Valve seats seem to be a fairly simple engine component but they play a critical role in sealing compression and cooling the valves. When a seat becomes worn, it may leak compression and allow the valve to run hotter than normal. The same thing can happen if the seat is out-of-round or has lost its concentricity with respect to the valve.

Any mismatch between the valve and seat, therefore, will have negative consequences on sealing, the operating temperature of the valves and valve longevity.

The key to achieving a long lasting valve seat is to match the seat alloy with the application and replace same with same or better. As a rule, most experts recommend replacing OEM valve seats with ones that are of a similar material—except in cases where extra durability is required because of a change in fuels (converting to propane or natural gas, for example), or an engine is being built for racing.

Replacement valve seats are available in a wide variety of alloys and types, from the more common standard cast iron alloys to harder nickel alloys to exotic alloys like copper beryllium for racing engines with titanium valves. And there’s powder metal, too.

Suppliers of cast alloy valve seats typically offer a variety of different alloys, so the best advice is to follow their recommendations as to which material works best in a particular application. One supplier may not agree with another as to which alloy they would recommend for a particular application, but one point they all agree on is to use the same alloy or type of seat within the engine. In other words, don’t just replace one or two seats with an alloy that differs from the OEM alloy and leave the rest alone. Replace all the seats with the same alloy.

What happens if you mix and match? You’ll probably run into trouble down the road. If a replacement seat is harder than the original seat, it will hold up better than the remaining original seats. Sooner or later one of the other seats will burn a valve and the engine will be back. If one exhaust seat is bad, replace all the exhaust seats.

Different seat materials can be used for the intake and exhaust valves because the exhaust valves run so much hotter than the intakes. For a racing application, you might only need to upgrade the exhaust seats to handle the extra heat.

The valve seat material must also be compatible with the type of valves that are used. For racing engines with titanium valves, copper beryllium or nickel aluminum bronze seats are usually recommended. These materials can also be used with stainless steel and stellite valves, too. Again, follow your suppliers’ recommendations for which type of seats they recommend.
Valve Seats

Consequently, the seats may need little work when the cylinder head is rebuilt.

One difference between cast alloy seats and powder metal seats is the way the seats are manufactured. Cast alloy seats are made by melting and mixing different metals together so they combine chemically. The molten soup is then poured into a mold and cast to shape. The rate of cooling and subsequent heat treatment of the metal determines its microstructure, hardness, strength and other physical properties.

Powder metal seats, by comparison, are made by mixing together various dry metal powders such as iron, tungsten carbide, molybdenum, chromium, vanadium, nickel, manganese, silicon, copper, etc., pressing the mixed powders into a die, then subjecting the die to high heat and pressure (a process called “sintering”). This causes the powders to bond together and form a solid composite matrix with very uniform and consistent properties.

One of the advantages of powder metal sintering is that materials that are difficult or impossible to mix together in a molten state can be blended together and bonded to create totally unique materials. For example, in powder metal bushings, a soft and bouncy material is combined with steel to make the material “self-lubricating.” This eliminates the need for grease and periodic maintenance.

Another advantage of the powder metal process is that parts can be manufactured very close to final tolerances, reducing the amount of machining that’s needed to finish the part to size. This lowers production costs and boosts productivity.

The main reason why vehicle manufacturers have switched from cast alloy seats to powder metal seat inserts is to extend durability. Most late model engines have to be emissions-certified to 150,000 miles or higher mileage engines are rebuilt, it’s especially important to pay close attention to the condition of the valve seats. In the case of cast iron heads with integral valve seats, as long as the seats are undamaged, free from cracks and have not receded into the head, they can be recut or reground to restore the sealing surface. If the seats are damaged or too badly worn to be remanufactured, the old seats can be cut out and replaced with inserts if the head is worth the effort to repair and has enough casting thickness to accept seat inserts.

Different materials can be used for the intake and exhaust seats because exhaust valves run much hotter than intakes.

With nonintegral seats in aluminum heads, it’s pretty much the same story with a couple of exceptions. As long as the original seats are in relatively good condition (not loose, cracked or heavily worn), they can usually be touched up with a cutter or grinding stones to restore the surface. But sometimes the seats are loose or have hairline cracks or other damage. In these cases, the original seat must be removed and replaced with a new one – preferably a seat that is made of the same or better material as the original.

Many late model domestic and import engines have seats that are made of powder metal. These types of seats are very hard and durable, so they typically show little wear at high mileages.

Valve Seats

Different Applications, Different Approaches

When the cylinder heads on high mileage engines are rebuilt, it’s especially important to pay close attention to the condition of the valve seats. In the case of cast iron heads with integral valve seats, as long as the seats are undamaged, free from cracks and have not receded into the head, they can be recut or reground to restore the sealing surface. If the seats are damaged or too badly worn to be remanufactured, the old seats can be cut out and replaced with inserts if the head is worth the effort to repair and has enough casting thickness to accept seat inserts.

