Options in Scrap Tire Management

From retreading to tire-derived fuel to asphalt rubber, waste tire handlers are making it easier to keep tires out of landfills.

While previous Waste Age articles have discussed legislation and technology (August 1991), and markets (October 1991), this article focuses on the options, in addition to landfilling, that are available in scrap tire management. Each option has its advantages and disadvantages and specific equipment requirements. Only by really exploring these options and allowing for their development will scrap tire disposal management problems be mitigated.

Retreading

The retreading of scrap tires is one of the most important forms of scrap tire management as well as a recycling/reuse management option. Retreading is a recapping process that puts a new tread on worn tires and allows them to begin a new cycle of service. Retreaded tires are sold with all the same markings and characteristics as new tires and typically have the same manufacturer guarantees, performance ratings, complete line of tread designs, durability forecasts, safety standards, vehicle fuel efficiency, and aesthetics.

The Tire Retread Information Bureau (TRIB) reported in August 1992 that retreaded tires contain over 75% post-consumer recycled materials, one of the highest percentages of all recycled materials produced.

Computer-designed tread patterns and new rubber compounding technologies have contributed to advances in retreading, and as a result, TRIB says that it is not unusual for a retreaded truck tire to deliver more miles than a comparable new tire. For example, in 1991, according to a TRIB study, truckers purchased 15 million retreads and only 11 million new tires. TRIB also reports that there are over 1,700 retreading plants in the U.S. and Canada, approximately 95% of which are owned and operated by small businesses.

One advantage of retreading is that it avoids landfill space and minimizes the potential for illegal disposal. Because of this advantage, the U.S. EPA encourages the use of retreads by the public and private sectors and mandates the use of retreaded replacement tires on government vehicles. Furthermore, tires are manufactured from fossil fuels and require more energy to produce; retreading uses lower amounts of these resources and emits less pollution associated with this process than with tire manufacturing. (Excluding transportation requirements, retreading a tire uses less than 40% of the fossil fuel and energy of a new manufactured tire.) It should be noted that the retreading process emits certain volatile organic chlorides and chlorinated fluorocarbons, which according to retread industry officials, are to be controlled in the next five years.

There are two distinct dis-
advantages in the management consideration of retreading that have resulted in a decline for passenger retreads. First, retreads are viewed by the automobile tire buying public as being inferior to new tires. The second disadvantage is the cost competitiveness of retreads. New tires made in Asia and Eastern Europe are sold in the U.S. market at prices so low that passenger retreads cannot compete. Another cost consideration is the structural characteristics of the tire casing have prevented retreaders from utilizing some of the cost benefits of mass production techniques used by other auto parts manufacturers/recyclers. The lack of mass-production techniques has kept retreading in small-size processing facilities and has not allowed retreading to mature in larger, more economical facilities. In addition, retreading passenger tires requires a much larger capital expenditure than in previous years, especially with newer, better-developed tires.

Tire-derived fuel options

Tire-derived fuel (TDF) is being used as a supplemental fuel in boiler operations mainly as an additive to other fuels—primarily coal. Because TDF burns and has a heating value (Btu content) similar to coal, it is becoming a potential fuel source for combustion systems. TDF has the flexibility to be used in a variety of industries. The cement and pulp and paper industries are currently the largest users of TDF. Among the cement kilns currently using TDF regularly are Ash Grove Cement (Durkee, Ore.), Arizona Portland Cement (Rillito, Ariz.), Genstar Cement (Redding, Calif.), Hawaiian Cement (Ewa Beach, Hawaii), Holnam (Seattle, Wash.), Medusa Cement (Clinefield, Ga.), Monarch Cement (Humboldt, Kan.), Southdown (Lyons, Colo.), and Southdown/Kosmos Cement (Kosmosdale, Ky.).

A 1991 EPA report suggests that a reason more kiln owners do not use TDF is because doing so would require reentering the permitting process. However, a 1991 survey by the Scrap Tire Management Council (STMC) showed that 52% of regulatory officials and others involved in scrap tire management believed scrap tires will be used as TDF by 1993. Mike Miguel, director of business development for TDF for Centech, L.P. (West Brook, Ill.), a wholly owned subsidiary of Holnam Cement and Chemical Waste Management, estimates that “in the next one to two years, two to three times as many cement kilns will be using TDF as there are today.”

