

# The Use and Market for WOOD in the ELECTROMETALLURGICAL Industry



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COVER PHOTO: View of a submerged-arc electric furnace as a mixture of ore and reducing agents — including wood chips — is introduced.

# The Use and Market for WOOD in the ELECTROMETALLURGICAL Industry

**W**OOD RESIDUES, particularly large chips, play an important role in the electric smelting of certain ferro-alloys. This is a report on the characteristics and growth potential of the market for wood in the electrometallurgical industry, including a brief account of how wood is used in electrometallurgical processes, a discussion of the preferred form of wood used, a description of plant locations and factors affecting the market, and a look to the future.

The information for this report was obtained from personal and telephone contacts with purchasing agents, metallurgists, plant managers, equipment manufacturers, government agencies, and university professors of metallurgy. From these contacts, a list was made of all known electrometallurgical firms in the United States that use wood. Plants in the upper Ohio River Valley were visited in early 1969, and all firms were interviewed by telephone in 1970.

## HOW WOOD IS USED IN ELECTRIC SMELTING

In smelting processes (fig. 1), which extract or reduce metals from their ores, wood is used as a reductant. In this paper wood is referred to as a woody reductant to distinguish it from the other reductants, coal and coke. Electric smelting is a continuous process in which a mixture of ore and reducing agents — wood chips, coke, and coal — is added into the top of an electric furnace at regular intervals (cover photo). Carbon electrodes submerged in the mix melt the material, which is periodically tapped from the bottom of the furnace.

The basic chemistry involved is the combining of oxygen in the ore with carbon from the reducing agents, thereby setting the metallic portion of the ore free. The carbon and oxygen form carbon monoxide, which escapes from the furnace as gas.

Wood constitutes 10 to 75 percent by weight of the furnace mix. This proportion varies according to the origin and particle

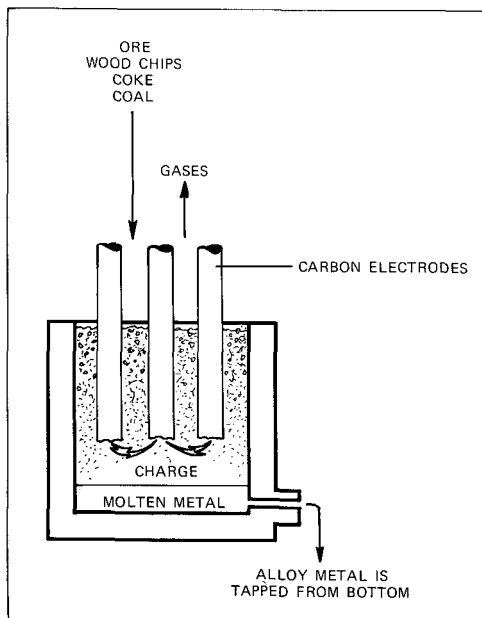


Figure 1. — Diagram of a submerged-arc electric furnace. The ore, wood chips, coke and coal — introduced at the top of the furnace — are mixed in varying proportions to produce the alloy desired.

sizes of the ore, the type and quality of the alloy being produced, the furnace design, the moisture content and size of the wood particles, and the artistry of the electric smelter. The metallurgy of electric smelting depends upon art as well as upon science. Hence the use of wood chips appears to reflect the individual metallurgist's or smelter's convictions as well as technological and economic considerations.

Although wood chips provide some of the carbon for chemical reaction, their primary usefulness in the charge is due to their bulk. Some of the reasons metallurgists cite for the use of wood in the charge are:

- To provide a large surface area for chemical reaction to take place more completely and at improved rates.
- To maintain a porous charge, thereby promoting gentle and uniform — instead of violent — gas venting.
- To help regulate smelting temperatures.
- To keep the furnace burning smoothly on top.
- To reduce conductivity.
- To promote deep electrode penetration.
- To prevent bridging, crusting, and agglomeration of the mix.
- To make possible the smelting of finely divided raw materials without sintering.
- To reduce dust, metal vapor, and heat loss; and as a result to improve working conditions near the furnace.

## **THE FORMS OF WOOD USED**

Throughout the United States the electrometallurgical industry uses wood from many sources: slabs, edgings, and trimmings from sawmills; trimmings from pallet, flooring, and furniture plants; roundwood; logging slash; bark; paper chips; oversize paper chip screenings; and, in the West, hogged fuel. Bark, paper chips, oversize paper chip screenings, and hogged fuel are used as is. Other sources are reduced in size by chippers.

