# SLAG—IRON AND STEEL

By Rustu S. Kalyoncu

**Domestic survey data and tables were prepared by Robin C. Kaiser, statistical assistant.**

As early as 350 B.C., the Greek philosopher-physician Aristotle prescribed iron slags for healing wounds. In the ensuing centuries, a number of applications for iron and steel slags were found. However, it was not until the early 20th century, when the modern processes of iron and steel production were developed, that the commercial, large-scale use of iron and steel slags became economical.

The American Society of Testing and Materials (ASTM) (1999) defines blast furnace slag as "the non-metallic product consisting essentially of calcium silicates and other bases that is developed in a molten condition simultaneously with iron in a blast furnace." To the casual observer, one of the most striking features of an iron and steel plant is the site of a mountainous slag pile that presents a continuous display as ladle after ladle pours its incandescent load down the side in the endless accumulation of this waste product. Almost a century ago, the term waste product aptly described slag. Slag was considered to be essential in the production of iron, but once it served its purpose in refining the metal, it was strictly a nuisance with little or no use. The usefulness of slags was realized with the first ore smelting process. The use of slags became a common practice in Europe at the turn of the 19th century, where the incentive to make all possible use of industrial byproducts was strong and storage space for byproducts was lacking. Shortly after, many markets for slags opened in Europe, the United States, and elsewhere in the world.

In the production of iron, the blast furnace (BF) is charged with iron ore, fluxing agents (usually limestone and dolomite) and coke as fuel and the reducing agent. The iron ore is a mixture of iron oxides, silica, and alumina. From this and the added fluxing agents, alkaline earth carbonates, molten slag, and iron are formed. Oxygen in the preheated air blown into the furnace combines with the carbon of the coke to produce the needed heat and carbon monoxide. At the same time, the iron ore is reduced to iron, mainly through the reaction of the carbon monoxide with the iron oxide to yield carbon dioxide ($CO_2$) and metallic iron. The fluxing agents dissociate into calcium and magnesium oxides and carbon dioxide. The oxides of calcium and magnesium combine with silica and alumina to form slag. The slag is transported into a cooling pit either directly or via iron ladles, depending on the distance between the pit and the furnace.

The principal constituents of iron and steel slags are silica ($SiO_2$), alumina ($Al_2O_3$), calcia (CaO), and magnesia (MgO), which make up 95% of the composition. Minor elements include manganese, iron, and sulfur compounds, as well as trace amounts of several others. The physical characteristics, such as density, porosity, and particle size, are affected by the cooling rates of the slag and its chemical composition. Depending on the cooling method, three types of BF slag are produced: air-cooled, expanded, and granulated.

Allowing the molten slag to cool slowly in air in an open pit produces air-cooled slag. Air-cooled blast furnace slag is defined in ASTM standard C-125 (American Society for Testing and Materials, 1999) as "the material resulting from solidification of molten blast furnace slag under atmospheric conditions. Subsequent cooling may be accelerated by application of water to the solidified surface." The solidified slag has a vesicular structure with closed pores. The rough vesicular texture of slag gives it a greater surface area than smoother aggregates of equal volume and provides an excellent bond with portland cement, as well as high stability in asphalt

**Slag—Iron and Steel in the 20th Century**

Early use of blast furnace slag in the United States was prompted by the desire to make use of material that was considered an expensive waste product. Its use in earnest started in the early 1900s in the construction field, principally for railroad ballast, portland-cement-concrete aggregate, and aggregates for bituminous and other types of road construction. The National Slag Association carried out a survey of slag shipments in the United States for the first time in 1938. In 1939, the first year for which comprehensive figures of marketed slag are available, 8.3 million metric tons of blast furnace slag valued at $6.4 million was used. The slag output from blast furnaces in 1947, the first year in which the U.S. Bureau of Mines collected production statistics, reached almost 30 million tons. Most slag was used in highway construction and railroad ballast.