Additionally, there are many waste-to-energy (and other non-energy-recovery waste combustion) facilities throughout the U.S. that are currently burning tires with other solid waste through current disposal practices. Two of these are considered dedicated tire waste-to-energy facilities; both are operated by the Oxford Energy Co. (Dearborn, Mich.)—Modesto Energy Project (Westley, Calif.) and Exeter Energy Project (Sterling, Conn.). The two projects currently burn an estimated 15 million tires annually, or about 7% of the total number of scrap tires generated nationally. Oxford has two other such facilities on the drawing board—Mowapa Energy Project (Mowapa, Nev.) and the “Michigan” Project. But Oxford is in great financial difficulty, according to Bob Graulich, communications director, and it is not known whether it will survive. “This is what we get for being pioneers,” says Graulich. (According to an August 7, 1992, Oxford press release, a bankruptcy filing is “extremely likely.”) In Europe, there are two tire-burn plants—a small, no-energy one in Germany and the planned Elm Energy Project in England. With the exception of these dedicated tire waste-to-energy facilities, nearly all power generation facilities mix TDF with other fuels (i.e., TDF is used in conjunction with a primary fuel and is not being used as a sole source fuel).

The type of fuel-feeding and combustion systems dictate the size and purity requirements of the TDF. Some combustion systems do not require any size reduction and can feed the tires whole. This is the case for cement kilns (with preheaters) and waste-to-energy facilities. Most others require size reduction and extensive removal of the ferrous metal. This size reduction of tires is often referred to as a “chipping” process and it makes “chip” rubber.

For most solid-fuel, stoker-fired boiler systems, the TDF must be sized at 2 in. x 2 in. or less and must be 95% deaired. Stoker-fired boiler systems are typically used in the pulp and paper industry, and other industries and institutions where steam and/or power generator requirements are low (under 500,000 pounds per hour, per boiler). For most cyclone-fired boiler systems, the TDF must be sized at 1 in. x 1 in. and almost completely deaired. For pulverized coal-fired systems, the TDF must be reduced to 50 to 200 mesh size and must be completely deaired.

For typical stoker-fired combustion systems, whole tires are reduced to a 2-inch size using one shredder (or a series of
shredders), screening equipment, and then magnetic separation equipment (For manufacturers of tire shredders, see the guide in this issue). The magnetic separation equipment is required to remove the steel. A rotary screen separation unit can be used where the 2-inch sized material falls through the screen openings, while the oversized material is recirculated back to the shredder equipment. Because a significant amount of rubber is entrained with the ferrous, additional shredding and ferrous removal is occasionally used to recover more rubber.

Like retreading, an advantage of TDF—if burned—is that it avoids landfill disposal, although the remaining ash and ferrous steel materials are required to be disposed or sold to the ferrous scrap market. (It should be noted that tires, when burned, generate very low amounts of ash and, on an energy basis, tires generate similar amounts of ash as coal.)

Furthermore, because TDF combustion generates energy in the form of steam and/or electricity, it displaces the need to generate energy from other power generating facilities and from other fuels, usually coal. This displacement will not only offset the use of certain fuels but will also offset the pollution emitted from other fuels. TDF combustion can emit less sulfur dioxide and nitrogen oxide than most types of coal on a net energy output basis. However, on particulate emissions, depending on the combustion system, TDF may emit greater amounts than coal.

The TDF option may be the most economical of all scrap tire management options and the one with the most potential. Michael Meagher, manager of business marketing for Browning-Ferris Industries (Houston) says, “While we are continuing to look at all options, the only market we feel is big enough is TDF.” The TDF processor must, however, be a close-hauling distance from the scrap tire source. Other factors need to be considered such as cost at the TDF user’s facility to modify the fuel-feed system, the combustion system, (possibly) the air pollution control system, and/or the air permit. Also, fuel and energy prices have and will continue to have a significant impact on TDF’s ability to be an economical supplemental fuel to a coal-fired boiler.

