

recovery show potential of increased efficiency and probable increased recovery of byproducts. (See section on cadmium).

Zinc competes with many alternate materials, principally aluminum and plastics, for major uses. In die-casting applications zinc is apparently on the defensive because aluminum and plastics are in good supply and price trends seem to favor such substitution.

Recycled scrap furnishes about 20 percent of domestic requirements. However, secondary recovery from some nondissipative end uses could be improved, notably in the die-casting area and specifically in such end-use items as appliances, automobiles, and industrial machinery.

Although zinc generally is mined from underground operations and there is no stripping waste problem, the solid waste and tailings piles represent a land use conflict problem in some of the more heavily populated areas in common with other mining operations for other commodities. Electrolytic zinc refineries present no solid waste problems since slimes are usually shipped to lead or copper smelters for further processing. Retort plants produce residues which require disposal, however, and plant stacks can give off heavy sulfur and other fumes which can add to the air pollution of urban areas. In common with other mining operations, the effects of mine subsidence is becoming of increasing concern to the public especially in view of the recent disaster in the Tri-State area.

At present there are few manufacturing facilities permitting galvanizing of large structural members, like bridge trusses, even though economic benefits through more effective corrosion resistance might result from such practice. The relative roles of zinc and other metals and coatings as corrosion inhibitors are not well established. Theoretically, major reductions in material demands should be realized through extending the useful life of end products before effective means of inhibiting corrosion is seen as an effective way to extend mineral supplies.

ZIRCONIUM

Zircon is the only zirconium mineral of commercial significance. At present it is imported in substantial quantities to accommodate U.S. demands. Domestic submarginal resources are very large. The coproduct relationship with titanium is important in the current economics of primary production of zircon. Development of techniques for selectively extracting zircon commercially without economic dependence on coproduct values or demand would improve the supply outlook.

The major use of zircon is in foundry sands where costs control the degree of competition from acceptable substitutes. Refractories also employ the mineral in specialized applications. A method for satisfactorily reusing zircon in foundry molding would ease need for increasing imports.

Zirconium metal attracts a majority of attention because of its relative recent emergence as a product of commerce and because of its properties, its high unit value and speculative significance in nuclear power applications. In this connection the mineralogical association of zirconium and hafnium in zircon is significant to the different supply-demand relationships of the two metals. Improvement in separation techniques would effect important cost reductions.

In almost every presently known end-use application substitutes may be employed with minor inconvenience or quality sacrifices. Accordingly, price will affect demand for any of the commercial forms—metal, hafnium-free metal, oxide or mineral. Process improvements that tend to reduce costs at any production stage from extraction through forming will significantly influence future demand and application. Conversely, zirconium may substitute for other substances (see section on tantalum) in less abundant supply, or find a variety of expanded applications where oxidation and corrosion resistance, low-neutron absorption and other properties may be significant.

Recovery from nondissipative end-use applications will demand attention in the future. Recycling of impure zirconium metal and alloy scrap presently is handled by retreatment through the chlorination, separation, reduction and melting stages. Pure hand sorted material is simply remelted with virgin sponge. If large quantities of material containing nuclear impurities become available less costly recycle methods probably will be required.