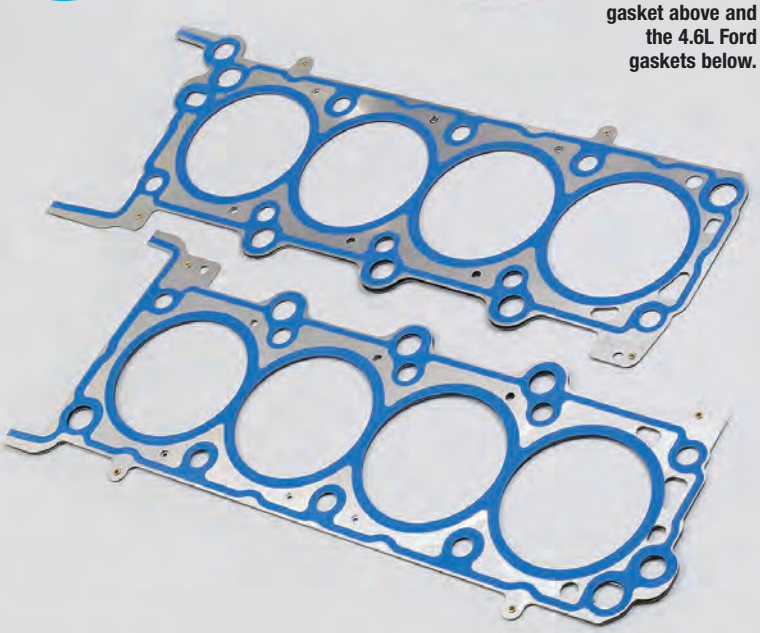
# MULTI-LAYERED STEEL GASKETS

The evolution of coatings shown on the BMW gasket above and the 4.6L Ford gaskets below.



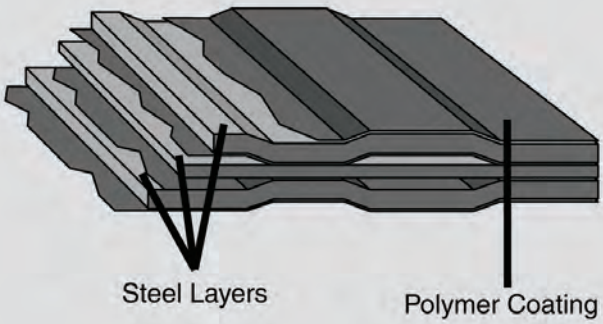
BY **BILL McKNIGHT**

In 1991, Ford introduced the 4.6L OHC V-8, commonly referred to as the Modular Ford V-8. It had, for the time, a revolutionary new head gasket design called MLS. Prior to that, most head gasket were steel core designs with some sort of gasket paper attached to the core, so this was a big change for the engine repair/rebuilding industry. Bill McKnight, MAHLE Aftermarket's training manager, remembers going around the country doing seminars for customers and the hot topic back then was MLS gaskets and how to insure they sealed properly. By the late 90's virtually every automotive engine in the world had MLS head gaskets and now in 2014, we hardly ever give them a second thought.

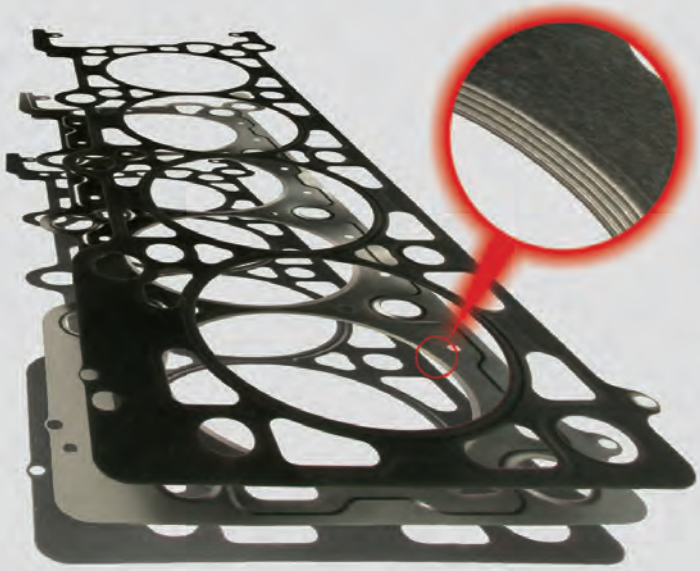
McKnight shares with us the inside story on MLS gaskets:

MLS actually stands for Multi-Layered Steel and describes the construction of the gasket. MLS gaskets usually have at least three layers.

**The two active layers and the passive layer are shown in the illustration below.**




**You can plainly see the multiple, concentric rings.**



The inner layer, sometimes referred to as a passive layer, serves three general purposes. It provides a means of getting the proper thickness for the gasket, it provides a layer for the top and bottom layers to push against and in most designs, provides extra thickness around the cylinder to insure good combustion seal. That extra thickness, often referred to as a "stopper", can be as simple as a folded over layer, or a laser welded thickness (Fel-Pro's Laserweld™ process) or in the case the Bugatti Veyron™, something called the Wavestopper™ design. *(continued)*

# MLS GASKETS

BY **BILL McKNIGHT**

This patented design by Victor Reinz uses raised, embossed, concentric rings around the combustion chamber. Each ring acts as a stopper, but provides a variable sealing based upon the load on the head gasket. Developed for the world's fastest and most powerful production car, Victor Reinz has used the design for performance gaskets fitting the 4.6L Ford and the 6.6L DURAMAX™.