Asphalt/rubber road construction

Scrap tires can also be processed to make “crumb” rubber. The main use for crumb rubber is in road construction paving applications. There are two main types of paving applications, one known as asphalt rubber, and the other as rubber modified asphalt concrete (RUMAC). Asphalt rubber is produced when crumb rubber is blended with asphalt cement at high temperature, and is used as an overlay to repair cracked roadways. RUMAC is produced by using crumb rubber in asphalt paving mixtures as an alternative to the conventionally used stone or sand aggregate material.

Generally, crumb rubber is prepared by reducing scrap tires down to the size of 10 to 40 mesh (about 6/100-inch or less) pieces and removing 99% or more of the steel and fabric from the scrap tires. Crumb rubber as small as 100 mesh, which is known as a powder, can also be produced; however, the process(es) involved are currently much more expensive than the process for producing the larger-sized crumb rubber. Thus, the powdered crumb rubber is not economically practical to use in asphalt paving applications. Crumb rubber is typically produced from whole tires under ambient temperature conditions for asphalt paving applications although cryogenic (sub-zero temperature) conditions can also be used. It can also be made from shredded tires, from buffings (a byproduct from retreading tires), or in some combination with whole tires.

The process includes grinding or shredding equipment for reducing the size of the rubber, separation equipment for removing the fiber and the steel, and screening equipment for separating the smaller-sized rubber pieces from the larger pieces (so that these larger pieces can be further reduced in size).

There are typically three stages used to make crumb rubber: primary, intermediate, and fine. In the primary stages, whole tires are reduced to 2-4 inch size by a slow speed shear shredder or a series of shredders. In the intermediate stage, the pieces are further reduced to less-than-1/4-inch pieces by cracking and grinding rubber rolls, screens, gravity separators, and aspiration equipment. In the fine stage, crumb rubber is produced and is about 6/100 inch in size by grinding rolls, vibrating screens, and aspiration equipment. The final product contains less than 0.5% total fiber and steel.

An advantage of manufacturing crumb rubber from scrap tires for use in asphalt paving applications is that it avoids disposal of the tires in a landfill. However, the steel and the fabric removed from the tires, if not sold to secondary markets, would have to be disposed in a landfill.

Another advantage of this option is that it can be used in conjunction with other options. Most of the equipment used in manufacturing crumb rubber can be operated to make TDF or other tire-derived products such as molded rubber products.

The demand will rise, says BIT’s Meagher, if proposed federal highway transportation legislation goes through, which will require the use of rubber-modified asphalt in 5% of the highways under construction by 1994—with increased percentage thereafter—as a prerequisite of getting federal funding.

Current use of asphalt rubber and RUMAC is limited mostly to experimental project applications; therefore, most
of the results are preliminary. Some of the results reported have shown the advantages of using asphalt rubber over conventional asphalt materials. These advantages include increased flexibility, traffic noise reduction, and improved crack-resistant characteristics. Reported advantages for using RUMAC include that it is a lighter material and has more volume than conventional asphalt so that more paving material per ton can be produced. Other reported advantages are that it has shown evidence of superior fatigue-life performance, increased skid resistance, decaying qualities, and traffic noise reduction. Positive results on the use of asphalt rubber have been cited by Arizona, California, Texas, and Washington. Positive results on the use of RUMAC have been reported by Alaska, California, Montana, and Massachusetts. New York has reported some problems with the use of RUMAC at two test sites, including the "stickiness" of the mixture causing it to stick to equipment.

According to several sources, the cost of asphalt rubber has been found to be about 30% to 100% higher than for conventional asphalt mixtures. The higher cost is due, in part, to the processing of the crumb rubber itself, added energy consumption and plant maintenance required for the asphalt mixed with rubber, and added cost for heavier-duty pumps to handle a material of greater viscosity than conventional asphalt mixtures. However, it is believed by some users of asphalt rubber that, in the long term, costs are comparable to those for conventional asphalt pavement because of the positive characteristics of the material, including increased longevity. One engineer for the city of Phoenix Street Transportation Department believes that the asphalt rubber hot mix used as an overlay on cracked pavements could last up to 12 years as opposed to 6 years for a conventional asphalt pavement overlay.

