



Auto and Truck Tires and the Environment

Quantitative

PURPOSE

- Calculate the energy available from burning tires to generate electricity
- Compute reductions in sulfur dioxide emissions from burning tires in place of coal for cement production
- Propose ways of conserving and reusing tires

INTRODUCTION

Drivers in the United States discard approximately 280 million tires per year, and the total number of cast-off tires now approaches 3 billion. When these tires are discarded, they collect water and breed mosquitoes, which can spread diseases such as malaria, St. Louis encephalitis, West Nile virus, and dengue. Even when buried, tires can work their way back to the surface.

Most tire piles are outdoors on open ground, where they pose a serious fire hazard. A tire pile in Winchester, Virginia, burned for nine months in 1983. In this fire, 7 million tires burned for 275 days, and 690,000 gallons of oil

Fig. 31-1

Most states have programs to remove the billions of tires that have been stockpiled in tire piles or just abandoned across the countryside.



running off from the fire were collected and sold for \$184,000. One of the largest sites, in Stanislaus County, California, had tires piled as high as six stories. In 1991 it held over 30 million tires. By 1999 it was down to about 7 million tires when lightning started a fire that burned for over a month. Fire would not ever have started at a tire pile near Hamden, Connecticut, where 15 million tires are stored underwater in a flooded quarry—an approach that also prevents breeding of mosquitoes.

One way to remove a pollutant or waste product from the environment is to make it into a profitable commodity. There have been many creative ways to use old tires in an attempt to reduce tire piles. Tires have been used in the making of artificial reefs off the coasts of New Jersey and Delaware. They have been ground up into pieces, called **crumb rubber**, that are a few millimeters in diameter and used for stabilizing hillsides and as a conditioner for soils, increasing the soil porosity and improving plant root growth. Crumb rubber is mixed with paving asphalt to improve the durability of highways. Whole tires and crumb rubber are used as fuels for power plants and cement manufacturing. There are many other uses for this overlooked resource.

Fig. 31-2

California Tire Diversion Rates (in millions)

The California Integrated Waste Management Board—2003

Year	Estimated Number of Tires Generated	Reused	Recycled	Retreaded	Tires to Fuel	Number of Tires Diverted	Percent Tires Diverted
1997	33.2	1.5	5.4	2.8	9.0	_____	_____
1998	33.8	1.5	9.1	2.8	7.5	_____	_____
1999	34.0	2.4	10.1	2.5	7.9	_____	_____
2000	34.5	3.6	13.0	2.4	5.2	_____	_____
2001	34.8	1.5	14.9	2.4	5.2	_____	_____

- Reused** Tires that have a lot of tread left and can be resold as used tires.
- Recycled** Tires mostly ground up into “crumbs” and reused in many applications.
- Retreaded** Tires with good sidewalls, processed to get a new tread surface. (Air Force One, most buses and taxis, and a high percentage of trucks all safely use retreads.)
- Tires to Fuel** Tires that are burned, either as whole tires in the making of cement or as crumbs in power plants. They can also be processed into oil to burn industrially.
- Tires Diverted** The total number of tires removed from the piles by reusing, recycling, retreading, or burning as a fuel.
- Percent Diverted** The percent of all the tires removed from the piles.



Show all your setups and use proper units.

1. As seen in the Tire Diversion chart, **Fig. 31-2**, recycling is the most efficient method of reducing old tires in recent years in California. Complete the chart, using the description of the various columns.
 - a. Plot the percent of tires recycled compared to the total number of tires generated each year.
 - b. Project what the percent recycled would be in 2004.

2. One tire can generate about 250,000 BTUs. The average American home consumes about 10,000 kilowatt-hours per year. Assume one BTU equals about 3×10^{-4} kWh and production of electricity from tires is 60% efficient.
 - a. How many tires would be needed to supply the 10,000 kWh per year?

 - b. Suppose 30% of the tires discarded in California in 2001 were burned for electric power at 60% efficiency. How many homes would that supply with electricity?

 - c. Assume 1 pound of coal produces 12,000 BTUs. How many tons of coal would be saved by using the tires instead of coal as the energy source? (1 ton = 2,000 lb)

3. Whole tires can be used as the energy source in kilns that make cement by heating limestone to over 2,500° F. At temperatures that high, no toxins are released, and the steel in the bead and belts of the tires is converted to iron oxide, which is necessary in the making of cement. Any small amount of ash that would be released is incorporated into the cement. By this process, a single kiln can use 2 million tires per year, saving more than 2 gallons of oil, or 25 pounds of coal, per tire used.

One ton of coal produces 80 pounds of sulfur dioxide, a major cause of acid rain. But tires have much lower sulfur concentrations than coal. By using tires in a cement kiln instead of coal, how many tons of sulfur dioxide are kept out of the environment?

4. One way to keep tire piles from being a problem is by conservation. By allowing our tires to last longer, they do not need to be replaced so quickly. The major cause of increased tread wear is underinflation. Driving on a tire that is 20% underinflated can reduce the life of the tire by almost 10,000 miles. It also lowers the fuel economy of your vehicle by 4–5%.

a. The average normal tire will drive 45,000 miles. If the tire is 20% underinflated, how far can it be driven under otherwise normal conditions?

b. Assume the average driver puts 15,000 miles a year on his tires. There are about 140 million cars in the United States. If 50% of them had on tires 20% underinflated, how many extra tires would be needed?

5. Last year, about 30 million tires were shredded for civil engineering projects.

a. Describe how shredded tires can be used as a soil conditioner for athletic fields and golf courses.

b. Identify and explain two other uses for shredded tires.