In 2000, 8.9 million tons of blast furnace slag valued at $58.3 million and 5.1 million tons of steel slag valued at $20.1 million were used. Major uses were in road construction, asphaltic concrete aggregate, portland cement manufacture, and various concrete products. In the early years of slag use, prospective consumers thought that slag was subject to disintegration and corrosion and was brittle. Slag cements also were questioned, and slag wool was believed to have high sulfur content. Only after years of research and promotion were these objections overcome. In 2000, the ferrous slag industry enjoyed the benefits of many individual and collective efforts expended in the development of slag markets. A broader market existed for slag, from mineral wool to roofing granules to agriculture. Virtually all of the slag produced by the iron and steel industry throughout the world was used in such applications as asphaltic concrete aggregate, cement extenders, fill, railroad ballast, road bases, and roofing granules.

mixtures.

Expanded slag is formed through controlled rapid cooling of molten slag in water or in water with combination of steam and compressed air. Steam and other gases enhance the porosity and vesicular nature of the slag, resulting in a lightweight aggregate suitable for use in concrete. Quenching the molten slag into glass granules by using high-pressure water jets produces granulated slag. Quenching prevents the crystallization of minerals constituting the slag composition, thus resulting in a granular, glassy aggregate. This slag is crushed, pulverized, and screened for use in various applications, particularly in cement production, because of its pozzolanic (hydraulic cementitious) characteristics.

Slags are also coproducts of steelmaking processes. Production of steel calls for the removal of excess silicon by mineralization and of carbon by oxidation from pig or crude iron. Steel slag is a hard, dense material somewhat similar to air-cooled iron slag. It contains significant amounts of free iron, giving it its high density and hardness, which make it particularly suitable as a road construction aggregate.

Slag is transported to processing plants, where it undergoes crushing, grinding, and screening operations to meet various use specifications. Processed slag is either shipped to its buyer for immediate use or, in slack seasons, stored.

**Legislation and Government Programs**

Classification of slags under several standard waste categories has been the subject of a number of past Government initiatives. The National Slag Association reported no major Government action concerning slag in 2000 (R.Y. Twitmyer, President, National Slag Association, oral commun., 2000). The effect of increased spending on highway construction and repairs, as a result of the passage of the Transportation Equity Act for the 21st century (Public Law 105-178) by Congress in 1998, with its $205 billion spending plan, did not show on the consumption and price of slags in 2000.

The Portland Cement Association is promoting slag use in portland cement production. The potential for a carbon tax levy on $CO_2$ emissions may provide the cement producers with incentives to find ways of reducing $CO_2$ emissions in portland cement production, where the burning fuel and decomposition of carbonates in the raw feed contribute to $CO_2$ emissions.

Texas Industries has developed a process for cement clinker production involving the use of steel slag. In this process, called CemStar, steel slag is fed into the rotary kiln as a part of the raw meal. Replacing a part of the raw meal directly with slag will result in the lowering of $CO_2$ emissions directly proportional to the quantities of slag used. Additional refinements of the process have been reported (Robert D. Rogers, President, Texas Industries, oral commun., 2000).

**Production**

The iron and steel industry does not routinely measure slag output; therefore, actual annual ferrous slag production data in the United States do not exist. The data collected by the U.S. Geological Survey (USGS) reflect the slag processing industry's sales rather than the output. Slag outputs in iron and steel production are highly variable and depend, partly, on the composition of the raw materials and the type of furnace. Typically, for ore feed with 60% to 65% iron, blast furnace slag production ranges from about 220 to 370 kilograms per metric ton of pig iron produced. Lower grade ores yield much higher slag fractions, sometimes as high as 1 ton of slag per ton of pig iron. Steel slag outputs are approximately 20% by mass of the steel output. About one-half of the slag is entrained steel, which is generally recovered and returned to the furnace. After removal of the entrained steel, the marketable slag is equivalent to about 10% to 15% of the original steel output.

