



2009 Minerals Yearbook

SLAG, IRON AND STEEL

SLAG—IRON AND STEEL

By Hendrik G. van Oss

Sales in 2009 of iron and steel slag in the United States totaled about 12.5 million metric tons (Mt), down by almost 34% from total sales in 2008 (table 1). The overall value of slag sales decreased by 29% to about \$235 million.

Iron and steel slags form through the addition of slagging agents and fluxes (chiefly limestone or dolomite and silica sand) to blast furnaces and steel furnaces to strip impurities from iron ore, steel scrap, and other ferrous feeds. The slag is a silicate melt that floats on top of the molten crude iron or steel and is tapped from the furnace separately from the liquid metal. After cooling by various means to solid form, the slag is processed and may then be sold and (or) returned to the furnace. Most forms of processed slag have very low unit values compared with those of iron and steel products and, for this reason, iron and steel companies generally contract with outside slag-processing companies to cool the slag and to remove it. Although the financial arrangements vary, typically the processing company receives the slag for free, crushes it to various marketable sizes, uses screens and magnetic separators to recover entrained metal from the slag (metal to be returned to the furnace for a low charge), sells the slag on the open market, and pays a small percentage of the net slag sales revenues or profits to the iron or steel company. Slag may be returned to the furnaces for use as flux and as a supplemental source of iron; this return of slag is not always included in the tonnages of slag reported as sold.

A list of slag processors, processing sites, and the iron and steel companies serviced is provided in table 4. Apparent duplication at some sites is because processing contracts may have been transferred to other companies during the year, and integrated iron and steel plants may have processing and (or) marketing contracts with different companies for different slag types produced at the plant. In some cases, the slag is cooled by one company but is then further processed and (or) marketed by another company or at another site.

Legislation and Government Programs

Consumption of slag in the construction sector is influenced by Federal and State programs that affect construction spending levels, encourage the use of “alternative” materials, and that may affect the availability of competing “alternative” or natural materials. Slags are promoted as “sustainable” raw materials mainly on the basis that slags substitute directly or indirectly for virgin raw materials (for example, for natural stone aggregates in concrete and for natural raw materials in cement manufacture), or, in the specific case of ground granulated blast furnace slag (GGBFS), can partially substitute for clinker in finished cement or for portland cement in concrete. With respect to clinker manufacture, substitution of slags for natural raw materials can reduce the unit consumption of fuel and limestone in the kiln, which then reduces the overall and unit emissions of certain pollutants, most notably carbon dioxide. Use of

granulated blast furnace slag [GGBFS, or unground (GBFS)] in the finish mill allows more finished cement to be made from the same amount of clinker. In 2009, the ASTM C-150 standard for portland cement was revised to allow for the inclusion of up to 5% (by weight) of inorganic process additions; this was expected to lead to more widespread use of GBFS as a grinding aid in cement manufacture.

In May, the U.S. Environmental Protection Agency (EPA) proposed, within a set of National emissions standards for hazardous air pollutants (NESHAP) for the U.S. cement industry, new, very low, limits on emissions of certain pollutants, most notably of mercury (U.S. Environmental Protection Agency, 2009). The NESHAP had the potential, through the closure of plants unable to meet the new limits, to reduce the supply of domestically produced cement on the U.S. market and thus to increase demand for alternative or supplementary cementitious materials (SCM) such as GGBFS and fly ash. The proposed rule likely would make fly ash (typically relatively high in mercury) less attractive as an alternative raw material for clinker manufacture and thus might increase demand for slag for this purpose. The EPA was also evaluating the reclassification of coal combustion byproducts, including fly ash, as hazardous waste for landfill disposal purposes (but not for beneficial use purposes). If even a limited designation as hazardous waste were to stigmatize fly ash, construction market demand for this material might fall significantly. It is unclear if the supply of GGBFS and other SCM would be adequate to fill the fly ash void, and this availability issue might work against efforts to promote increased use of these materials.

