged) can become lodged in very tight, hidden areas and require extra attention to get them out. In addition, you may have to mask the area off to keep the media from getting in.

Another note of caution with using a media blaster is that you may damage the surface of the aluminum by moving the metal, affecting tolerances or changing the texture of the surface.

One form of media that does neither of these is soda media. This media is essentially made from a form of baking soda. It is considered a "one pass" prod-

uct. This means that it can only be used once and cannot be recycled, but it still can be efficient and affordable for shops.

Experts say soda is the softest of all media: it is rated at 2.5 on the Mohs hardness scale: plastic is 3.5, glass is 5 to 6, sand is 7 and aluminum oxide is 9. The soda media also comes in a variety of sizes to suit your particular cleaning situation. Yet even though it is soft, it is quite effective on aluminum.

It can remove carbon without damaging the aluminum and is completely water-soluble. This gives the peace of mind of knowing potentially damaging media won't be left behind in oil galleys, water jackets, boltholes or other blind areas.

Because there is no need to prewash the aluminum or do extensive rinsing as with other types of blast media, soda blasting can save time for the rebuilder because you can clean in one step without damaging the substrate.

Despite some of the shortcomings of glass bead, it is still used in some shops to clean aluminum. Glass bead can be recycled to use over and over before needing to be replaced therefore it is not as expensive. But you have to be careful. This media can become lodged in bind holes and galleys and you'll have to spend extra time to be sure it is removed in the rinsing process. Shops using glass bead on aluminum often-times will mask off areas where the bead may be trapped. Furthermore, most media blasters work best when combined with another type of cleaning process, which may be a thermal or aqueous-based system.

Airless shot blasting is another type of media used for cleaning aluminum. These automated systems are designed to sling either stainless or steel shot onto the aluminum part in various patterns.

One of the benefits of airless blasting is that you can load the parts in the cabinet and walk away. And, aluminum cleaned with stainless shot leaves a new looking finish. Manufacturers recommend that you allow the aluminum to cool (but not too much, to around 200 degrees F) and dry before putting the workpiece in the airless blaster because the shot may change the integrity of the aluminum if it is too hot. It is also very

important that the piece be completely dry—no oils or water-filled bolt-holes—because otherwise the shot may become trapped.

Ultrasonic

According to various sources, ultrasonic parts washers will do as good of job cleaning the external surfaces as bead media without damaging ports and other critical surfaces. Ultrasonic cleaning also offers the convenience of being an automatic process: you can throw the part in, turn it on, and walk away to do something else.

According to manufacturers of ultrasonic systems, many engine builders are using jet spray washers to pre-wash aluminum parts to get the heavy grease off and then using the ultrasonic system to do the precision cleaning.

Ultrasonic cleaning works well because you're not using a high impact force to do the cleaning, so you're not changing the tolerances of the aluminum. It creates a vacuum bubble that when it hits the part and pops it doesn't blow out it implodes. This is what is called cavitation. It is basically sucking dirt off the part you're cleaning.

Just because aluminum is a softer metal than steel or cast iron doesn't mean it's any easier to machine, at least in the sense of being any less complicated. All traditional machining operations can easily be performed on aluminum—if the machine and its tooling are designed for it.

Aluminum alloys allow very high speeds of cutter tool rotation, but also has a tendency to stick to the tool's cutting edge. Proper tool material and coating selection is important, so discuss what's best for your application with your equipment and abrasive supplier.

Working with aluminum engine parts is already part of your daily routine. According to experts, that trend won't change.

When deciding on what equipment or chemicals may be right for your aluminum repairs the first step is education. The more you know about each type and how it is used, the better armed you'll be to choose the right equipment.

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