According to statistics reported by the American Iron and Steel Institute, U.S. pig iron production was about 46 million tons (Mt) and 48 Mt in l999 and 2000, respectively. The iron slag production figures for these years were about 11.5 Mt and 12 Mt in 1999 and 2000, respectively. Similarly, U.S. steel production was reported to be 97 Mt for 1999 and 101 Mt for 2000. The expected steel slag production was about 11 Mt for 1999 and 13 Mt in 2000. As with the United States, no data are available on world slag production. The International Iron and Steel Institute (2000, p. MM16) reported the world pig iron output to be about 570 Mt and crude steel production to be 828 Mt in 2000. The estimated figures for ferrous slag production from this output was approximately 200 Mt.

Tables 1 through 8 list data compiled from the USGS survey of domestic slag processors. The data for l999 and 2000 reflect a response by 90% of the processors queried. Where applicable, estimates have been incorporated for data omitted from the returned questionnaires. Table 8 lists the production facilities that responded to the survey in 2000. Redland Mill Services no longer appears in the table because Lafarge Corp. bought it 2 years ago.

Nucor Corporation's new 1-million-ton-per-year electric-arc furnace steel mill in Hertford County, NC, the construction of which was started in 1998 (Kalyoncu, 1999), became operational in October 2000 (Giff Daughtridge, plant manager, Nucor Plant, oral commun., 2001). Currently [2000], the mill is operating at 70% capacity and generating approximately 25,000 tons of slag, which is processed by Heckett MultiServ Co.

GSC Partners is in the process of acquiring Envirosource (R.Y. Twitmyer, National Slag Association, oral commun., 2001).

**Consumption**

Uses of iron and steel slags range from building and road construction to waste stabilization. Iron and steel slags are also used in cement manufacture, concrete aggregates, agricultural fill, glass manufacture, and as a mineral supplement and liming agent in soil amendment. The correlation between slag production and availability is not a good indicator of consumption trends because time lags between production and sale of the slag to the final customer can be significant. The primary reason for the lag is the necessity of aging the new slag to reduce its free-lime content for certain applications, such as concrete production. High levels of free lime can adversely affect concrete performance. Generally, slag, especially steel slag, will be stored to cure for 6 months or longer to allow expansion of dicalcium silicate and to reduce the free-lime content to acceptable levels. Furthermore, many slag producers accumulate large stockpiles to be able to participate in bids to supply large construction projects.

Air-cooled slag accounted for the bulk of slag production (sales) in the United States. The total U.S. sales of about 9 Mt, worth more than $59 million, of domestically produced air-cooled blast furnace slag recorded a slight increase in value (table 1). Expanded and granulated slag sales increased. Total revenues of more than $141 million (iron plus steel slags) for

2000 were slightly higher than those of l999. The mid-Atlantic region, for a second year, remained the leader in sales value of blast furnace slag with $55 million, accounting for more than 45% of total revenues for the whole country, with the north-central region accounting for most of the remaining business (table 3).

In 2000, sales for concrete and asphaltic road construction, including road base, again accounted for more than three quarters of the consumption of air-cooled BF slags in the United States; other uses were in soil conditioning, sewage treatment, and mineral wool production (table 4).

Road base was the primary use of steel slag, followed by fill and asphaltic concrete aggregates. The steel slag sales of $20.1 million in 2000 lagged behind the 1999 figure of $23 million by almost 13% (table 5). Slag prices showed a range of values depending on their use categories (table 6). A significant amount of slag, 2.4 Mt, was never shipped but used at the plants (table 7).

In 2000, the United States imported 1.5 Mt of ferrous slags. Granulated blast furnace slag (GGBFS), which commands the highest price among ferrous slags, led the imports. In 2000, approximately 1 Mt of GGBFS was imported. Imports of GGBFS, in descending order, were mainly from Italy, Canada, France, South Africa, and Brazil. Principal discharge ports were Tampa, FL, New Orleans, LA, Philadelphia, PA, and Detroit, MI. In 2000, imports accounted for about 5% of total ferrous slag shipments in the United States.

