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By John E. Zeitz

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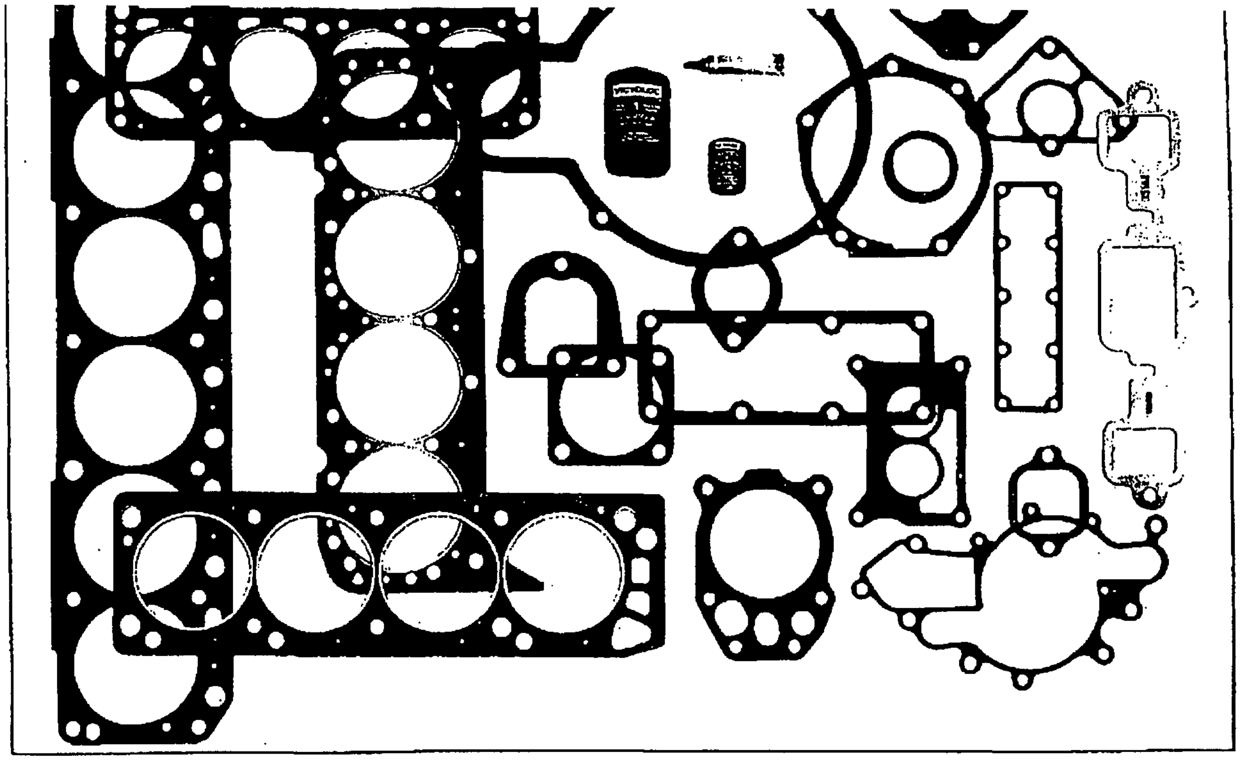

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GASKET suppliers and gasket material producers have been working for several years on programs to develop asbestos-free gasket materials for use in all the sealing needs of vehicular and industrial applications. And the tempo of this development is increasing.

Asbestos has been an important part of gasket materials since the advent of the internal combustion engine. It has a number of good characteristics, and has been used extensively. These good characteristics are the physical properties of asbestos, such as high heat resistance, excellent crush resistance, dimentional stability, and the ability to be produced into a homogeneous product.

The ability to produce a homogeneous product is greatly aided by the material's high surface area per unit weight, a factor as high as 60 sq. ft./gram (5.6 m^2/gram). Added to these physical properties, relatively low cost and ease of processing must be included among the advantages of asbestos.

However, there are a number of disadvantages with the material. First, there is growing emphasis on costly preventive health and control substance programs required for those handling the materials. There is also a growing belief on the part of influential users and producers of asbestos products, as well as outside groups, that the use of asbestos in automotive and other vehicles should be curtailed.