Production

Data on actual annual production of slag are generally unavailable because the amount of slag tapped is not routinely measured; also, not all of the slag formed is tapped during a heat. However, U.S. and world production of ferrous slags can be broadly estimated based on typical slag to metal production ratios, which in turn are related to the chemistry of the ferrous feeds to the furnaces. For typical iron ore grades (60% to 66% iron), a blast furnace normally will produce about 0.25 to 0.30 metric tons (t) of slag per metric ton of crude or pig iron produced. For ores of lower than average grade, the slag output will be higher, in some cases as much as 1.0 to 1.2 t of slag per ton of crude iron. Steel furnaces typically produce about 0.2 t of slag per ton of crude steel, but up to 50% of this slag is entrained metal, most of which is generally recovered during slag processing and returned to the furnace. The amount of marketable steel slag remaining after entrained metal removal is thus usually equivalent to about 10% to 15% of the crude steel output. Using these ratios and data for U.S. and world iron and steel production from the American Iron and Steel Institute (2009, p. 121–126), U.S. blast furnace slag production in 2009 was estimated to be in the range of about 5 to 6 Mt, and world

output, 230 to 270 Mt. Similarly, U.S. output of steel slag (after metal removal) in 2009 was estimated to be 6 to 9 Mt, and world output, 120 to 180 Mt. Apparent production of slag may differ from the sales of slag (table 1) because of a combination of undocumented returns of slag to the furnaces, stockpiling of slag by the processors, and sales from stockpiles.

The market uses for ferrous slag are determined mainly by how the slag is cooled. Marketed blast furnace slags are of three main types—air-cooled, granulated, and pelletized (or expanded). Air-cooled blast furnace slag is formed by allowing the molten slag to cool relatively slowly under ambient conditions; final cooling can be accelerated with a water spray. Although it can have a vesicular texture with closed pores, the cooled slag is hard and dense and is especially suitable for use as construction aggregates. Formation of GBFS is by quenching molten slag in water to form sand-sized particles of glass. The disordered structure of this glass gives the material inherent moderate hydraulic cementitious properties when the slag is very finely ground, and the cementitious properties become strong if the GGBFS accesses free lime during hydration. Pelletized or expanded slag is cooled through a water jet, which leads to rapid steam generation and the development of innumerable vesicles within the slag. The vesicular texture reduces the overall density of the slag and allows for good mechanical binding with hydraulic cement paste. This slag type is most commonly used as a lightweight aggregate, but if very finely ground, it can have cementitious properties similar to those of GGBFS. Blast furnace slag (generally air-cooled) also can be made into mineral wool. Slag for this purpose is remelted and then poured through an air stream or jet of steam or other gas to produce a spray of molten droplets; alternatively, the droplets can be formed by passing the melt through a perforated or fast spinning disc. The droplets elongate into long fibers that are collected and layered, and this material is suitable for use as thermal insulation.

Steel furnace slag is cooled similarly to air-cooled blast furnace slag, has similar properties to it, and is used for some of the same purposes. Steel slags containing large amounts of dicalcium silicate are prone to expansion and commonly are cured in piles for several months to allow for the expansion and for leaching out of lime.

Consumption

Data in this report are based on an annual U.S. Geological Survey (USGS) canvass of slag processors and importers and relate to sales of processed slag, not the amount of slag produced or processed during the year. Processed slag is sold from stockpiles and although most of the material is a byproduct of current or recent iron and steel output or is of imported material, some slag sales are of material mined from old slag piles (slag banks) produced by iron and steel plants now closed. In 2009, canvasses were sent to 22 companies, covering 137 processing and (or) importation sites, and at least partial data (some as consolidated responses) were received for 130 sites; the reported data accounted for slightly more than 96% of the total iron and steel slag total in table 1. For 2008, canvasses were sent to 28 companies, covering 135 processing sites, and at

least partial data were received for 122 of the sites, accounting for slightly more than 90% of the gross tonnage listed for the year. Owing to a wide range in the level of data detail reported to the USGS and the need to estimate activities of survey nonrespondents, the data in table 1 have been heavily rounded. For both years, data on pelletized blast furnace slag have been withheld to avoid disclosing company proprietary data, but the quantities sold were very small. Sales data for granulated slag in both years exclude material sold by importers who as yet do not take part in the USGS canvass.

