Plastic in discarded telephones can now be recycled into warehouse trays and molded parts for central office equipment. The recycled material is inexpensive, strong, and durable—and combines well with other plastics for special uses.

Recycling turns scrap phones into new plastic products

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MILLIONS OF TELEPHONES come back to Bell System service centers each year, many with their housings, handsets, and other molded plastic components bruised and battered. Some can be put back in shape by buffing, solvent polishing, or painting. Others wind up in piles, later to be carted away as land fill.

Recently, a team of engineers and scientists from Western Electric and Bell Labs decided to do something about this waste. They developed a way to recycle these plastics, most of which are ABS resins (butadiene-rubber reinforced styrene acrylonitrile copolymer).

Recycling serves three purposes:

- It conserves the petroleum-derived materials from which ABS plastics are made. These materials are in limited supply now and are becoming increasingly scarce.
- It eliminates the accumulation of waste materials that must be discarded or destroyed.
- It saves money for the Bell System by reducing the cost of materials for items that can be made from the recycled ABS plastics. These include central office equipment such as connector blocks, warehouse trays for Western Electric plants, and other items that require good mechanical properties at low cost.

Recycled ABS also can be used as a molding compound, with or without flame-retardant additives. For example, it can be combined with polyvinyl-chloride (PVC) resins and antimony oxide to make excellent flame-retardant plastics for molding connector blocks and other central office equipment.

Recycling involves separating the contaminants from the reusable plastic and processing it to impart the strength, resiliency, color, and other characteristics necessary for broad application. As a rule, the rejected plastic telephones are in very bad shape—beyond repair. They are abraded and scratched and may have had paper and cellophane tapes stuck on.

Recycling must also cope with the non-plastic items that are part of the working telephone—the cotton balls in the handset and the brass and steel inserts and screws in the housings. Removing these by hand and peeling off paper stickers would be prohibitively expensive. It would be cheaper to use new plastic.

The Bell System team's answer was to break the telephone parts down mechanically into tiny pellets. A hammermill or knife-blade granulator served this purpose very well (see the photograph on page 428), producing metal chips, bits of paper, dust, and plastic pellets.

A few words here about the plastic molding process will point up the necessity of separating out contaminants during recycling. Molding with injection machines involves forcing highly viscous molten plastic through a narrow gate under high pressure into a cavity. Careful processing techniques must be observed to avoid degrading the plastic. Under these circumstances, metallic chips are absolutely intolerable. They would obstruct the narrow gate at the entrance to the mold cavity, or score the polished inner surfaces of the injection barrel or the cavity. Paper and other light particles, though not directly damaging to the equipment, lower the mechanical performance of the finished product. The impact strength and yield strength of recycled plastic drop as much as 50 percent when the pellets are contaminated with these particles.

After evaluating many possible separation methods, both for results and economic feasibility, the team adapted a technique used by the food and mining industries. In this technique—commonly used to separate heavy ores from lighter soils or light grains from heavier stone pebbles—air blows down a vibrating inclined screen. When the mixture of crushed plastics, metal, paper, and cotton was placed on the screen, this method was found to work very well. In a test run of 10,000 pounds of crushed housings, not a single batch of plastic pellets contained metal particles of detectable size (see the left-hand photo, opposite page).

Early batches of pellets did include, however, some undesirable thermosetting plastics such as phenolics, which—having set with heat—would not remelt and would therefore clog up the injection molding machine. The phenolic plastic came from black phones that were manufactured by Western Electric until the early 1960s. Such phones are scarce today, but when they show up for recycling they pose a problem. One feasible and economical solution was to scrap all black phones.

The plastics development group also attempted to separate out the phenolics by passing mixed pellets of phenolics and other plastics through an extruder equipped with a screen. Because the thermosetting resin would not melt, the phenolic pellets were caught by the screen. The percentage of phenolic particles in plastic pellets is fortunately small, so this method was also judged economically feasible. Many piece parts were subsequently molded, and proved strong and durable.

Recently a screening nozzle was installed on the injection molding machine, furnishing what seems to be the most satisfactory solution of all. A high pressure is needed to force the molten particles through the nozzle holes, which measure only 0.03 inch in diameter. Under this pressure, phenolic pieces are apparently broken up and enter the mold cavity in particles no larger than particles of other fillers and additives found in commercial virgin resins. After many hours of successful molding from pellets containing phenolic particles, the screen was dismantled and only a few particles of phenolics were found. Another advantage of this technique is that cleaning the screen, though a simple and quick procedure, is not necessary as it is with extrusion.

Having developed these techniques for recycling ABS plastics, members of the Plastics Processing, Reclamation, and Prototype Molding group are now busily engaged in setting specifications for different compounds that can substitute for raw resins in many molded parts. Although all the recycled plastics studied so far have fairly uniform properties, their characteristics will need to meet certain critical requirements that differ with each planned use.

A small number of suggested uses are not practical. For example, recycled ABS is not expected to be made into items that are evaluated partly on the basis of color—such as telephone housings; it isn't possible to get the desired clarity of color because of the mixture of colors in the recycled plastic.

Impact strength also decreases with recycling, probably because the impurities in the mix create flaws around which cracks are likely to propagate. For this reason, recycled ABS plastic should not be used in critical applications that require high impact strength in severe environments.

For a large number of applications, however, this tough, durable material is economical and easy to use. It is already showing up, for example, in the rectangular trays—about 18 by 20 inches by 6 inches high—employed

Turning scrap into scraps. *Herb Kern of the Plastics Research and Development department feeds battered plastic telephone housings into a knife-blade granulator.*

From telephones to trays. *Among the products of recycled* ABS *made from telephone housings are warehouse trays. At Western Electric's Nashville Service Center, such trays are being used to store and transport more housings for recycling.*

Final sorting. *Heavy contaminants fall into the left bin and partially separated pellets that must be resorted into the center bin. Special equipment (right foreground) removes any remaining metallic bits from the pellets falling into the recycling bin.*

in many Western Electric plants to carry parts on conveyor systems (see photograph, above right). These trays, manufactured by an outside vendor, rate high in both performance and appearance. Another use contemplated for recycled ABS is as a substitute for the approximately one hundred million pounds of virgin PVC annually being made into plastic conduits for the Bell System.

Perhaps the only substantial shortcoming of the recycled ABS plastic resin is that it is not flame-retardant by itself, as PVC is. However, ABS can be made flame-retardant by the addition of chemical ingredients, at the cost of increased expense and a slight loss of the originally good overall properties. The new ingredient may be either PVC or flame-retardant additives. Since the cost of recycled ABS is low, the resulting flame-retardant ABS compound is competitive in price with other plastics such as PVC and PVC copolymers. Bell Laboratories has developed a mixture based on scrap ABS and PVC (with antimony oxide added) that could economically replace many flame-retardant plastics in connector blocks and other apparatus parts. Still another recycled ABS is being developed to replace the flame-retardant plastic based on virgin ABS that is now used in many internal parts of telephone apparatus.

The Bell System program of recycling ABS plastics is still at the beginning stage. The pioneering work continues at Western Electric, and the rate of production is expected to reach half a million pounds per year. The Nassau Recycle Corporation on Staten Island, New York, is setting up a similar reclamation plant. The amount that potentially can be reclaimed may total as much as 6 million pounds a year from scrap phones alone, and reclamation of other components is anticipated.

Plans are also being made to reclaim plastics other than ABS that are used in quantity in the Bell System. Some early recycling experiments have been conducted with thermoplastics—plastics that soften and resoften easily with heat. Preliminary results indicate that there will probably be no technical difficulties in reclaiming many kinds of thermoplastics used in the Bell System. □