The outer layers, referred to as active layers, are tempered stainless steel. They have raised beads, called embossments, surrounding the critical sealing areas. This would be, of course, the combustion opening, the water jacket openings and in the case of OHC engines, the oil passage from the block to the head.

When you installed the head on the engine and start to tighten all the fasteners, aka headbolts, the spring steel beads of the active layers resist flattening out and push back against the passive layer on one side and the head or block on the other. It is this spring pressure that creates the seal and also gives the ability for the gasket to keep sealing as the engine runs and the heads actually lift off the block. We're speaking of sealing combustion pressures of 1200 psi or more here, so this is a big deal. In the head gasket business, we refer to this as cylinder head lift-off and cruising down the highway, this is going on a thousand times a minute the entire time you are driving, racking up millions of cycles over the life of the engine! The MLS gasket relaxes and compresses every time this occurs. Make the stainless steel too soft and the gasket fails. Make the steel too hard and the gasket cracks and fails. It takes a skilled gasket company to get it right, every time.

Now if our engine had no coolant and no oil that needed to pass through the head gasket, we could stop our conversation right now! Because that's not the case, we have another enhancement to MLS head gaskets that is absolutely required to make them work. That would be "rubber" coatings. Now calling these coatings "rubber" is kinda like calling LeBron James a "basketball player"! Neither term gives justice to what we're talking about. Our rubber is actually carefully compounded, carefully tested, skillfully applied polymer coating. It gives the gasket the ability to seal fluids perfectly through the millions of cycles we mentioned above!

When the first generation of MLS gaskets hit the market, concern was widespread because the surface finish of the head and block had to be literally as smooth as a sheet of glass in order for the gaskets to seal. Many machine shops didn't have equipment to get the desired finish and even fewer shops had a measuring tool to measure the finish. What was driving this finish requirement was the quality of the early polymer coatings used on the gaskets. Ra of 10 micro-inch (average rough roughness of 10 millionths of an inch) was what we were looking for and that was literally "glass smooth"! Thank goodness technology has improved since 1991! Today we can tolerate readings of 40-80 RA for good MLS seal due totally to improved elastomers! This is well within the range of most good machine shops.

If the head and block are smooth, flat and clean, you're ready to install the head gasket. Please, don't even think of applying anything to the gasket to improve the seal. At Victor Reinz if a sealant is ever needed for a gasket, it'll be included in the box with the gasket. Some engines have a left and right head gasket and a few have a top and bottom or front and back, so look yours over carefully. Lay your gasket on

**You can see embossments for both the combustion cylinders and the coolant passages on this 6.0L Ford diesel head gasket.**

**This AJUSA head gasket illustrates the "full surface" application of the polymer coating. Contrast that to the "selective silk screening" method used on the 4.6L Ford shown earlier. There's not a right or wrong method, just means to an end!**

## MLS GASKETS

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the block making sure the locating dowels are in the block and that the gasket slips down over them. Carefully set the head down on the gasket, again making sure if fits over the locating dowels. We have engines like the DURAMAX™ that have different dowel diameters for different years so always make sure you check the details!

At this stage, you're ready to install the fasteners, aka head bolts, and tighten them to the factory specifications. We might digress here for a minute and mention that about the same time that MLS gaskets came along, so did torque-to-yield fasteners. Along with torque-to-yield fasteners came the associated technology of torque-turn-to tighten, a new means of insuring we had the desired head bolt load.

Here is a short version of what all this means… Basically, steel head bolts are elastic. Think of them kind of like a rubber band. You stretch them out and they want to spring back. It's that elastic tension that creates the load that compresses the gasket and keeps it compressed as the engine runs, temperatures change and the head tries to lift off the block. None of this was new! What was new was engineers recognized that the bolts had a yield point where they became permanently stretched. Tightening them to just shy of this point gave maximum load on the gasket — a good thing. Getting the bolts to just shy of yield required a more precise means of tightening than just measuring resistance of turn with a torque wrench, hence the introduction of torque-turn-to tighten, where we are measuring the angle of turn to tighten the fasteners. Think of how many times the engine in the vehicle has been started, driven, stopped, cooled and the re-started. Again, each of these cycles causes thermal expansion of the head, block and head bolts. Then think how many times the cylinder has fired creating head lift-off, which causes mechanical stretching of the head bolts. Now consider the labor involved to R&R a cylinder head for a bolt/fastener failure. Not replacing cylinder head bolts is an invitation for problems down the road!■

Bill McKnight has worked for MAHLE Clevite Inc for over 30 years. He ran the engine rebuilding training provided by Dana for 22 years, then moved to Clevite as director of training. Over the years at Clevite, he served as director of marketing, motorsports sales management, and in his current position as team leader of training. He has a master's degree in education and has served on the board of directors of AERA, program committee of PERA and as a technical presenter at both AERA and PERA. He's often found at the race track, especially NHRA and NASCAR events and loves engines that make lots of power!