Sales data exclude much of the ferrous slag returned to the furnaces and the weight of free metal recovered from the slag. For both years, air-cooled blast furnace slag and steel furnace slag together accounted for 82% of sales tonnages; however, the tonnages for both slag types fell by about one-third in 2009 (table 1). Although both slag types are used in the general construction sector, their market areas tend to be somewhat restricted geographically relative to natural construction materials, and sales are commonly based upon long-term contracts; both factors have tended to protect slag sales in some years (such as in 2008) relative to competing materials. In contrast to relative sales volumes in 2008, the percentage decline in sales of slag in 2009 was larger than that of some other, more widely consumed, construction materials canvassed by the USGS [cement (as a proxy for concrete overall), down by 26%; crushed stone, down by 20%; and sand and gravel, down by 25%]. All of these declines reflected low construction spending levels; those for slag, however, appear to have also reflected reduced supplies resulting from wholesale closure or long-term idling of blast furnaces and steel furnaces during the year and an increasing trend for steel companies to take back more of the slag for use as a flux and (or) ferrous feedstock.

Air-cooled blast furnace and steel furnace slags are used primarily for a variety of aggregate applications (table 3). Because of potential expansion problems, steel slag finds little use in applications requiring maintenance of a fixed volume (for example, concrete). Both slag types also are used as a raw material for cement (clinker) manufacture (the slag contributes several major oxides), but steel slag has proven to be especially suitable for this use. Differences evident among the usage breakout percentages for these two slag types in table 3 are difficult to evaluate because the data incorporate estimates, and much of the plant-level data reported in recent years have revealed only the dominant use(s) for the slag and thus the less common uses are likely understated.

Despite the significantly lower tonnages sold in 2009, selling prices for air-cooled and steel furnace slags appear to have fallen only modestly (table 2); however, the changes shown may not be statistically significant owing to the incorporation of estimates and a lack of response detail on many canvasses. Because of generally low unit sales values, slag sold for aggregate generally cannot be economically transported over long distances, particularly overland. Thus, the major factors affecting the sales volumes and prices of these two slag types are dominated by local competition from natural aggregates, the overall level of construction activity (particularly that for roads), and the existence of long-term supply contracts. Air-cooled and steel furnace slags sold for uses other than aggregates can

command higher prices than slags sold as aggregates. Pelletized slag (not revealed in tables 1–3) can sell for prices well above those for air-cooled slag.

Sales of GBFS slag decreased by 31% to 2.2 Mt in 2009, and while this was only 18% of total slag sales tonnages, GBFS accounted for 73% of the value of total slag sales and 84% of the value of blast furnace slag sales, owing to the high unit value of the granulated material (tables 1, 2). Actual sales of GBFS in some years have been higher than those shown in table 1 because of some imports being missed by the USGS canvass; however, it is unclear if this was the case in 2009. About 92% of total reported GBFS sales represented GGBFS and the rest was unground material; the GGBFS fraction in 2008 was about 86%. The high unit sales value of GBFS reflects the dominant use of GGBFS as a partial substitute for portland cement in blended cements and in concrete. In concrete containing a proportion of GGBFS, hydration of portland cement releases the lime needed to fully activate the slag. Concretes incorporating GGBFS generally develop strength more slowly than concretes that contain only portland cement but can have similar or even superior long-term strength, release less heat during hydration, have reduced permeability, and generally exhibit improved resistance to chemical attack. Despite its relatively high unit price, GGBFS still sells at a 20% to 25% discount to portland cement. Unground GBFS was sold primarily to cement plants, to dedicated slag-grinding plants for conversion to GGBFS, or to cement plants to be used as a grinding aid (for portland cement) in their finish mills. Overall sales for cementitious uses of GBFS and GGBFS totaled 2.1 Mt in 2009, down by 25%. A small fraction of the unground GBFS on the market has been sourced from old slag piles and lacks cementitious character as a result of weathering; this material still has use in concrete (as a fine grain aggregate), but sells for much lower prices than those indicated for the cementitious material in table 2.