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Cooling is more of an issue with exhaust valves because exhaust valves run much hotter than intake valves. Cooling is provided by heat transfer from the valve to seat during the time which the valve is closed, and by conduction up through the valve stem and into the head. titanium valves do not shed heat as quickly as stainless steel valves, so the tradeoff for switching from steel to titanium to save weight and special alloy iron running valves. The higher the temperature of the exhaust valve, the greater the risk of the seat from falling out). Those that don’t have any detrimental effect on the seats.

### Take A Seat, Please

The first step in replacing an integral valve seat is getting the seat out of the head. Any number of techniques can be used here, ranging from pulling and prying to heat shrinking, cutting and machining. Sometimes thermal cleaning alone will do the trick. When the heads get hot, the seats fall out. Those that don’t can be extracted by means of straightening a head can often be used to check the quality of the seat and valve. The best way to check concentricity is with a runout gauge. Pulling vacuum on the valve port with the valve in place is another method. Refinishing powder metal seats requires a slightly different touch than cast alloy seats as a rule. If grinding, you typically need harder stones (ruby, for example) or lите. If cutting, you need a good sharp carbide cutter and to slow it down a bit. The one thing you want to avoid when cutting powder metal is any chatter on the seat surface. Powder metal seats can accept a high quality finish, but the finish is only as good as the tools that are used to cut them. EB

interference fit, then machining will be necessary. Most seat suppliers say staking, peening and/or the use of an aeroneb sealer should not be necessary if a seat is installed with the proper amount of interference fit in the counterbore. The amount of interference required to lock a seat in place depends on the diameter of the seat (the larger the seat, the greater the interference that’s required), the type of head (aluminum or cast iron), the application (hotter running applications typically require more interference to keep the seats from falling out), and in some cases the type of material used in the seat itself (hard seats can’t take much more interference as softer seats). If the OEM publishes the interference specifications for their seats, follow their guide-

For racing applications using either stainless steel or titanium valves exhaust valves, some suppliers recommend a sintered valve seat insert, which includes a blend of finely dispersed tungsten carbide in a matrix of tempered M22 tool steel and special alloy iron particles. These powder metal seats have a very uniform microstructure, and are highly machinable. Because powder metal seats work hard as they age, they don’t have to be as hard initially to provide good long term durability, and the self-lubricating qualities of the material allows it to handle a wide variety of fuels, including unleaded and leaded gasoline, straight alcohol, nitrous oxide and nitro methane. A shot of nitrous will cause combustion temperatures to soar, but the dose usually doesn’t last long enough to have any detrimental effect on the seats.

For dry fuel (propane and natural gas and high load (diesel and racing) applications, harder seat materials are almost always recommended. These include tool steel tungsten carbide seats and high nickel alloy seats.

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Beryllium copper seats are often used in drag racing, NASCAR, Formula 1 and Indy racing because of the materials work well with titanium valves and has a higher thermal conductivity than steel alloy seats. The main reason why many suppliers of titanium valves recommend seat materials such as beryllium copper.

### Beryllium copper valve seats such as these are used in performance applications to cool titanium valves.

The next step up is a high alloy seat material, for applications where high heat resistance is required, such as a propane or natural gas fired stationary engine but also for high performance engines, heavy-duty and extreme duty engines where longevity is a must, seats are made out of a high speed tungsten carbide tool steel, which gives it ceramic-like character-

### Beryllium copper valve seats such as these are used in performance applications to cool titanium valves.

After an old seat has loosened up and is moving, the counterbore in the head should be enlarged to accept an oversize replacement seat. Simply pressing in a new seat probably won’t work because the interference fit has been lost. Using some anerobic sealer to hold a new seat in place is no guarantee it will stay put if there is not enough interference to lock it in place.

If the original seat was loose, if the counterbore is wider than .001˝ (wider at the top than the bottom), or if the difference between the counterbore’s inside diameter (ID) and a standard seat’s outside diameter (OD) isn’t enough to provide the desired interference fit, then machining will be necessary. Most seat suppliers say staking, peening and/or the use of an aeroneb sealer should not be necessary if a seat is installed with the proper amount of interference fit in the counterbore. The amount of interference required to lock a seat in place depends on the diameter of the seat (the larger the seat, the greater the interference that’s required), the type of head (aluminum or cast iron), the application (hotter running applications typically require more interference to keep the seats from falling out), and in some cases the type of material used in the seat itself (hard seats can’t take much more interference as softer seats). If the OEM publishes the interference specifications for their seats, follow their guide-

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