



2012 Minerals Yearbook

SLAG—IRON AND STEEL

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By Hendrik G. van Oss

About 16.0 million metric tons (Mt) of iron and steel slag was sold by U.S. slag processors in 2012, up by about 4% from total sales in 2011 (table 1). The value of slag sales increased by about 5% to an estimated \$275 million.

Ferrous slags are produced 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 being cooled by various means to solid form, the slag is processed and may then be sold or, in some cases, returned to the furnace. Most types of processed slag have very much lower unit values than do iron and steel (metal) and, for this reason, iron and steel companies generally contract with outside slag-processing companies to cool the slag and to remove it. 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 can be returned to the furnaces for use as flux and as a supplemental source of iron, but despite having a value, this return flow is not always included in the tonnages of slag reported as sold.

A listing of slag processors, processing sites, slag types, 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 because it is common for integrated iron and steel plants to have processing or marketing contracts with various companies for different types of slag produced at the plant. In some cases, the slag is cooled by one company but is then further processed or marketed by another company or at another site.

Legislation and Government Programs

The market for slag for construction is influenced by Federal and State programs that affect construction spending, encourage the use of “alternative” materials in construction, and that may affect the availability of competing alternative or natural materials. Slags are considered to be sustainable raw materials mainly because they can substitute directly or indirectly for virgin 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 [either GGBFS or unground material (GBFS)] in the finish mill allows more finished cement to be made from the same amount of clinker.

The future viability of some cement plants may be in jeopardy as a result of the very low limits for emissions of mercury, total hydrocarbons, hydrochloric acid, and particulates, set forth in a 2010 final rule within the National Emissions Standards for Hazardous Air Pollutants (NESHAP) and various amendments to the 2010 rule, but for which the compliance date was, in 2012, proposed to be extended to September 2015 (U.S. Environmental Protection Agency, 2012). Should plants close as a result of the NESHAP, the supply of domestically produced cement on the U.S. market would be reduced and likely could not be entirely offset in some markets by increased cement imports. This has the potential to increase demand for alternative or supplementary cementitious materials (SCM), such as GGBFS and fly ash. Also, the NESHAP 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 U.S. Environmental Protection Agency continued to evaluate proposals to reclassify coal combustion byproducts, including fly ash, as hazardous waste for landfill disposal purposes but not for beneficial use purposes. Should fly ash become stigmatized as a result of even a limited designation as hazardous waste, construction market demand for this material might fall significantly. It remained 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

The amount of slag tapped from the furnaces is not routinely measured and not all of the slag formed is tapped during a heat; accordingly, data on annual production of slag are generally unavailable. Output levels 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 would likely be 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 (2012, p. 117–122), U.S. blast furnace slag production in 2012 was estimated to be in the range of about

8 to 10 Mt, and world output, 280 to 330 Mt. Similarly, U.S. output of steel slag (after metal removal) in 2012 was estimated to be 9 to 13 Mt, and world output, 160 to 230 Mt. Estimated production of slag usually will differ from total sales of slag (table 1) because of a combination of undocumented returns of slag to the furnaces, stockpiling of slag by processors, and sales from stockpiles, including material in old piles (slag banks) from iron and steel plants long-since closed.

The commercial 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, air-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 (GGBFS), and the cementitious properties become strong if the material accesses free lime. In concrete having a proportion of GGBFS in the mix, 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. 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, which itself is glassy. The vesicles reduce the overall density of the slag and allow for good mechanical binding with hydraulic cement paste. This slag type is most commonly used as a lightweight aggregate but when very finely ground, can have cementitious properties similar to those of GGBFS. Blast furnace slag (generally air-cooled) also can be made into mineral wool. For this purpose, slag 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.

Iron and steel slags also find uses in environmental applications, such as water filtration, although the data on such uses, in terms of tonnages consumed, are very incomplete.