## Transportation

Most of the of ferrous slag sold and not consumed at the plant was transported by truck; rail and barge transportation accounted for 21.5% of the total (table 7). Most ferrous slag was transported less than 100 kilometers; trucks were the most economical means of transportation for such distances.

## Current Research and Technology

No significant developments were made in slag processing technology during 2000. Because slag is a low unit-value, high-volume commodity, and slag processing is an established, conservative industry, all the slag that is processed is readily sold. Therefore, the industry seldom feels the need for innovations and, therefore, invests little, if any, in expensive research efforts. Previously reported advancements in granulating techniques (Kalyoncu, 1999) resulted in some improvements in slag granulation systems, especially in reducing the energy costs.

## Outlook

Potential classification by the U.S. Environmental Protection Agency of iron and steel slags as hazardous wastes is of constant concern to the slag industry. Absent such a classification, ferrous slag has a secure future in the construction industry. Some blast furnace operations, however, have been closing because of an inability to compete in the marketplace. In the case of continuing plant closings, availability of domestic blast furnace slag may decline, which may necessitate an increase in imports. With its more limited uses, the long-term supply of steel slag appears to be more stable. An increase in the use of steel slags may be on the horizon as blast furnace slag production declines.

## References Cited


American Society for Testing and Materials, 1999, Standard terminology relating to concrete and concrete materials: West Conshohocken, PA, American Society for Testing and Materials, 4 p.

International Iron and Steel Institute, 2000, Steel statistical yearbook: Brussels, International Iron and Steel Institute, 112 p.

Kalyoncu, R.S., 1999, Slag—Iron and steel: U.S. Geological Survey Mineral Commodity Summaries 1999, p. 94-95.


## U.S. Geological Survey Publications


Iron and Steel. Ch. in Mineral Commodity Summaries, annual.

Slag—Iron and Steel. Ch. in Mineral Commodity Summaries, annual.

TABLE 1
IRON AND STEEL SLAG SOLD OR USED IN THE UNITED STATES 1/ 2/

(Million metric tons and million dollars)

| | Blast furnace slag | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | Air-cooled | | Expanded 3/ | | Total | | Steel slag | | Total slag | |
| Year | Quantity | Value 4/ | Quantity | Value 4/ | Quantity | Value 4/ | Quantity | Value 4/ | Quantity | Value |
| 1999 | 8.9 | 58.30 | 1.9 | 62.20 | 10.8 r/ | 120.00 | 6.2 r/ | 23.00 r/ | 17.1 r/ | 140.40 r/ |
| 2000 | 8.9 | 58.60 | 2.3 | 62.40 | 11.2 | 121.00 | 5.1 | 20.10 | 16.3 | 141.20 |

r/ Revised.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Excludes imported slag.
3/ Includes granulated slag to avoid disclosing company proprietary data.
4/ Value is the selling price at plant and includes, for a few facilities, estimates reported by the plants and/or made by the U.S. Geological Survey.

TABLE 2
AVERAGE VALUE AT THE PLANT FOR IRON AND STEEL SLAG SOLD
OR USED IN THE UNITED STATES, BY TYPE

(Dollars per metric ton)

| | Iron blast furnace slag | | | | |
|---|---|---|---|---|---|
| Year | Air-cooled | Expanded 1/ | Total iron slag | Steel slag | Total slag |
| 1999 | 6.50 | 32.00 | 11.00 | 3.92 r/ | 8.78 r/ |
| 2000 | 6.61 | 27.21 | 10.80 | 3.92 | 8.62 |

r/ Revised.
1/ Includes granulated slag to avoid disclosing company proprietary data.

