



Valve Application Note

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Insight Into a Proven Carbon raptor Application

Valve wear is a problem for nearly every type of racing engine. Wear hurts valve sealing, causing horsepower loss that can only be recovered by remachining or replacing valves, seats, or guides. Leading racers and engine builders turn to Carbon Raptor®, to cut those losses.

Longer Seat Life

Valve sealing losses can be traced to metal to metal, or fretting, wear caused when the valve impacts the cylinder head seat insert. Seating impact also tends to move or deform metal on the seat angle. Titanium valves are more flexible and are softer than steel valves, resulting in greater wear and damage to the seat area.

As titanium valves are lightened or as spring forces are increased, intake valves cup after they seat, causing greater wear on the valve and seat inserts.

Carbon Raptor is applied to the valve seat area to combat fretting wear and seat angle deformation. Carbon Raptor is a hard coating containing semi-crystalline and graphitic carbon. Its high hardness and low friction protects the seat area, cutting power loss in half at the end of a 400 mile race. Valves in Figure 1 are uncoated and coated titanium intake valves from the same engine shop and run in the same races but different engines.

Less Wear On Seat Inserts

Carbon Raptor coated valve seats also reduce damage and wear rates to cylinder head seat inserts compared to uncoated valves. The benefit is a longer life for original seat insert shape



Fig. 1 – Identical valves, run under identical conditions. Uncoated on left, coated on right.

and intake flow pattern. Another benefit is less seat insert re-machining when cylinder heads are freshened.

A Better Stem Coating

In traditional designs the manufacturer undercuts part of the stem several thousandths of an inch, applies a molybdenum or stainless steel coating, then regrinds the stem to the required diameter, roundness, and finish. Spray metal coatings have varying degrees of porosity in them, which trap oil, but also are rough surfaces wearing against the guide.

Some engine builders are concerned about the undercut, perceiving it as a weak point. Unlike Carbon Raptor, a

metal stem coating is a stressed, thick, brittle film, and it has been known to flake off into the engine.

Carbon Raptor is applied to stems produced without the undercutting and metal coating. Engine builders report Carbon Raptor coated stems significantly improve valve stem and guide life.

Carbon Raptor Facilitates Smaller Diameter Stems

Eliminating stem undercutting also will help facilitate making the stem hollow or making it a smaller diameter, all for a stronger yet lighter valve. By not undercutting and applying Carbon Raptor, the stem retains its original dimensions and strength, an important feature as stem size decreases.

Another benefit is that valve manufacturing steps are simplified by eliminating the sequence of undercutting, spray application, and regrinding to finish dimensions. Manufacturing processes can focus on grinding the stem to dimension and geometry and then finishing. Carbon Raptor adds 2 microns, or 80 millionths inch to the surface, which can be accommodated with guide sizing or stem machining.



Coating options include the tip, head, stem or the entire valve to suit your application.

Preserves Titanium Valve Tips

Titanium valves with 7 mm or smaller stems are too thin for steel tip inserts. Steel lash caps are used to buffer the wear action between the rocker and the titanium valve tip. However, lash caps often cause high wear on the stem and have been known to friction weld the valve tip to the inside of the lash cap. The valve assembly is then difficult to disassemble. Stem wear reduces the valve's ability to accept opening and closing loads.

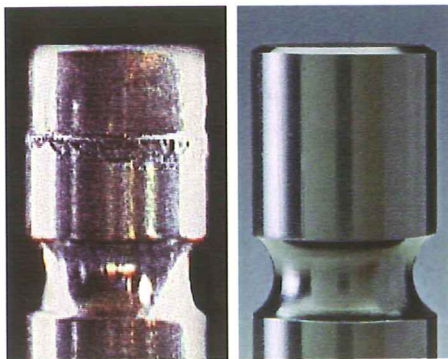


Fig. 2 - Worn uncoated valve tip at left. New coated tip on right.

Carbon Raptor® applied to valve tips prevents the lash cap from galling or sticking to the valve tip, making disassembly easier and minimizing tip rounding, see Figure 2. Easier disassembly of lash caps reduces the potential for damage and valve train failures. Carbon Raptor lengthens tip life, enhancing overall valve life.

Adhesion

A coating is only as good as its adhesion. The plasma enhanced chemical vapor deposition (PECVD) process used to apply Carbon Raptor is unique in its ability to produce physical and chemical bonding to the substrate for high adhesion and extended valve life.

Lubrication and Friction

Carbon Raptor neither sheds nor retains oil. Although metals used for stem coating are lower friction than titanium, they

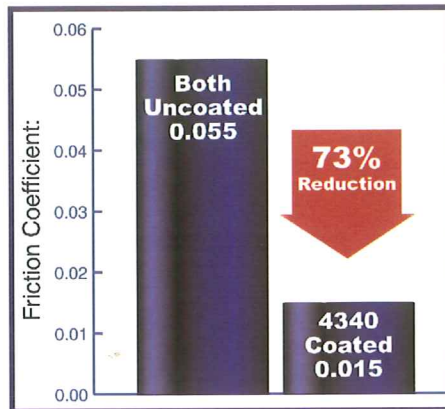


Fig. 3 Friction Reduction - Test Conditions:
Materials - 4340 Steel vs 8620 Steel.
Castrol® Synthetic 20W50 Oil @ 175°C (347°F)

are only marginally lower than metals such as steel. Carbon Raptor, however, eliminates three fourths of the friction experienced with uncoated steel, a reduction unmatched by any other coating, see Figure 3. Valve stems, first microfinished, then Carbon Raptor coated, require less oil than metal coated stems. Carbon Raptor, successfully preventing galling on wrist pins in thousands of race engines with low oil volume and viscosity, works the same way on valve stems.

Preserves Valve Angle Integrity

Valve head dimensions and angles play an important role in cylinder head flow and are important to maintain with any wear coating. Carbon Raptor does not fill in angle edges, but instead preserves the sharp edges, fully preserving intended cylinder head flow.

Improves Steel Valves, Too

Although steel valves have lower wear rates than titanium, wear nevertheless affects engine performance. Carbon Raptor applied to steel valves reduces seat wear rates, thereby reducing performance losses during a lengthened valve life.

Other Properties

Some of Carbon Raptor's industry leading properties that combine for success on intake valves:

High Hardness - Surface hardness is more than 35 percent greater than $R_C 60$.

Flexibility - Unlike metal coatings, Carbon Raptor is flexible. It will not chip or flake away as the valve flexes in use.

High Surface Conformance - Highly finished valves retain their finish with Carbon Raptor, with no post-processing steps. Measurements on a polished surface with an average roughness (R_a) of 0.5 microinches increased by only 0.05 microinches after Carbon Raptor was applied.

Heat Transfer - Unlike other coatings, Carbon Raptor is a good thermal conductor, lengthening the life of components by spreading heat away from hot spots.



State-of-the-art vacuum plasma technology assures consistency and reliability.

Carbon Raptor® - Successful on more than a dozen engine parts!

Demand Carbon Raptor for demanding conditions!

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