The USGS slag survey does not distinguish between GBFS sold directly to cement companies and that sold directly to concrete companies, but data from recent USGS cement surveys indicate that cement producers consume only about 15% of the total granulated slag sold. Sales in the United States of GGBFS under the designation “slag cement” are promoted by the Slag Cement Association (SCA), whose members accounted for much of the country’s GGBFS output. The SCA reported sales by its members of 2.1 Mt of GGBFS in 2009, a decline of 31% (Slag Cement Association, unpub. data, November 2010).

Foreign Trade

Slag imports are dominated by GBFS, but the data within the appropriate tariff code commonly contain entries that, because of unreasonably high or low unit dollar values, are likely either slags from other metallurgical industries or are not slag at all (such as silica fume, cenospheres from fly ash, other industrial residues). Thus, while the data from the U.S. Census Bureau list imports of granulated slag totaling about 1.28 Mt in 2009, down only by about 3% from levels in 2008, the true GBFS tonnages within the data for both years are unclear. Taken without adjustment, the leading import sources of GBFS tonnages in 2009 were Japan (50%), Canada (38%), South Africa (7%), and Italy (3%). Comparison of the Census Bureau import

data for slag with data from the United Business Media Ltd.’s Port Import Export Reporting Service (PIERS) has generally revealed higher totals for PIERS in recent years, suggesting that the Census Bureau data were incomplete. In 2009, however, the PIERS total was just 1.12 Mt. Much of the difference in 2009 stems from an apparent absence of imports from South Africa in the PIERS data; the very high unit value for this material in the Census Bureau data suggests that the South African material may not have been slag at all. Both data sets showed abnormally low unit values for 0.1 Mt to 0.2 Mt of the material from Japan; informal information about this material indicates that it was slag from another metallurgical industry and not GBFS.

Outlook

Construction spending levels, especially for public sector projects, will continue to be the key determinant of sales of ferrous slags for use as aggregates. Demand for slag is expected to benefit from Government programs to promote the use of recovered mineral components in public sector construction projects but may not be able to capture a large share of this market because of limited slag availability. The declining number of operating blast furnaces in the United States makes the future supply of air-cooled blast furnace slag highly vulnerable to even temporary closure of integrated iron and steel complexes, such as were experienced in 2009. Steel slag supplied from basic oxygen furnaces is also vulnerable to closures, although overall slag availability from electric arc furnaces is more assured. A growing constraint on steel slag availability is a recent tendency for steel plants to retain more slag for return to the furnaces at times of high prices for iron ore and scrap. In terms of actual sales volumes, however, the effects of these increased returns to the furnace are hard to quantify because of the tendency of slag processors to stockpile slag so as to be able to bid on large projects. Slags are useful alternative raw materials for clinker production, and such use can reduce a cement plant’s fuel consumption and overall emissions of carbon dioxide. Availability of sufficient slag near the cement plant will continue to be a major determinant of demand for this purpose, as will the slag’s chemical suitability.

Growing acceptance of GGBFS as a component of finished cement and concrete would seem to assure a steady demand for this slag type, contingent on overall construction levels. The supply of GBFS from domestic blast furnaces is severely constrained by the fact that granulation cooling is currently installed at only four blast furnaces in the United States. Installation of granulators at other blast furnaces is possible but expensive and would hinge on the perception of the specific furnace’s future viability. Further, some blast furnaces produce a slag that, while suitable for aggregate use, is chemically unsuitable for use as GBFS. It is likely that significant future growth in the domestic market for GGBFS will hinge on increased availability of imported material.