The cost of company-wide health programs and controlling the environment in which asbestos is handled is causing many to seek alternatives to using the product. One problem for all suppliers and users of asbestos products is how the end user disposes of the product. In the gasket business this is a particularly sensitive area because often the end user finds himself using a wire brush or scraper to scrape asbestos off of an engine part to clean up residue gasketing.

Unfortunately, it is the asbestos you cannot see that finds its way into the lungs. So unless special preventive health procedures are followed, the end user of asbestos gaskets may be in more potential danger than the personnel in the producer's facility. This could be particularly true in large volume engine rebuild operations.

Government regulatory agencies are keenly interested in seeing asbestos usage curtailed, or eliminated from industrial and commercial products. Though no timetables have been set, it is very likely a special license or waiver will be needed as early as 1985. And, by 1990, the use of asbestos may not be permitted under any circumstances.

It may be that government regulations alone may eventually force the elimination of all asbestos from areas where it is now used — including gaskets. The number of regulatory agencies controlling asbestos continues to grow. There are primarily six federal agencies concerned with asbestos. There are the Environmental Protection Agency (EPA), the Department of Transportation (DOT), the Consumer Protection Safety Commission (CPSC), the Mine Safety Health Administration (MSHA), the Occupational Safety and Health Administration (OSHA), and the Food and Drug Administration (FDA).

Among these six agencies, approximately 20 regulations have been promulgated to control

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exposure of asbestos from various sources. Added to these are the many international and state regulations, and the regulatory situation is certainly challenging.

Another disadvantage of asbestos is its scarcity. Compared to oil, the U.S. is more completely dependent on foreign sources for asbestos than it is for petroleum. Although general asbestos supplies seem adequate, the long grades such as number 4 and 5 fiber lengths used extensively for gasket materials have been in tight supply for the past four years.

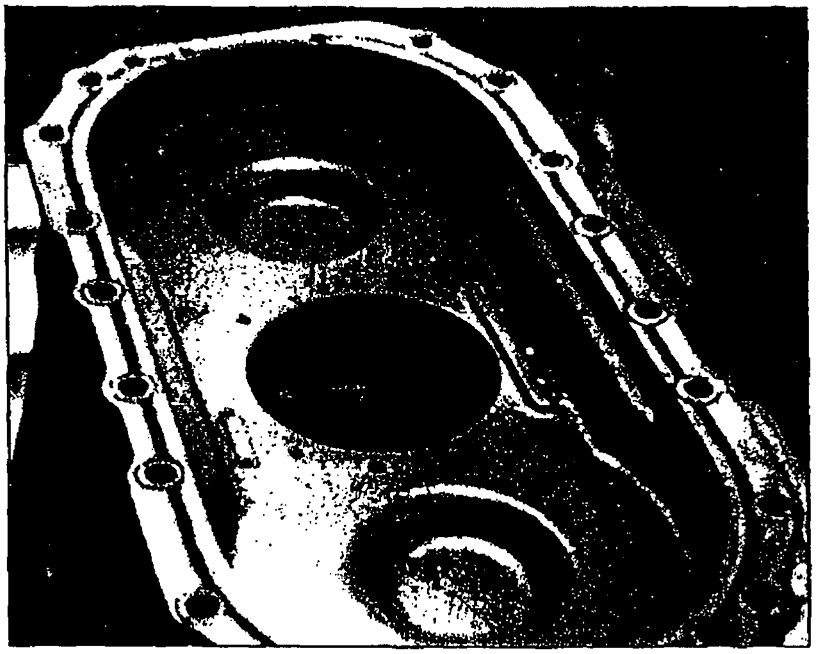
The final disadvantage of asbestos is that it does not always solve all the problems that it is asked to solve. In short, better heat resistance sealability and crush resistance are often required. Asbestos has served us well and will continue to do so but there are more and more demands for better solutions. At present, the majority of gaskets in the U.S. do contain asbestos. Most of them contain 80% asbestos in their composition with the rest being polymer binder systems and fillers.

