Organic fibers also have potential. Aramids such as Kevlar and polyamides such as Nomex are examples of current organic fibers. These fibers have tremendous tensile strength and modulus, and yet some grades are relatively flexible. Although these materials begin degrading at 500 F, they do not disintegrate or gasify and at 2000 F have higher strength than asbestos and are being used in compounds in small quantities.

High strength or engineering ceramics have possibilities, too, although there are technical problems on how the ceramic fibers are bonded together. Ceramics are typically metal oxides, nitrides, or carbides and have a temperature range of up to 3000 F, and compressive strength which is more than twice that of asbestos. At these temperatures the binder systems disintegrate and it is necessary to still keep the ceramic together. In addition, ceramic fibers are 30 times the diameter of asbestos, so homogeneity is a problem; but for high temperature exhaust gas applications this is an acceptable alternative when blended with other fibers.

Coated metals will also find a niche. They have the physical strength of the substrate metals coated with a well bonded yet embossable sealing coating of nitrile or silicone. There is no wicking because of the solid steel barrier as well as good relaxation properties and good extrusion properties.

As a result of current programs, we can predict that in exhaust and turbocharger applications, graphite, ceramic fibers and fillers, and mica, combined with stainless steel substrates, will be popular materials. For cylinder head and intake manifold applications, we see the use of organic fibers and binders and inorganic fillers formed by a paper making process and also combined to metal substrates. Embossed steel or aluminum with high temperature coatings will continue to be used where engine structure permits.

In high load and high extrusion gasket applications, the most prevalent materials will be rubber coated steel, cellulose fibers with elastomeric binders, glass fiber with fillers and elastomeric binders, densified organic fibers and fillers with elastomeric binders, and liquid systems such as RTVs and anaerobics.

The final cost of non-asbestos materials is still not resolved. Material suppliers have been given a target of less than two times what we are paying for material today and most feel comfortable with this. Since the asbestos-free material makes up only a portion of the gasket's cost, the total selling price should be significantly less than twice current pricing. In the long term, it is expected that asbestos-free products with improved properties will sell for no more than current products — certainly on a total engine package basis.

The trick to replacing asbestos is to blend the fibers and fillers and polymers to reduce the cost and optimize the physical and chemical properties using multivariable analysis. And the initial results look excellent. Currently, asbestos free versions of Victor's popular Victocor, Solicor, Victopac, Corbestos, and Coramic materials are being sampled and tested by O.E. diesel and gasoline manufacturers in the U.S. and abroad and compare favorably in performance to existing materials. The current price structure is considered attractive.

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