Current proposed changes in environmental rules governing the manufacture of portland cement and the characterization of fly ash have the potential of increasing the demand for slag as an alternative raw material for clinker manufacture and as an SCM. This assumes that supplies of portland cement and SCM in general do not become so constrained as to cause delays to,

or cancellation of, construction projects, or make impractical the widespread use of SCM in concrete.

References Cited

American Iron and Steel Institute, 2009, Annual statistical report: Washington, DC, American Iron and Steel Institute, 126 p.
 U.S. Environmental Protection Agency, 2009, National emissions standards for hazardous air pollutants from the portland cement manufacturing industry; proposed rule; Federal Register, 40 CFR Parts 60 and 63, v. 70, no. 86, May 6, p. 21136–21192.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publication

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

Other

National Slag Association.
 Portland Cement Association.
 Slag Cement Association.

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

(Million metric tons and million dollars)

| | 2008 | | | | | 2009 | | | | |
|--------------------|---------------------------------|------------|--------------------|--------------------|---------------------------|---------------------------------|------------|--------------------|--------------------|---------------------------|
| | Blast furnace slag ¹ | | | Steel furnace slag | Total iron and steel slag | Blast furnace slag ¹ | | | Steel furnace slag | Total iron and steel slag |
| | Air-cooled | Granulated | Total ² | | | Air-cooled | Granulated | Total ² | | |
| Quantity | 6.9 | 3.2 | 10.1 | 8.7 | 18.8 | 4.6 | 2.2 | 6.8 | 5.7 | 12.5 |
| Value ^e | 53 | 236 | 288 | 43 | 332 | 33 | 172 | 205 | 30 | 235 |

^eEstimated.

¹Excludes expanded (pelletized) slag to protect company proprietary data. The quantities are very small (about 0.1 unit or less).

²Data may not add to totals because of independent rounding.

TABLE 2
 SELLING PRICES FOR IRON AND STEEL SLAG IN THE UNITED STATES¹

(Dollars per metric ton)

| Slag type | 2008 | | 2009 | |
|----------------------------|----------------|---------|----------------|---------|
| | Range | Average | Range | Average |
| Blast furnace slag: | | | | |
| Air-cooled | 1.84 – 19.84 | 7.64 | 3.31 – 19.84 | 7.35 |
| Granulated ² | 24.65 – 100.50 | 82.64 | 20.00 – 100.00 | 81.37 |
| Steel furnace slag | 0.20 – 15.39 | 5.02 | 0.19 – 14.66 | 5.28 |

¹Data contain a large component of estimates and some respondents provide values only on their total sales of a slag type, not value by type of use. Thus the value ranges shown are likely too restrictive.

²Values are for material reported for use as a cementitious additive in cement or concrete manufacture. Material at or near the low end of the range was sold in unground form. Sales other than for cementitious use were generally at unit values below the ranges shown.

TABLE 3
SALES OF FERROUS SLAGS IN THE UNITED STATES, BY USE¹

(Percentage of total tons sold)

| Use | 2008 | | | 2009 | | |
|----------------------------|---------------------------------|------------|---------------|---------------------------------|------------|---------------|
| | Blast furnace slag ² | | Steel slag | Blast furnace slag ² | | Steel slag |
| | Air-cooled | Granulated | | Air-cooled | Granulated | |
| Ready-mixed concrete | 18.1 | -- | -- | 16.9 | -- | -- |
| Concrete products | 3.2 | -- | -- | 3.7 | -- | -- |
| Asphaltic concrete | 13.4 | -- | 10.9 | 16.8 | -- | 8.2 |
| Road bases & surfaces | 40.2 | 9.4 | 60.3 | 39.1 | 4.2 | 59.9 |
| Fill | 12.7 | -- | 10.8 | 9.3 | -- | 12.7 |
| Cementitious material | -- | 87.1 | -- | -- | 94.3 | -- |
| Clinker raw material | 2.8 | 2.5 | 5.0 | 0.9 | 1.0 | 2.2 |
| Miscellaneous ³ | 8.2 | -- | 0.5 | 11.9 | 0.5 | 0.5 |
| Other or unspecified | 1.3 | 1.0 | 12.7 | 1.4 | -- | 16.5 |

-- Zero.

