Nylon

Closing the Loop

Nylon cannot be melted down and used again, and recycling nylon requires it to be broken down into its constituent chemicals. But the process offers an alternative to sending billons of kilograms of nylon carpets to landfills each year in the United States alone. DuPont, Evergreen, and BASF Corporation have built nylon-carpet recycling facilities in North America and Europe. While the purification and remanufacturing processes do create some waste, this system (which recycles 25 million kilograms of carpet annually) is nearly a closed loop.

For the 1 billion tires discarded worldwide each year, numerous alternative uses are possible. Half of U.S. tire scrap is burned as fuel in cement kilns, waste-to-energy plants, and industrial boilers. Burning a tire yields about one-sixth the energy required to produce it, and doing so releases the carbon that constitutes 85 percent of a tire. More than half the tires discarded in California are patched up for further driving or shredded to become products such as insulation, playground cushioning, and mulch. A Connecticut public health study, however, warned in 2007 that tire crumbs could release carcinogenic chemicals into the air and ground water.

The leading alternative to nylon, at least for clothing, is polyester, but it also consumes significant oil during production. Although the manufacture of cotton foregoes fossil fuels, in the world's leading cotton-producing country, the United States, cotton accounts for a quarter of the country's energy-intensive, polluting pesticides. Despite recent increases, organic cotton production still amounts to a mere 0.03 percent of the worldwide total. Moreover, a Cambridge University study found that polyester materials consume less life-cycle energy than organic apparel, which require frequent washings at high temperatures, tumble-drying, and ironing. Perhaps a Nobel Prize in chemistry awaits the green chemist who invents a sustainable alternative.

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Nylon stocking quality inspectors, Marks and Spencer, 1955.

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Fresh from mechanical spiders: spools of nylon yarn.

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Nylon on the moon with Alan Shepard, 1971.

Overview

This October marks the month 70 years ago when the U.S. chemical giant DuPont announced "one of the most significant developments in the history of industrial research": the miracle fiber nylon. It was, they said, as strong as steel and fine as a cobweb.

Ironic, then, that its first application was in socks. Nylon first proved itself as a cheap alternative to silk in women's stockings, and demand quickly outpaced production. But World War II soon forced women to abandon them cold turkey; the "miracle fiber" was needed for parachutes, tires, tents, ropes, and ponchos. (Many of the wealthy turned to the black market, although some made their sacrifices: actress Betty Grable sold a pair of nylons for $40,000 in a war-effort fundraiser.) After the war, nylon production expanded for the clothing, carpeting, and automobile industries as the U.S. economy boomed. In 1969 it went to the Moon, in the astronauts' space suits and the flag they planted on the surface.

Production

Nylon production combines the highly toxic hexamethylenediamine and adipic acid, which accounts for 5–8 percent of global human-caused emissions of the greenhouse gas nitrous oxide (N_2O). The manufacturing process for all nylon products depends heavily on large amounts of crude oil.

Nearly 4 million tons of nylon were made in 2005. The United States is the lead producer of adipic acid and nylon as a whole, although China's nylon factories are quickly closing the gap. Overall production appears to be falling about 0.35 percent each year due to the rise of polyester. Nylon filaments, on the other hand, are growing in demand for tire production as China and India purchase more cars.