

SB040

Valve Seat Inserts

When replacing valve seat inserts (VSI) in a cylinder head, it is important to consider the valve face material, the cylinder head material, the engine fuel, and the likely operating conditions when selecting the replacement VSI material and size. Many machinists will install the new VSI into the old counterbore without remachining the counterbore. While this is possibly an acceptable practice in a large, heavy section, cast iron cylinder head, it is not a recommended practice for aluminium and light cast iron cylinder heads. It is much better practice to cut a new VSI counterbore to insure the correct fit. This will then insure concentricity and perpendicularity with the valve guide, good heat transfer from the VSI to the cylinder head and longer valve life.

To machine the VSI counterbore in a cast iron cylinder head, a cutting speed of 100 to 250 RPM with no cutting oil or fluid is recommended. In aluminium cylinder heads, a cutting speed of 400 to 600 RPM with cutting oil is recommended. The correct interference fit of the VSI is also critical. If the manufacturer does not provide a recommended fit, Table 1 will provide a good guide.

Outside Diameter of VSI		Cast Iron Cylinder Head		Aluminium Cylinder Head	
[inch]	[mm]	[inch]	[mm]	[inch]	[mm]
0.7874 – 1.1811	20 – 30	0.003	0.08	0.005	0.12
1.1811 – 1.5748	30 – 40	0.004	0.11	0.006	0.15
1.5748 – 1.9685	40 – 50	0.005	0.13	0.007	0.18
1.9685 – 2.3622	50 – 60	0.006	0.16	0.008	0.20
2.3622 – 2.7559	60 – 70	0.007	0.18	0.009	0.22

Table 1. Recommended interference fits for VSI.

If the VSI has a radius on the lower outside edge, it should be possible to install it without “freezing” the VSI and/or heating the cylinder head. However, these may still be options if there is concern about the force required to install the VSI. Care must be taken in using liquid nitrogen or similar to freeze VSI, as cryogenic or near-cryogenic temperatures can change the metallurgy of some special VSI.

Many O.E. cylinder heads are fitted with specialised valve and valve seat materials. It is important to select the correct material when replacing the VSI. Most VSI manufacturers supply a range of generic sizes and materials and VSI materials for specific applications to match O.E. requirements. That range typically consists of:

- Powder Metal (PM) or sintered inserts that are suitable for most petrol (including unleaded) engine applications.

- high chrome stainless steel or nickel base inserts that are suitable for most diesel engines and turbocharged petrol engine applications.
- nickel/cobalt or tungsten non-magnetic inserts that are suitable for exhaust applications on Propane, LPG, Natural Gas engines and any other extreme heat applications, such as high performance engines, heavy duty and extreme duty applications.
- special material applications to meet O.E. specifications that includes various iron, nickel and cobalt base alloys along with several proprietary materials.

Machining the VSI counterbore

- When selecting the VSI, its outside diameter should be approximately 2.5 mm (0.100") larger than the valve head diameter.
- The inside diameter of the VSI will typically need to be approximately 2.5 mm (0.100") smaller than the valve head diameter.
- The VSI thickness is typically in the range of 4.7 - 6.4 mm (0.188" - 0.250"). The counterbore depth will probably be deeper than this to allow for combustion chamber design and to meet valve head recession specifications.
- Some cylinder heads do not have room to install VSI with outside diameters larger than the valve head outside diameter.

Inserting the VSI

- Verify that the VSI dimensions are correct for the application.
- Verify that the counterbore dimensions are correct for the VSI.
- Make sure the counterbore is clean and free of swarf and other debris.
- Use a seat installation tool to insure the VSI is inserted squarely into the counterbore.
- Use a flat and square VSI driver tool whose size is slightly smaller than the outside diameter of the VSI.
- Use the correct size valve guide pilot when using the VSI inserting tool.
- Insert the VSI with the radius or chamfered edge down.