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 rather than 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 slag banks produced by iron and steel plants now long closed. In 2012, canvasses were sent to 24 companies, covering 138 processing and (or) importation sites, and at least partial data (some within consolidated responses) were received for 135 sites; the reported data accounted for 94% of the total iron and steel slag tonnage for 2012 in table 1. In 2011, canvasses were sent to 25 companies, covering 134 sites, and at least partial data were received for 131 sites, accounting for 98% of the gross tonnage listed for the year. Because responses to the USGS canvasses vary greatly in the detail provided and because estimates were made where needed, the tonnage data in table 1 have been rounded to the nearest 0.1 Mt. For both years, data on pelletized blast furnace slag have been withheld to avoid disclosing company proprietary information, but the quantities sold were very small. Sales data for granulated slag in both years exclude material sold by a few importers who as yet do not take part in the USGS canvass. Slag sales data in table 1 also exclude the free metal recovered from the slag; this metal is sold separately.

Domestic production of crude iron and crude steel increased in 2012 by 6.1% and 2.7%, respectively (American Iron and Steel Institute, 2012, p. 117–120), and this would imply a similar increase in slag production and availability. However, actual construction market availability of slag is difficult to evaluate. Overall slag sales data reported to the USGS commonly exclude a significant fraction of the slag (especially steel furnace slag) returned to the furnaces. In 2012, a 39% increase was reported in the tonnage of slag (all as steel slag) reported as returned to the furnace relative to the amount reported in 2011. It was unclear if this increase reflected underreporting of the returns in 2011 (which were 20% less than those reported for 2010), more complete reporting in 2012, or an actual increase in the returns in 2012. Slag returns to the furnaces would be expected to increase if the price of major ferrous feeds (ores and scrap) increased; however, prices in 2012 for iron ore were relatively stagnant, and for U.S. iron and steel scrap, actually somewhat lower.

Air-cooled blast furnace slag and steel furnace slag together accounted for about 83% of total sales tonnages in 2011 and almost 86% in 2012 (table 1). These two types of slag are used as aggregates in general construction (table 3) but, as low unit price materials, can really only service market regions close to active iron and steel furnaces or to slag banks so as to avoid long-distance transportation charges. These constraints, along with the common existence of long-term sales contracts and tendencies by processors to stockpile slag to allow bidding on large contracts, result in trends in slag consumption volumes that commonly differ, at least in percentage change terms, from those for sales of competing natural aggregates and for cement. The 4% increase noted earlier in overall slag sales in 2012 may thus be compared to USGS monthly and quarterly data for total sales of crushed stone (largely for aggregate), which were virtually unchanged in 2012; sales of construction sand and gravel, up by about 1%; and sales of portland and blended cement (a proxy for concrete consumption), up by 8.9%.

Most air-cooled blast furnace and steel furnace slag is sold into 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 but steel slag has proven to be especially suitable for this use. Relative changes, especially small percentages, in the sales by type of use 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, leaving the less common uses understated. Thus, for example, the steel slag sales for use as a raw material for clinker manufacture appear to have fallen significantly in 2012 to only about 145,000 t, but this is in contrast to more detailed USGS data for raw materials consumed by the U.S. cement industry, which (despite some ambiguity in slag identities) show a steel slag consumption for clinker in 2012 of 444,000 t, an increase of 50%. Although it is possible that the cement industry in 2012 sourced a majority of its slag from stocks already in hand (that is, purchased prior to 2012), it is more likely that the slag sales for clinker manufacture in table 3 are underreported relative to some more general use category (perhaps fill). Among the general construction aggregate categories for air-cooled slag, the apparent changes in the split between ready-mixed concrete and concrete products may simply reflect reporting ambiguities; the sum of these two concrete applications did not change much. Likewise, a reporting assignment issue may explain the shifts in sales of air-cooled slag for road bases and surfaces versus those for fill.