TABLE 3
BLAST FURNACE SLAG SOLD OR USED IN THE UNITED STATES, BY REGION AND STATE 1/ 2/

(Million metric tons and million dollars)

| | 1999 | | | | 2000 | | | |
|---|---|---|---|---|---|---|---|---|
| | Air-cooled | | Total, all types | | Air-cooled | | Total, all types | |
| Region and State | Quantity | Value 3/ | Quantity | Value 3/ | Quantity | Value 3/ | Quantity | Value 3/ |
| North-Central: Illinois, Indiana, Michigan, Ohio | 5.3 | 34.80 | 6.3 | 53.60 | 4.9 | 32.00 | 5.8 | 50.00 |
| Mid-Atlantic: Maryland, New York, Pennsylvania, West Virginia | 1.9 | 13.30 | 2.8 | 56.80 | 2.1 | 15.60 | 3.2 | 55.00 |
| Other 4/ | 1.8 | 10.10 | 1.8 | 10.10 | 1.9 | 11.20 | 2.2 | 16.00 |
| Total | 8.9 | 58.30 | 10.9 | 120.00 | 8.9 | 58.60 | 11.2 | 121.00 |

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Excludes imported slag.
3/ Value based on selling price at plant.
4/ Includes Alabama, California, Kentucky, Mississippi, and Utah.

TABLE 4
AIR-COOLED BLAST FURNACE SLAG SOLD OR USED IN THE UNITED STATES, BY USE 1/ 2/

(Million metric tons and million dollars)

| | 1999 | | 2000 | |
|---|---|---|---|---|
| Use | Quantity | Value 3/ | Quantity | Value 3/ |
| Asphaltic concrete aggregate | 1.7 | 11.30 | 1.7 | 11.30 |
| Concrete aggregate | 1.2 | 8.60 | 1.2 | 8.70 |
| Concrete products | 0.3 | 1.70 | 0.2 | 1.50 |
| Fill | 1.1 | 5.20 | 0.8 | 3.90 |
| Mineral wool | 0.5 | 4.40 | 0.5 | 5.00 |
| Railroad ballast | 0.2 | 0.60 | (4/) | (4/) |
| Road bases | 3.0 | 16.70 | 3.3 | 18.40 |
| Roofing, built-up and shingles | (4/) | 0.50 | (4/) | (4/) |
| Other 5/ | 1.0 | 9.30 | 1.2 | 9.80 |
| Total | 8.9 | 58.30 | 8.9 | 58.60 |

See footnotes at end of table.

TABLE 4--Continued
AIR-COOLED BLAST FURNACE SLAG SOLD OR USED IN THE UNITED STATES, BY USE 1/ 2/

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Excludes imports.
3/ Value based on selling price at plant.
4/ Less than 1/2 unit.
5/ Includes cement, ice control, glass manufacture, sewage treatment, soil conditioning, and miscellaneous.

TABLE 5
STEEL SLAG SOLD OR USED IN THE UNITED STATES, BY USE 1/ 2/ 3/

(Million tons and million dollars)

| | 1999 r/ | | 2000 | |
|---|---|---|---|---|
| Use | Quantity | Value 4/ | Quantity | Value 4/ |
| Asphaltic concrete aggregate | 1.0 | 5.30 | 0.9 | 5.00 |
| Fill | 1.0 | 3.40 | 1.0 | 3.00 |
| Railroad ballast | 1.2 | 0.30 | 0.4 | 1.10 |
| Road bases | 1.8 | 6.02 | 1.7 | 6.30 |
| Other 5/ | 1.2 | 8.00 | 1.1 | 4.70 |
| Total | 6.2 | 23.00 | 5.1 | 20.10 |

r/ Revised.
1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Excludes imports.
3/ Excludes tonnage returned to furnace for charge material.
4/ Value based on selling price at plant.
5/ Includes ice control, soil conditioning, and miscellaneous uses.