There is currently very little information on the long term environmental impacts of RUMAC or asphalt rubber pavement applications. Two states have performed tests to determine the leaching effects on shredded tires used in sub-grade areas of road construction structures.

For the leaching tests performed on shredded tires used in sub-grade road sections in Minnesota, the groundwater samples taken at the test site had high metal concentration results in excess of the recommended allowable limits (RAL) for drinking water. From these results, it was recommended that shredded tires not be used in areas that could retain water. In a study in Wisconsin, leaching tests indicated that shredded tire samples were not likely to be considered as hazardous waste. With continued leaching, however, some metals (barium, iron, manganese, and zinc) showed increasing concentrations. Because of these results, it was recommended that tires be used in locations above the water table and not in areas in contact with open water bodies.

Because the leaching properties of shredded tires used in sub-grade surfaces may be different than those of asphalt containing crumb rubber used above grade, there are no conclusions that can be stated on the leachability of crumb rubber asphalt.

Options for shredded and crumb rubber

Sewage Sludge and Composting. Researchers have been studying the use of rubber as a bulking agent in sewage sludge composting. Tire chips have been used with and as a substitute for wood chips in this application. The high cost and availability problems with wood chips have motivated researchers to explore tire chips for this use. At Rutgers University, Professor A. J. Higgins has found that shredded rubber cannot be used by itself as a bulking agent for sludge, but works successfully when mixed with sawdust.

In Windsor, Ontario, tire chips were used for about eight years as a bulking agent at a sewage sludge composting facility. The composting operation was shut down about two years ago because of complaints from a new building development about the odor problems. The sludge is now stabilized with lime and used on farmlands in the vicinity.

When the Windsor facility was using tire chips as a sludge composting bulking agent, the tire chips were taken out of the compost after each cycle and reused. The wood chips would decompose after about three cycles and had to be replaced by new wood chips. Thus, tire chips saved the facility money. According to a staff member at the facility, the use of rubber chips was very successful, and the shutting down of the composting operation was not related to this. The compost was used for landfill cover, for landfill closures, and by the parks department as a soil amendment in public parks.

Lightweight Fill. In September 1990, the city of Minneapolis placed about 2,500 cubic yards of tire shreds on top of an underground parking ramp at the new Minneapolis Convention Center. The University of Minnesota was granted $45,000 by the state to conduct a two-year study on the use of shredded tires as lightweight fill. Specifically, to understand some of the engineering properties of shredded tires used as an alternate to gravel or sand. It was found that the load on the underground parking ramp was approximately 70% less dense than it would have been for conventional fill material, and therefore determined to be inadequate.

Oil and Heavy Metal Absorbent. At the University of Minnesota, a study was carried out on the use of chipped tires as a floatable absorbent to be used in oil spills. The product is called surface modified rubber. The rubber will absorb up to three times its weight in crude oil within minutes after being applied to an oil spill. In addition, after more than a day, the rubber will absorb up to eight times its weight in oil. Preliminary tests show that the rubber will float almost indefinitely.
It will also decompose at a very slow rate, and therefore could hypothetically be left in place for years.

After the rubber is used at an oil spill, the oil can be extracted and the rubber can be reused to absorb up to 80% of the oil that it originally absorbed. In addition, the tire chips can be burned as fuel or, if the oil is removed, used in rubberized asphalt applications.

Landfill Drainage. In Florida, landfill operators are allowed to use scrap tire chips to aid drainage in the bottom of their new landfill cells. In Iowa, a company called Rosebar Tire Shredding is working with an engineering firm to determine the feasibility of using the tire chips as part of a leaching program in landfills.

Other uses for shredded and crumb rubber are for artificial reefs/breakwaters, soil enhancement, railway pads, and fabricated products. Altogether, these other options use only about 5% of the total scrap tires generated.

So many options, what effect?

The June 29, 1992, Financial Times of Canada reports that in the three years since the Ontario government instituted a $5-a-tire surcharge to encourage tire recycling, $120 million in tire taxes have been collected. Unfortunately, only $5 million have been spent on tire recycling projects, with the remainder going to general revenues. The explanation given is that the markets for tire-rubber products are not well-developed and so, in spite of the enormous tax revenues, most of Ontario tires continue to go to landfills.

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