Although representing just 15% of the total sales tonnage, sales of granulated blast furnace slag in 2012 accounted for 70% of the total value of slag sales and 83% of the blast furnace slag subset in table 1. 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 significant in 2011–12. In 2012, all of the granulated slag sales in table 1 were of GGBFS. In recent years, a modest fraction (8% in 2011) of the granulated slag was reported as sold unground and was mainly of weathered material that had been sold as a fine aggregate at unit prices much lower than those for GGBFS. Overall sales of GGBFS for cementitious use totaled 2.4 Mt in 2012, significantly unchanged.

No distinction is made in the USGS slag survey between combined GBFS and GGBFS sold directly to cement companies and GGBFS sold directly to concrete companies, but data from recent USGS cement canvasses indicate that cement producers consume only about 12% to 15% of the total granulated slag sold, including that used to make clinker, blended or masonry cement, or used as a grinding aid to make portland cement. Sales in the United States of GGBFS under the designation “slag cement” are promoted by the Slag Cement Association (SCA), whose members account for much of the country’s GGBFS output and sales. The SCA reported sales by its members of 2.3 Mt of GGBFS in 2012, an increase of 11.2%; nearly 2.2 Mt of this total was as direct sales and the remainder was material within blended cements (Slag Cement Association, 2013; Slag Cement Association, unpub. data, August 23, 2013).

Prices

Average sales prices for air-cooled blast furnace slag and for steel slag appear not to have changed significantly in 2012 (table 2). Major market factors affecting the 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. The average high unit sales value of granulated slag reflects the dominant use of GGBFS as a partial substitute for portland cement in blended cements and, especially, in concrete. Despite its relatively high unit price, GGBFS had, for many years, sold at a 20% to 25% discount to portland cement, but the discount in 2011–12 was about 15%, owing to relatively low prices for portland cement in these years.

Foreign Trade

Most actual iron and steel slag imports were of granulated slag (GBFS or GGBFS). However, import data within the granulated slag tariff code (HTS 2618.00) commonly contain entries that, based on excessively high or low unit dollar values, are either slags of other metallurgical industries (especially copper slag) or are unrelated materials altogether (such as silica fume, fly ash pozzolan, cenospheres from fly ash, other industrial residues, or metal concentrates). For example, data from the U.S. Census Bureau listed imports of “granulated iron and steel slag” under tariff code HTS 2618.00 totaling about 1.59 Mt in 2012, a decrease of 14% from the equivalent total in 2011. However, only about 1.13 Mt of the 2012 total appeared to actually be granulated blast furnace slag, and this total becomes 1.23 Mt if likely granulated slag imports within tariff code HTS 2619.00 are added. Within tariff code HTS 2618.00, about 0.4 Mt of the material excluded in the adjusted total above was inexpensive copper slag from Japan imported for use as an iron feed and as sand-blasting grit. Retained within the adjusted total of HTS 2618.00 was a modest amount of pelletized blast furnace slag from Canada that was imported for grinding into a form of GGBFS.

Data from the United Business Media Ltd.’s PIERS has, in most years, revealed higher totals for tariff code HTS 2618.00 imports than did the Census Bureau, but when adjusted to remove material that was revealed or suspected not to be GBFS, the PIERS total in 2011, nearly 1.5 Mt, was slightly lower than that for the Census data. In 2012, the PIERS grand total was 1.85 Mt, and this adjusts to 1.43 Mt after excluding about 0.4 Mt of copper slag.

Census Bureau data for slag exports included many low tonnage shipments of very high unit value that were unlikely to be slag. Exports having unit values suggestive of granulated slag totaled only about 31,000 t in 2012; PIERS reported only 800 t.

