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Reversing the Rubber Vulcanization Process

Do you think it would be a good thing if the tires on a vehicle lasted longer? Truth be told, the carcasses of discarded tires are currently indestructible so they will never biodegrade. If their final resting place is in a landfill, they will be around forever. (See Photo 1.) Since tires have been in use for such a long time, stockpiles of discarded ones in the U.S. alone have grown to number over 2 billion. Some solutions have marginally addressed the problem, but up to now the quickest solution has been to burn the discarded tires as a fuel.

The solutions that have marginally addressed the problem include using them basically unchanged to build artificial reefs, as collision energy absorption barriers for highways, and as dock bumpers. The use that you see most often is tire particles combined with other materials to create shock-absorbing playground surfaces and sports arena floor mats. Less known is their use in asphalt mixtures to resurface roads and as an elastic aggregate in some concrete mixtures to modify concrete brittleness. (See www.astm.org/DIGITAL_LIBRARY/JOURNALS/CEMENT/PAGES/CCA10447J.htm) In everything mentioned above, the individual rubber particles don't actually bond with other rubber particles in the product.

While researching the topic for this month's column, I was surprised to learn that the U.S. Environmental Protection Agency sees the burning of discarded tires as an environmentally compliant solution. "Currently, more than 80 facilities in about 30

states incinerate scrap tire material for energy recovery. A total of 130 million scrap tires were used as tire-derived fuel (TDF) in 2003, up



EPA Ohio Gov

Photo 1—In a landfill, these tires will never biodegrade.

from 25 million in 1990. ... In general, results from 22 industrial facilities indicate that properly designed existing solid fuel combustors can supplement their normal fuels (e.g., coal, wood, and various combinations of coal, wood, oil, coke, and sludge) with 10% to 20% TDF and still satisfy environmental compliance air emissions limits." (See www.epa.gov/osw/conserves/materials/tires/faq.htm#ques2)

But researchers who have been working on new technologies to recycle tires and other discarded rubber products seem to have made a breakthrough. Some of the companies at the forefront of this technology indicate that their process reverses vulcanization, allowing discarded rubber products to be truly recyclable. Time will tell if the processes these companies have developed will really solve the recycling of tires using new clean processes that don't hurt our environment.

The Fraunhofer Institute for Environmental, Safety, and Energy Technology UMSICHT in Oberhausen, Germany, has recently spun the technology for its rubber-recycling process into a new company named RUHR Compounds. RUHR is now working on bringing the Fraunhofer process to market. It seems a similar technology has also been developed by two American companies: Rubber Research Elastomerics Inc. of Minneapolis, MN, and RW Technology Inc. of Cheshire, CT.

Basically, each company is reporting that it has found a way to turn old vulcanized rubber into a powder that can once again be bonded together by the heat and pressure of an extrusion machine or the injection molding process. If these companies have found a process that can turn the clock back to the point that their recycled rubber particles act as if they were never vulcanized, we then have rubber particles that can bond

with other rubber particles that can be manufactured into high-quality products.

The Fraunhofer Institute never uses the term de-vulcanization when they describe their process. It indicates that high-quality products can be made using their EPMT (elastomer powder modified thermoplastics) compound that contains up to 80% scrap rubber. However, it feels that it is necessary to limit how much scrap rubber goes into its EPMT to guarantee that high-quality products made with it will have the same desired properties as if they were made only using new rubber. You can see many of the products that manufacturers are now producing using EPMT in Photo 2.

The two other companies men-

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tioned above have used the term de-vulcanization to describe how the powder that they have created has been restored so that their individual particles can once again form bonds when they are heated and pressure molded together. Time will tell if Fraunhofer is being conservative or the other companies are being overly liberal in their claims.

This description of the recycling process pulls together information from these companies and it therefore might include or leave out steps germane to each company's process. To get the rubber from an old tire ready, the steel and polyester in the tire must first be removed. So the tires are chopped up into very fine particles so industrial magnets can be used to remove the steel and large blowers and vacuums can be used to extract all of the polyester fibers. Fraunhofer uses liquid nitrogen to reduce the rubber to an elastomeric powder. It then adds polypropylene or other thermoplastic additives to this powder to give it the correct properties for it to be injected or extruded into products.

When I taught graphic arts, my demonstration of vulcanization was built around making rubber stamps. Students observed how vulcanization changed the rubber so it could no longer be formed into another shape



The Fraunhofer Institute for Environmental, Safety and Energy Technology UMSICHT

Photo 2—Using the Fraunhofer recycling process, higher-quality products can be made from recycled rubber.

and I accurately pointed out to them that this process was not reversible. Time will tell if these companies have nailed down a financially viable process that de-vulcanizes rubber.

Recalling the Facts

1. What is the significant difference between the old recycling method for vulcanized rubber and the new processes that have been developed by the companies discussed in this column?

2. If scientists prove that the rubber powder produced by these companies is actually de-vulcanized, how does this scientific advancement change what products can be manufactured out of recycled rubber? ©



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