TABLE 6
AVERAGE AND RANGE OF SELLING PRICES AT THE PLANT FOR IRON AND STEEL SLAG IN THE UNITED STATES IN 2000, BY USE

(Dollars per metric ton)

| | Iron blast furnace slag 1/ | | Steel slag | |
|---|---|---|---|---|
| Use | Average | Range | Average | Range |
| Asphaltic concrete aggregate | 5.00 | 4.00-8.00 | 4.00 | 2.00-8.00 |
| Concrete products | 5.00 | 3.30-8.00 | (2/) | (2/) |
| Fill | 4.00 | 2.00-9.00 | 2.00 | 0.99-14.00 |
| Mineral wool | 7.00 | 4.00-10.00 | W | (2/) |
| Railroad ballast | 4.00 | 3.00-8.00 | 2.00 | 2.00-3.00 |
| Road bases | 5.00 | 1.00-8.00 | 3.00 | 2.00-12.00 |
| Roofing, built-up and shingles | 11.00 | 6.00-14.00 | (2/) | (2/) |
| Other 3/ | 7.00 | 6.00-79.00 | 5.00 | 4.00-8.00 |

W Withheld to avoid disclosing company proprietary information.
1/ Air-cooled slag only. Price range breakouts, by use, for granulated and expanded slag are withheld to avoid disclosing proprietary information; overall, prices ranged from $2.00 to $8.00 per metric ton for iron and steel slag.
2/ No use reported.
3/ Includes cement manufacture, glass manufacture, sewage treatment, and soil conditioning.

TABLE 7
SHIPMENTS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2000, BY METHOD OF TRANSPORTATION 1/ 2/

(Million metric tons)

| Method of transportation | Quantity |
|---|---|
| Truck | 10.9 |
| Rail | 0.8 |
| Waterway | 2.2 |
| Total | 13.9 |
| Not transported (used at plant) | 2.4 |

1/ Data are rounded to no more than three significant digits; may not add to totals shown.
2/ Excludes imported slag.

TABLE 8
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2000

| | | Steel slag | | | Iron slag | |
|---|---|---|---|---|---|---|
| Company | Plant location | Basic oxygen furnace | Open hearth | Electric arc furnace | Blast furnace | Slag type |
| Blue Circle Cement Co. | Baltimore, MD | X | | | X | Granulated. |
| Buffalo Crushed Stone, Inc. | Buffalo, NY | X | | | X | Air cooled. |
| C.J. Langenfelder | Baltimore, MD | X | | | | |
| Do. | Braddock, PA | X | | | | |
| Edward C. Levy Co. | Detroit, MI | X | | X | X | Air cooled and expanded. |
| Heckett MultiServ Co. | Armorel, AR | | | X | | |
| Do. | Fontana, CA | X | | | X | Air cooled. |
| Do. | Wilton, IA | | | X | | |
| Do. | Chicago, IL | | | X | | |
| Do. | Sterling, IL | | | X | | |
| Do. | East Chicago, IN | X | | | | |
| Do. | Indiana Harbor, IN | X | | | | |
| Do. | Ashland, KY | X | | | X | Air cooled. |
| Do. | Coalton, KY | | | X | | |
| Do. | Newport, KY | | | X | | |
| Do. | Owensboro, KY | | | X | | |
| Do. | Kansas City, MO | | | X | | |
| Do. | Canton, OH | | | X | | |
| Do. | Mansfield, OH | X | | | | |
| Do. | Massillon, OH | | | X | | |
| Do. (Warren Plant) | Warren, OH | X | | | | |
| Do. | do. | | | X | | |
| Do. | Youngstown, OH | | | X | | |
| Do. | Butler, PA | | | X | | |
| Do. | Provo, UT | | X | | X | Air cooled. |
| International Mill Services | Fort Smith, AR | | | X | | |
| Do. | Kingman, AZ | | | X | | |
| Do. | Pueblo, CO | X | | | | |
| Do. | Claymont, DE | | | X | | |
| Do. | Cartersville, GA | | | X | | |
| Do. | Alton, IL | | | X | | |
| Do. | Chicago, IL | | | X | X | Air cooled. |
| Do. | Kankakee, IL | | | X | | |
| Do. | Gary, IN | | | X | | |
| Do. | Huntington, IN | | | X | | |
| Do. | Laplace, LA | | | X | | |
| Do. | Jackson, MI | | | X | | |
| Do. | Monroe, MI | | | X | | |
| Do. | St. Paul, MN | | | X | | |
| Do. | Jackson, MS | | | X | | |
| Do. | Charlotte, NC | | | X | | |
| Do. | Perth Amboy, NJ | | | X | | |
| Do. | Riverton, NJ | | | X | | |
| Do. | Sayreville, NJ | | | X | | |
| Do. | Auburn, NY | | | X | | |
| Do. | Hubbard, OH | | | X | | |
| Do. | Marion, OH | | | X | | |
| Do. | Mingo Junction, OH | X | | X | | |
| Do. | Warrent, OH | | | X | | |
| Do. | McMinnville, OR | | | X | | |
| Do. | Portland, OR | | | X | | |
| Do. | Brideville, PA | | | X | | |
| Do. | Coatesville, PA | | | X | | |
| Do. | Holsopple, PA | | | X | | |
| Do. | Houston, PA | | | X | | |
| Do. | New Castle, PA | | | X | | |
| Do. | Midland, PA | | | X | | |
| Do. | Pricedale, PA | X | | X | | |
| Do. | Reading, PA | X | | X | | |
| Do. | Darlington, SC | X | | X | | |
| Do. | Georgetown, SC | X | | X | | |
| Do. | Jackson, TN | X | | X | | |
| Do. | Beaumont, TX | X | | X | | |