¹A number of respondents provide breakouts that represent only the dominant use(s) of their slag; accordingly, the minor use categories are likely underreported. The data also incorporate some estimates and thus should be viewed as good to no more than two significant figures.

²Excludes expanded or pelletized slag; this material is generally sold as a lightweight aggregate.

³Reported as used for mineral wool, railroad ballast, roofing, sewage treatment, or soil conditioner.

TABLE 4
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2009

| Slag Processing Company | Plant Location | Steel Company Serviced ^{2,3} | Slag and furnace types ¹ | | | | | | |
|------------------------------|--|---------------------------------------|-------------------------------------|----|-----|--------------------|-----|-----|---|
| | | | Blast furnace slag | | | Steel furnace slag | | | |
| | | | AC | GG | Exp | BOF | OHF | EAF | |
| Alexander Mill Services Inc. | Hollsopple, PA | North American Höganäs, Inc. | | | | | | | X |
| Barfield Enterprises, Inc. | LaPlace, LA | ArcelorMittal USA | | | | | | | X |
| Beaver Valley Slag | Aliquippa, PA | Old slag pile site | X | | | | X | X | |
| Beelman Truck Co. | Granite City, IL ⁴ | United States Steel Corp. | X | | | | | | |
| Beemsterboer Slag Corp. | East Chicago, IN | ArcelorMittal USA (East side) | X | | | | | | |
| Do. | Gary, IN | United States Steel Corp. | X | | | | | | |
| Blackheart Slag Co. | Muscatine (Montpelier), IA | SSAB North America | | | | | | | X |
| Edward C. Levy Co. | Decatur (Trinity), AL | Nucor Corp. | | | | | | | X |
| Do. | Butler, IN | Steel Dynamics, Inc. | | | | | | | X |
| Do. | Columbia City, IN | do. | | | | | | | X |
| Do. | Crawfordsville, IN | Nucor Corp. | | | | | | | X |
| Do. | East Chicago (Indiana Harbor), IN | ArcelorMittal USA (West side) | X | | | | | | |
| Do. | Detroit, MI | Severstal North America, Inc. | X | | | | X | | |
| Do. | do. | United States Steel Corp. | X | | | | X | | |
| Do. | Columbus, MS | Severstal North America, Inc. | | | | | | | X |
| Do. | Delta, OH | North Star BlueScope Steel LLC | | | | | | | X |
| Do. | Canton, OH | The Timken Co. | | | | | | | X |
| Do. | Huger, SC | Nucor Corp. | | | | | | | X |
| Do. | Seattle, WA | do. | | | | | | | X |
| Essroc Corp. | Middlebranch, OH | Miscellaneous domestic & foreign | | | | X | | | |
| Fritz Enterprises, Inc. | Birmingham (Fairfield), AL ⁵ | United States Steel Corp. | X | X | | | X | | |
| Do. | Sparrows Point, MD | Severstal North America, Inc. | X | | | | | | |
| Gerdau Ameristeel Corp. | Jacksonville, FL | Gerdau Ameristeel Corp. | | | | | | | X |
| Do. | Charlotte, NC | do. | | | | | | | X |
| Holcim (US) Inc. | Birmingham (Fairfield), AL ⁵ | United States Steel Corp. | | | | X | | | |
| Do. | Camden, NJ | Foreign | | | | X | | | |
| Do. | Gary, IN | United States Steel Corp. | | | | X | | | |
| Lafarge North America Inc. | South Chicago, IL | ArcelorMittal USA | | | | X | | | |
| Do. | East Chicago (Indiana Harbor), IN ⁶ | do. | | | | X | X | | |
| Do. | Sparrows Point, MD | Severstal North America, Inc. | X | X | | | | | |
| Do. | Cleveland (Cuyahoga Co.), OH ⁴ | ArcelorMittal USA | X | | | | | | |
| Do. | Lordstown, OH | Old slag pile site | | | | X | | | |
| Do. | McDonald, OH | do. | X | | | | | | |
| Do. | Salt Springs (Youngstown), OH | do. | X | | | | | | |
| Do. | Warren, OH | Severstal North America, Inc. | X | | | | | | |
| Do. | West Mifflin (Duquesne), PA | United States Steel Corp. (ET Works) | X | | | | | | |