Outlook

Most ferrous slag will continue to be used in the construction sector and consumption levels will thus depend on construction

spending levels, especially for public sector projects, perceived applicability of slag for specific construction applications, and, especially for aggregate applications, slag availability near the construction projects. Slag sales should 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 U.S. cement industry is under pressure to reduce its carbon dioxide emissions and to reduce fuel costs, and this could increase demand for slag as a raw material to partially substitute for limestone in the manufacture of clinker. Demand for this purpose could also increase if the cement industry reduces its consumption of fly ash in an effort to reduce mercury emissions. However, availability of sufficient slag near cement plants will continue to be a major determinant of demand for slag for clinker manufacture, as will the slag's chemical suitability. Long-term availability is especially problematic for blast furnace slag, because all of the U.S. blast furnaces are old, costly to operate, and require very expensive major periodic maintenance. In addition, 2 of the 23 blast furnaces that were in operation during at least part of 2012 were closed permanently by midyear. As components of major integrated iron and steel complexes, blast furnaces are especially vulnerable to prolonged shutdowns during major economic downturns. Operational disruptions at the blast furnaces also affect the downstream basic oxygen furnaces and hence the availability of the steel slag from them; slag availability from electric arc furnaces, however, is more assured. Steel slag availability for the construction market is further constrained at times of high iron ore and scrap steel prices, when the steel companies tend to take back more of the slag as a ferrous feed to the furnaces.

Increasing acceptance of GGBFS as a cementitious material should ensure a steady or increasing share in the U.S. cement and concrete markets for this slag type. However, the supply of domestically produced GBFS remains severely constrained because granulation cooling was installed at only three U.S. blast furnaces at yearend 2012 (a fourth having closed earlier during the year). The closed blast furnace's GGBFS (grinding) plant was to remain operational, however, as it had access to

imported granules. Installation of granulation cooling at other U.S. blast furnaces is possible but unlikely; it is expensive and would depend upon the perception of the specific furnace's future viability. Furthermore, not all blast furnaces produce a slag that is chemically suitable for GGBFS. Future increases in GGBFS sales will thus depend on the availability of imported GBFS or GGBFS; many GBFS-producing countries incorporate more slag in their cement and concrete products than does the United States and their (local) markets will be competing with the U.S. market for this slag.

Changes in environmental rules governing the manufacture of portland cement and, potentially, the characterization of fly ash could increase the demand for slag as an alternative raw material for clinker manufacture and as an SCM.

References Cited

- American Iron and Steel Institute, 2012, Annual statistical report: Washington, DC, American Iron and Steel Institute, 122 p.
- Slag Cement Association, 2013, U.S. slag cement shipments: Farmington Hills, MI, Slag Cement Association. (Accessed November 4, 2013, at <http://www.slagcement.org/News/Shipments.html>.)
- U.S. Environmental Protection Agency, 2012, National emissions standards for hazardous air pollutants from the portland cement manufacturing industry and standards of performance for portland cement plants: Federal Register, 40 CFR Parts 60 and 63, v. 77, no. 138, July 18, p. 42368–42412.

GENERAL SOURCES OF INFORMATION

U.S. Geological Survey Publications

- Historical Statistics for Mineral and Material Commodities in the United States, Data Series 140.
- 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)

	2011				2012					
	Blast furnace slag ¹		Total iron and steel slag ²	Steel furnace slag	Blast furnace slag ¹		Total ²	Steel furnace slag	Total iron and steel slag ²	
	Air-cooled	Granulated			Air-cooled	Granulated				
Quantity ³	5.5	2.5	8.0	7.3	15.4	5.5	2.4	7.8	8.2	16.0
Value ⁴	39	185 r	224 r	38	262 r	40	193	233	43	275

^rEstimated. ¹Revised.

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	2011		2012	
	Range	Average	Range	Average
Blast furnace:				
Air-cooled	2.20–18.46	7.14	3.85–19.98	7.31
Granulated ²	9.92–107.21	76.45 ^r	53.75–118.48	73.69
Steel furnace	0.02–25.53	5.18	0.25–29.13	5.22

^rRevised.