TABLE 8--Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2000

| | | Steel slag | | | Iron slag | |
|---|---|---|---|---|---|---|
| Company | Plant location | Basic oxygen furnace | Open hearth | Electric arc furnace | Blast furnace | Slag type |
| International Mill Services--Continued: | El Paso, TX | X | | X | | |
| Do. | Jewett, TX | X | | X | | |
| Do. | Longview, TX | X | | X | | |
| Do. | Plymouth, UT | X | | X | | |
| Do. | Seattle, WA | X | | X | | |
| Do. | Saukville, WI | X | | X | | |
| Do. | Weirton, WV | X | | X | | |
| Holnam Inc. | Gary, IN | | | | X | Air cooled, granulated, and expanded. |
| Do. | Weirton, WV | | | | X | Granulated. |
| IMS Waylite Corp. | Bethlehem, PA | X | X | | X | Air cooled and expanded. |
| Do. | Cambria, PA | | X | | X | Air cooled. |
| Lafarge Corp. | Cuyahoga, OH | | X | | | do. |
| Do. | Lordstown, OH | | X | | X | Granulated. |
| Do. | McDonald, OH | | X | | | |
| Do. | Mingo Junction, OH | | | | X | Air cooled. |
| Do. | Warren, OH | | | | X | do. |
| Do. | Youngstown, OH | | X | | | |
| Do. | West Mifflin, PA | | | | X | do. |
| Do. | Weirton, WV | | | | X | do. |
| The Levy Co. Inc. | Burns Harbor, IN | X | | | X | do. |
| Do. | East Chicago, IN | | | | X | do. |
| Martin Marietta Aggregates | Raleigh, NC | X | | | X | do. |
| Maryland Slag Co. | Baltimore, MD | | | | X | do. |
| Olympic Mill Services | Seguin, TX | | | X | | |
| Stein, Inc. | Decatur, AL | X | | | | |
| Do. | Cleveland, OH | X | | | X | do. |
| Do. | Lorain, OH | | | | X | do. |
| Vulcan Materials Co. | Alabama City, AL | | | | X | do. |
| Do. | Fairfield, AL | X | | | X | do. |