See footnotes at end of table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2009

| Slag Processing Company | Plant Location | Steel Company Serviced ^{2,3} | Slag and furnace types ¹ | | | | | |
|--------------------------------------|---|---------------------------------------|-------------------------------------|----|-----|--------------------|-----|-----|
| | | | Blast furnace slag | | | Steel furnace slag | | |
| | | | AC | GG | Exp | BOF | OHF | EAF |
| Lafarge North America Inc.—Continued | Seattle, WA | Foreign | | X | | | | |
| Lehigh Cement Co. | Evansville, PA | do. | | X | | | | |
| Lehigh/Hanson Slag Cement, Inc. | Cape Canaveral, FL | do. | | X | | | | |
| Lehigh Northeast Cement Co. | Cementon, NY | do. | | X | | | | |
| The Levy Co., Inc. | Burns Harbor, IN | ArcelorMittal USA | X | | | | X | |
| Mountain Enterprises, Inc. | Ashland, KY ⁴ | AK Steel Corp. | X | | | | | |
| MultiServ | Birmingham, AL | SMI/CMI Steel Group | | | | | | X |
| Do. | Blytheville, AR | Nucor Corp. | | | | | | X |
| Do. | Blytheville (Armored), AR | Nucor-Yamato Steel Co. | | | | | | X |
| Do. | Pueblo, CO | Evrz Inc. NA | | | | | | X |
| Do. | Wilton (Muscatine), IA | SSAB North America | | | | | | X |
| Do. | Indiana Harbor, East Chicago, IN ⁷ | ArcelorMittal USA | | | | | X | |
| Do. | Pittsboro, IN | Steel Dynamics, Inc. | | | | | | X |
| Do. | Ghent, KY | Gallatin Steel Co. | | | | | | X |
| Do. | do. | North American Stainless | | | | | | X |
| Do. | Ahoskie (Cofield), NC | Nucor Corp. | | | | | | X |
| Do. | Canton, OH ⁸ | Republic Engineered Products, Inc. | | | | | | X |
| Do. | Mansfield, OH | AK Steel Corp. | | | | | X | |
| Do. | Warren, OH | Severstal North America, Inc. | | | | | X | |
| Do. | Brackentridge, PA | Allegheny Ludlum Corp. | | | | | | X |
| Do. | Butler, PA | AK Steel Corp. | | | | | | X |
| Do. | Coatsville, PA | ArcelorMittal USA | | | | | | X |
| Do. | Koppel, PA | TMK IPSCO | | | | | | X |
| Do. | Latrobe, PA | Allegheny Ludlum Corp. | | | | | | X |
| Do. | Natrona Heights, PA | do. | | | | | | X |
| Do. | Steelton, PA | ArcelorMittal USA | | | | | | X |
| Do. | Midlothian, TX | Gerdau Ameristeel Corp. | | | | | | X |
| Do. | Geneva (Provo), UT | Old slag pile site | | | X | | | |
| Phoenix Services LLC | Riverdale, IL | ArcelorMittal USA | | | | | | X |
| Do. | Indiana Harbor, East Chicago, IN ⁷ | do. | | | | | | X |
| Do. | Wilton, IA | Gerdau Ameristeel Corp. | | | | | | X |
| Do. | Sparrows Point, MD | Severstal North America, Inc. | | | | | | X |
| Do. | Latrobe, PA | Latrobe Specialty Steel Co. | | | | | | X |
| Do. | Vinton (El Paso), TX | ArcelorMittal USA | | | | | | X |
| Do. | Roanoke, VA | Steel Dynamics, Inc. | | | | | | X |
| Do. | Weirton, WV | Old slag pile site | | | | | | X |