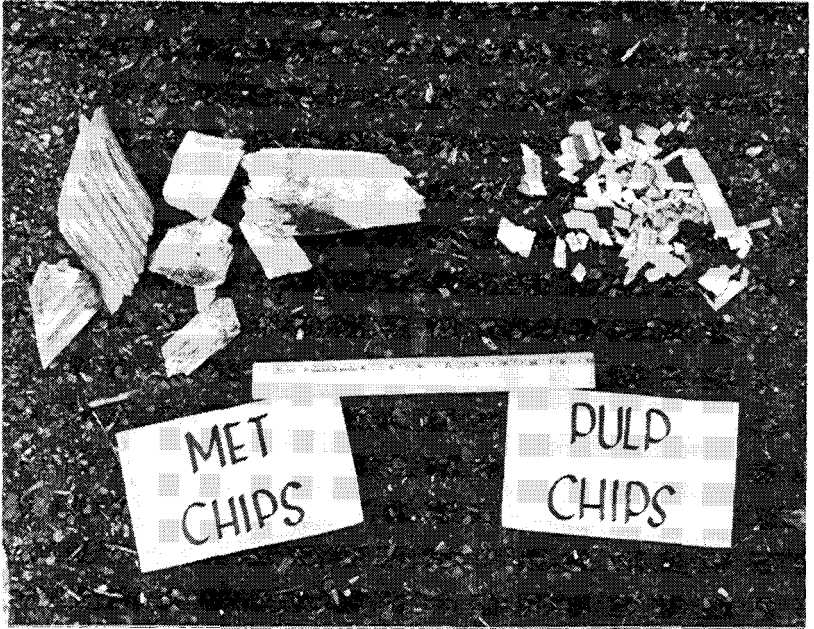


Figure 2. — A comparison of metallurgical chips and pulp chips.

The form of wood best suited for electric smelting is the metallurgical or met chip. The met chip is several times larger than the more familiar pulp chip (fig. 2). These chips are produced by specially built metallurgical chippers designed for big loads and for cutting large chips.

## AMOUNT AND LOCATION OF WOOD USED

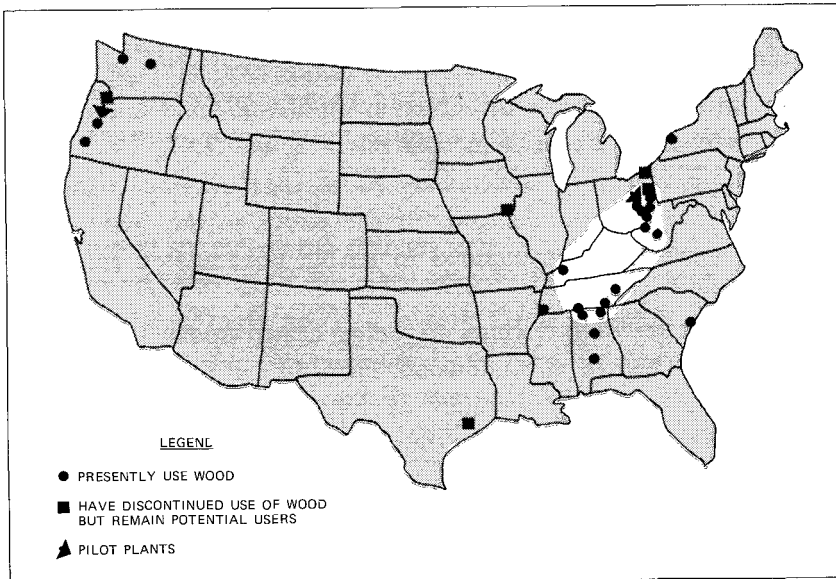
The electrometallurgical industry consumes about 796,000 tons (green weight) of wood annually — enough to operate a 500-ton-per-day pulpmill for 1 year. Fifty-nine percent, 480,000 tons, is consumed by plants in the Ohio and Tennessee River Valleys (fig. 3). Consumption varies from 6,000 tons to 78,000 tons per plant per year. Average annual consumption per plant is 36,000 tons.

Bark residues represent about 5.3 percent of the total amount of woody reductants consumed. Of these bark residues, 30,400 green tons are hardwood bark and 12,000 green tons are pine bark.

## FACTORS AFFECTING WOOD PURCHASES

The general conditions that govern the purchasing of wood for the industry concentrated in the Ohio and Tennessee River Valleys do not necessarily hold true for plants scattered in other parts of the country. Consider the market for wood in terms of the met chip only, as it is the best woody reductant found today.

Figure 3. — The location of electrometallurgical plants in the United States that use wood chips. The study was concentrated in the Ohio and Tennessee Valley region (unshaded area).



## Supply and Demand

The supply of met chips is not adequate in certain areas. In fact, the one plant that discontinued using wood in this region (fig. 3) did so not because wood residues were not available, but because the proper type of met chip was not available. Situations like this arise because: (1) the demand for wood in electric smelting is concentrated in certain areas; (2) other wood buyers such as pulpmills, particleboard plants, and charcoal producers seek similar raw materials in large quantities to meet their requirements; and (3) winter and wet weather hamper logging operations, which in turn affect the availability of all forest products.