The problem of replacing asbestos is of very large magnitude. However, before we get into reviewing what is being done to replace asbestos, we should probably consider what the asbestos suppliers are currently saying about the situation. They state very simply, that once the material reaches the consumer, the asbestos is locked-in by the various processes used in manufacture. Granted, this may be true, but it is very difficult for most gasket suppliers to verify that this condition continues throughout the use of the product when they consider the asbestos-contained material is typically sheared, torn, calendered, scraped, sanded, punched, burned, formed, compressed, and ground in its further manufacture and use as a gasket.

Because of the disadvantages mentioned and the lack of technical verification of the safety of the material when processed and used as gasketing, several major domestic users have embarked upon programs to eliminate asbestos gaskets from their product lines. Let's examine what asbestos-free materials will have to do when they replace asbestos products in gaskets. Replacement materials will have to have high-heat resistance, excellent crush resistance, dimentional stability, and homogeneity. As another reference point, we should examine those products currently available in the marketplace. These are cellulose, anaerobics, RTV, and rubber-coated steel.

A number of companies have eliminated asbestos gasketing, and gaskets in general, from their current assemblies. The General Motors Corporate V-6 has only two gasket applications in the engine: the cylinder head gasket and the intake manifold gasket. Both of these applications are with asbestos containing materials. Many transmission manufacturers are also eliminating gaskets from their assemblies and replacing them with liquid sealant to reduce the tolerances required for assembly. This permits them to develop quieter-running transmissions and gear boxes — another upcoming regulation.

Asbestos seems to be used in the majority of cylinder head applications and intake manifold applications, exhaust manifold applications, and a large number of extremely heavily loaded flanges. However, the critical requirements of these various applications are not the same from application to application. Cylinder head and intake manifold applications require materials having good homogeneity and the resulting conformability that permits a good fluid seal. Exhaust manifold applications require the high-heat resistance characteristics of asbestos and heavily loaded flanges require the crush and extrusion resistance of asbestos. So it is possible to replace asbestos in different ways for different applications. More importantly, it appears that if we could improve certain properties in certain applications, we could present design engineers and the marketplace with an improved product with greater appeal.



Anaerobic and other liquid sealants are one way to solve the problem of eliminating asbestos from many sealing products. Shown here is a 28 in. long housing with a liquid gasket seal ready for assembly.

For years gasket material producers and designers have attempted to improve the binder systems in gaskets. This work was done because the binder system appeared to be the limiting ingredient in gasket functional design. Little was done to improve the fiber characteristics and to obtain increased functional characteristics through this method. We are now looking at that 80% of the gasket which represents the fiber to see what can be done in replacing asbestos to improve its functional characteristics. However, to do this, one quickly finds that no single man-made fiber or other high temperature material approaches asbestos in its crucial physical properties. It is therefore necessary to blend materials to obtain the desired properties. The types of materials blended are mainly various fibers and fillers, although rubber coated steel is also considered an alternative.

Clay is one such filler. It is inexpensive, compressible in bulk, and fills the voids between the larger fibers of glass, nylon, or aramid. Clays are easily dispersed in mixtures of water. From a sealing point of view, the clay reduces the spring rate of the facing, and improves the load bearing capabilities. Temperature resistance is above 3000 F (1649 C).

Clay, when added to most materials, increases the surface area to the magnitude of asbestos. Clay has better conformability properties than asbesetos.

Mica is basically a filler, also, and has been used for years in the paper industry. Vermiculite is the thermal or chemically expanded form of mica which is very economical, has high surface area, and good temperature resistance (above 2000 F). It has relatively low strength, but good slip characteristics, caused by the low coefficient of friction of the particle. Mica has better torque and heat resistant properties than asbestos.

Graphite has the highest heat resistance of the materials presently under consideration with the tensile strength increasing until 4000 F and heat resistant above 5000 F. The material is very costly but can be used in layers. The unique low frictional characteristics of the platelets help where motion is a problem.

Glass fiber is another candidate. It normally endures heat to 1100 F, where softening and fusing takes place. However, it has good strength and the thinnest diameter or highest surface area of any man-made fiber. It will be used to reinforce mica, clay or barytes based compounds in the same way as aramids and nylons will be used.

In some applications cellulose fiber may be favored. But it is used very sparingly, if at all, in materials requiring high temperature resistance because of its low charring temperature. In applications where heat is not above 300 F, however, the fiber can be used as a successful carrier web or matrix for a variety of fillers.

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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