See footnotes at end of table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2009

| Slag Processing Company | Plant Location | Steel Company Serviced ^{2,3} | Slag and furnace types ¹ | | | | | |
|--------------------------------|---------------------------|--|-------------------------------------|----|--------------------|-----|-----|-----|
| | | | Blast furnace slag | | Steel furnace slag | | | |
| Tube City IMS, LLC —Continued: | | | AC | GG | Exp | BOF | OHF | EAF |
| Do. | Mingo Junction, OH | Severstal North America, Inc. | X | | | X | | X |
| Do. | Youngstown, OH | V&M Star | | | | | | X |
| Do. | Sand Springs, OK | Gerdau Ameristeel Corp. | | | | | | X |
| Do. | Braddock, PA | United States Steel Corp. | | | | | X | |
| Do. | Bridgeville, PA | Universal Stainless & Alloy Products, Inc. | | | | | | X |
| Do. | Midland, PA | Allegheny Ludlum Corp. | | | | | | X |
| Do. | New Castle, PA | Ellwood Quality Steels Co. | | | | | | X |
| Do. | Park Hill (Johnstown), PA | Old slag pile site | X | | | | | X |
| Do. | Pricedale, PA | do. | | | | | X | |
| Do. | Reading, PA | Carpenter Technology Corp. | | | | | | X |
| Do. | Cayce, SC | SMI/CMC Steel Group | | | | | | X |
| Do. | Darlington, SC | Nucor Corp. | | | | | | X |
| Do. | Jackson, TN | Gerdau Ameristeel Corp. | | | | | | X |
| Do. | Knoxville, TN | do. | | | | | | X |
| Do. | Beaumont, TX | do. | | | | | | X |
| Do. | Jewett, TX | Nucor Corp. | | | | | | X |
| Do. | Lone Star, TX | Lone Star Steel Co. | | | | | | X |
| Do. | Longview, TX | LeTourneau Technologies Steel Products | | | | | | X |
| Do. | Seguin, TX | SMI/CMC Steel Group | | | | | | X |
| Do. | Plymouth, UT | Nucor Corp. | | | | | | X |
| Do. | Petersburg, VA | Gerdau Ameristeel Corp. | | | | | | X |
| Do. | Saukville, WI | Charter Steel | | | | | | X |
| Uniserve LLC | Newport, AR | Arkansas Steel Associates, LLC | | | | | | X |
| Do. | Gallatin, TN | Hoegaenaes Corp. | | | | | | X |
| Vulcan Materials Co. | Tampa, FL | Foreign | | | | | | X |
| Do., do. ditto. | | | | | | | | |

¹Blast furnace slag type abbreviations: AC = air-cooled; GG = granulated; Exp = expanded. Steel furnace slag types: BOF = basic oxygen furnace; OHF = open hearth furnace; EAF = electric arc furnace.

²“Foreign” refers to the fact that the facility imports unground granulated blast furnace slag and grinds it onsite to make ground granulated blast furnace slag—commonly now referred to as “slag cement.” “Domestic” implies grinding slag sourced from the domestic market, not a service contract.

³Currently operating iron and (or) steel company. Company is not shown for old slag pile sites.

⁴For the air-cooled slag, Stein was responsible for the cooling but the processing and marketing were handled by Beelman Trucking (Granite City, IL), Lafarge Corp. (Cleveland, OH), and Mountain Enterprises, Inc. (Ashland, KY), respectively.

⁵For granulated slag, Fritz Enterprises operates the granulator but Holcim owns the apparatus and markets the slag.

⁶Lafarge grinds some of the granulated slag from East Chicago, IN, at several of its cement plants located elsewhere.

⁷Phoenix Services LLC was awarded the contract for the “west side” at Indiana Harbor in February 2009 and that for the “east side” in August 2009.

⁸Contract was transferred to Stein, Inc. in August 2009.