The demand for met chips at any one plant, though relatively constant from year to year, can vary as much as 600 percent from month to month. This fluctuation is caused by changes in the production schedule. Each alloy requires a different amount of met chips per unit of production; so any change in the type of alloy being produced is likely to cause up to a sixfold change in the amount of wood needed.

The purchaser of met chips has to deal with these problems of fluctuating demand on the one hand, and changing levels of supply on the other. Some of the methods used in coping with these problems involve inventory manipulation, new sources of raw material, and long-term contracts.

A large inventory is necessary to balance out the changing levels of supply and demand. At the plants in the study area, enough material is maintained to enable unhampered smelting for 2 weeks to 2 months.

New sources of met chips are being drawn upon. The source with most potential is roundwood. Firms in the Ohio Valley are purchasing increasing amounts of roundwood, storing it, and chipping it as needed in metallurgical chippers installed at the plant site (fig. 4). Several of these chippers have been sold as mobile units to loggers, who process logging slash with them. At present two plants obtain 50 percent or more of their wood requirements from roundwood.

Another way of obtaining new sources is to extend the buying



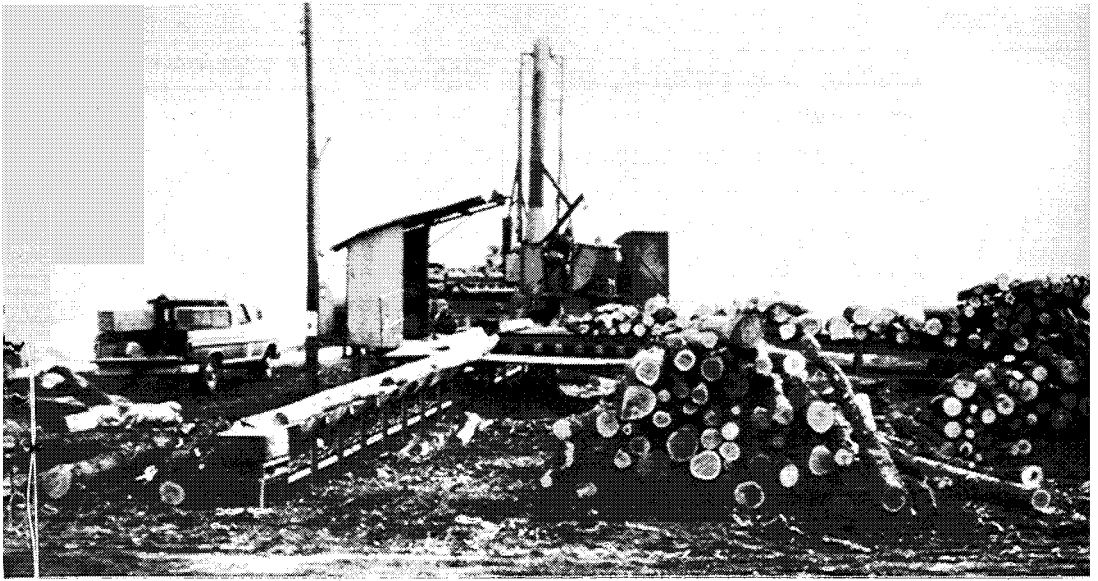


Figure 4. — A metallurgical chipper and roundwood storage.

radius. Most woody reductants are purchased within a 100-mile radius. However, when wood is scarce, metallurgical firms go as far as 200 miles in search of adequate supplies.

Several metallurgical firms have adopted long-term contracts to insure a steady supply of met chips. These contracts may call for the entire production of chipped residues from wood-processing plants for 2 or more years. And they stipulate approximate delivery rates. An added incentive is provided by bonuses given for chips in excess of the delivery rate.

More prevalent than the relatively new long-term contracts are monthly or quarterly purchase orders. Firms seeking to minimize capital tied up in stockpiles use these for flexibility in meeting changing monthly wood requirements. However, forest-products firms are reluctant to produce for these fluctuating markets.

### **Specifications**

Specifications for woody reductants can be expressed only in generalizations. They differ from place to place because of the kind of material available, the type of equipment used in

handling these materials, and the requirements of a particular metallurgist.

According to the companies asked, the most important specification is for particle size. In the Ohio and Tennessee River Valleys, specifications on particle sizes range from 2.5 inches square by 0.5 inch thick to 8 inches square by 1 inch thick. Particles larger than these, as well as some very stringy hardwood barks, are limited primarily by the plant's materials-handling equipment. Small particles, including sawdust, generally are of no benefit because they burn up too fast in the furnace.

