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# TECH

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## ENGINE BEARING FUNDAMENTALS PART 8 "OVERLAYS"

In part 7, our discussion of trimetals dealt mainly with the various materials used in the intermediate layers. We did describe the overlay briefly as a layer of babbitt which is normally .001" thick.

**OVERLAYS** - Remember back in part 5 we said the term babbitt defines a family of soft "white metal" alloys used mainly for their surface properties. Keeping the overlay layer thin reduces some. of the problems associated with babbitt bearings, like very limited fatigue resistance and temperature sensitivity. There are really only two formulations of babbitt commonly used for bearing overlays today. The most widely used is an alloy of lead, tin and copper which is plated on the bearing surface to a closely controlled thickness with no subsequent machining. The second is an alloy of lead and indium. These metals are plated separately and the bearings undergo a diffusion process at elevated temperature which causes the indium to combine with the lead. Appearance of both types is similar with a light gray color and a satin finish from the plating process.

The nominal composition of lead-tin-copper overlay is 87% lead, 10% tin, and 3% copper. Lead is used for its relatively low cost along with its surface properties. Tin is used for its surface properties as well, but mainly to provide corrosion resistance to the acids which may form in an engine crankcase. The function of the copper is to add strength. At .001" thickness, this material offers a good compromise between strength and surface properties. Where extremely high loads are encountered, the overlay layer may fatigue. The term commonly used by mechanics to describe this condition is flaking. To reduce the tendencies of overlay fatigue in High Performance engines and in certain highly loaded diesel engines, overlay thickness is reduced to a nominal .0006". A slight reduction in surface properties dictates that more care be used in building these engines to ensure good surface finishes, alignment, and cleanliness. This is another of the trade-offs necessary when operating at a higher level of loading.

**BONDING LAYERS AND CHEMICAL BARRIERS** - If you have been paying attention to the chemical compositions of the overlay and intermediate layers, .you may have noticed that trimetal copper-lead bearings use the same three elements in both of these layers. Both are made up of lead, tin, and copper but in dramatically different proportions. If the overlay is plated directly onto the intermediate layer, we would bring dissimilar concentrations of these common elements together at the interface. When bearings operate inside an engine, they are exposed to elevated temperatures which tend to speed up chemical reactions. Since tin has a natural

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attraction for copper, the higher concentration of tin in the overlay would migrate toward the high concentration of copper in the intermediate layer. This would result in the formation of brittle copper-tin compounds at the bond line which weaken the overlay's bond to the intermediate layer.

The resulting reduction of tin in the overlay will also reduce its corrosion resistance. To prevent these undesirable effects, a "nickel dam" is used. A very thin layer of pure nickel (approx. .000050") is plated onto the copper-lead layer before the overlay is applied. The nickel dam forms a chemical barrier to prevent tin migration and preserves the chemical make-up and performance of the overlay.

Some material systems do not require a chemical barrier. For example, lead-indium can be plated directly over copper-lead. Although the indium will eventually diffuse through the overlay and into the copper-lead layer, the effects are not detrimental. Lead-indium overlays, however, offer poorer resistance to wear than lead-tin-copper resulting in potentially shorter life.

Aluminum intermediate layers present an altogether different set of problems. The common overlays cannot be plated directly onto aluminum based alloys. A zincate layer must first be applied. This is generally followed by a plated layer of copper or brass. Some manufacturers then apply a pure nickel layer before the overlay, and others plate the overlay directly onto the copper based layer. This system has a number of drawbacks, not the least of which is its additional complication. Without a nickel dam, tin migration to the copper barrier is a problem which will eventually weaken overlay bond strength and reduce corrosion resistance.

**FLASH PLATING** - Most trimetal bearings use what is called a "flash plating". This is an extremely thin layer (approx. .000030') applied all over to provide uniform appearance and protection from rust and oxidation in storage. The common flash platings are either an alloy of lead and tin ranging from 10 to 20% tin content or pure tin. Pure tin has a more whitish color while the lead-tin alloys are a medium gray color. Both have a satin finish. Although not quite as pretty as pure tin, lead-tin has superior bearing qualities for break in.

Lead-tin-copper with a nickel dam is the oldest and most widely used overlay system in use today. It provides the flexibility of meeting the needs of conventional, high performance and heavy duty applications with good surface properties and corrosion resistance as well as good wear resistance. Trimetal copper-lead bearings with a nickel dam also offer superior resistance to cavitation erosion, which is a form of premature overlay removal prevalent in some engines under specific operating conditions.

Next: "Camshaft Bearings"