Woody reductants should be free of foreign material, because it imparts impurities to the alloys being produced. Because barks frequently carry dirt and mud, they are also undesirable. However, 16 of 22 United States plants do accept certain proportions of bark in their requirements for woody reductants. For instance, several plants accept wood chips from unbarked roundwood, but not from unbarked slabs and edgings because they have a higher proportion of bark.

The specifications on moisture content reflect the conflict between the art of electric smelting and economics. Most ferro-alloy plants prefer green oven-dry material because it works deeper into the furnace before burning up. However, others are more concerned about the extra expense of transporting the water and driving it off in the furnace; so they prefer dry material. To assure a more uniform moisture content in the woody reductant portion of the furnace mix, some plants blend the chips they receive from different sources.

Wood used in ferro-alloy manufacture must be free of decay.

In locations where both hardwood and softwood residues are available, hardwoods are preferred because they last longer in the furnace.

Roundwood specifications are determined by the size of log that can be handled in the metallurgical chippers. Larger chippers can handle logs up to 22 inch maximum diameter; but specifications call for 16- to 18-inch logs to take care of crook, swell, knots, and occasional oversize logs.

## Prices

All wood residues and roundwood are bought by weight. The average delivered price of met chips per green ton in the study area is \$8.50, with a range of \$6.50 to \$10.00. Roundwood costs approximately \$2.00 a ton less than chips. And bark is bought at or slightly above the cost of transportation.

## Transport

Most metallurgical plants prefer delivery of wood by truck. Trucking allows more flexibility in the timing and location of deliveries. Dump-trucks are used to haul most of the chipped wood. However, a recent innovation in handling is the installation of hydraulic dumpers (fig. 5) at several plants. These allow

Figure 5. — A hydraulic dumper; met chip pile in background.



the larger chip vans to more efficiently haul and dump material. Rail and barge shipments are used to a lesser extent.

## **OUTLOOK FOR FUTURE WOOD USE**

Changes in the volume consumed, forms of, and sources of woody reductants for metallurgical purposes can be expected in the future.

Indications are that the volume of wood used in electric smelting in the future will increase. The three principal markets for ferro-alloys — alloy steel, aluminum, and silicone industries — are growing. The average increase in production of alloy steel over the past 6 years has been 6 percent annually (calculated from figures on alloy steel production supplied by the American Iron and Steel Institute, Washington, D. C.) Silicon alloys, which consume the greatest volume of met chips per unit of production, are used by the rapidly growing aluminum and silicone industries.

Changes in the form of wood used in electric smelting will probably occur in the future. Large modern furnaces need precise and uniform raw-material inputs for efficient computerized control. And since met chippers provide the most suitable material available, the trend in their use should continue to rise. This means that more and more wood residues, roundwood, and logging slash will be used to help satisfy the increasing demand for high-quality woody reductants in large quantities.

Bark is now being used, but use of bark relies on favorable economics rather than on its record of performance. The use of bark in electric smelting is still considered as experimental. Future technological advances could conceivably make bark more appropriate for this use.

In the past, experiments with sawdust compressed into briquettes for electric smelting have been unsuccessful. However, interest has been renewed; and sawdust-briquetting trials have been started at the University of Ohio, in Athens.

The most apparent and meaningful trend to be expected in future purchasing practices for wood is the changeover from

purchase orders to long-term contracts. Their more widespread use would provide a more stable and attractive market for suppliers of metallurgical chips.

## APPENDIX

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### LIST OF U. S. ELECTROMETALLURGICAL PLANTS USING WOOD CHIPS

<i>Company</i>	<i>Location</i>
Airco Alloys	Niagara Falls, New York
Airco Alloys	Charleston, South Carolina
Airco Alloys	Calvert City, Kentucky
Calumet & Hecla, Inc.	Selma, Alabama
Chromium Mining & Smelting Co.	Woodstock, Tennessee
Footo Mineral Co.	Graham, West Virginia
Footo Mineral Co.	Wenatchee, Washington
Hanna Nickel Smelting Co.	Riddle, Oregon
Interlake Steel Corp.	Beverly, Ohio
National Metallurgical Corp.	Springfield, Oregon
Ohio Ferro-Alloys	Powhatan Point, Ohio
Ohio Ferro-Alloys	Brilliant, Ohio
Ohio Ferro-Alloys	Philo, Ohio
Ohio Ferro-Alloys	Tacoma, Washington
Reynolds Aluminum	Sheffield, Alabama
Roane Electric Furnace	Rockwood, Tennessee
Tennessee Alloys	Bridgeport, Alabama
Tennessee Metallurgical Corp.	Jasper, Tennessee
Union Carbide Corp.	Alloy, West Virginia
Union Carbide Corp.	Marietta, Ohio
Union Carbide Corp.	Sheffield, Alabama
Woodward Iron Co.	Woodward, Alabama



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