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 in 2011, but in 2012, no sales of unground material were reported (although they certainly took place) and the price range shown for 2012 is thus just for the ground material. 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	2011			2012		
	Blast furnace slag ²		Steel furnace slag	Blast furnace slag ²		Steel furnace slag
	Air-cooled	Granulated		Air-cooled	Granulated	
Ready-mixed concrete	11.1	--	--	5.8	--	--
Concrete products	5.1	--	--	7.3	--	(3)
Asphaltic concrete	19.3	--	12.1	21.1	--	8.6
Road bases and surfaces	38.7	4.5	46.8	47.5	--	45.8
Fill	13.3	--	19.3	8.4	--	23.6
Cementitious material	--	95.0	--	--	99.9	--
Clinker raw material	0.8	--	4.7	0.8	--	1.8
Miscellaneous ⁴	6.6	0.5	--	4.8	--	0.5
Other or unspecified ⁵	5.1	(3)	17.1	4.3	0.1	19.7

-- 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 accurate to no more than two significant figures.

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

³Less than 0.05%.

⁴Reported as used for railroad ballast, roofing, mineral wool, or soil conditioner.

⁵Including return to furnaces (likely underreported) and other uses.

TABLE 4
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2012

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
Ash Grove Cement Co.	Portland, OR	Foreign		X				
Barfield Enterprises, Inc.	LaPlace, LA	ArcelorMittal USA						X
Beaver Valley Slag	Aliquippa, PA	Old slag pile	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			X		
Blackheart Slag LLC	Muscataine (Montpelier), IA	SSAB Americas						X
City Slag LLC	Sharon, PA	Old slag pile					X	
Dragon Products Co., LLC	Thomaston, ME	Various domestic and foreign		X				
Edw. C. Levy Co.	Decatur (Trinity), AL ⁵	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 (Dearborn), MI	Severstal North America, Inc.	X			X		
Do.	Detroit (Ecorse), MI	United States Steel Corp.	X			X		
Do.	Columbus, MS	Severstal North America, Inc.						X
Do.	Canton, OH	The Timken Co.						X
Do.	Delta, OH	North Star BlueScope Steel LLC						X
Do.	Huger, SC	Nucor Corp.						X
Do.	Memphis, TN	do.						X
Do.	Seattle, WA	do.						X
Essroc Cement Corp.	Middlebranch, OH	Various domestic and foreign				X		
Fritz Enterprises, Inc.	Fairfield, AL ⁶	United States Steel Corp.	X	X		X		
Do.	Sparrows Point, MD	RG Steel, LLC ⁷		X				
Gerdau Longsteel North America	Jacksonville, FL	Gerdau Longsteel North America						X
Do.	Charlotte, NC	do.						X
Harsco Metals & Minerals	Birmingham, AL	CMC Steel						X
Do.	Blytheville, AR	Nucor Corp.						X
Do.	Blytheville (Armored), AR	Nucor-Yamato Steel Co.						X
Do.	Pueblo, CO	Evrax Inc. NA						X
Do.	Wilton (Muscatine), IA	SSAB Americas						X
Do.	Pittsboro, IN	Steel Dynamics, Inc.						X
Do.	Ghent, KY	Gallatin Steel Co.						X
Do.	do.	North American Stainless						X
Do.	Ahoskie (Coffield), NC	Nucor Corp.						X
Do.	Warren, OH	RG Steel, LLC ⁷					X	
Do.	Brackenridge, PA	ATI Allegheny Ludlum						X
Do.	Butler, PA	AK Steel Corp.						X

See footnotes at end of table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2012

Slag processing company Harsco Metals & Minerals—Continued	Plant location	Steel Company serviced ^{2,3}	Slag and furnace types ¹					
			Blast furnace slag			Steel furnace slag		
			AC	GG	Exp	BOF	OHF	EAF
Do.	Koppel, PA	TMK IPSCO					X	
Do.	Latrobe, PA	ATI Allegheny Ludlum					X	
Do.	Midland, PA	do.					X	
Do.	Steelton, PA	ArcelorMittal USA					X	
Do.	Midlothian, TX	Gerdau Longsteel North America					X	
Do.	Geneva (Provo), UT	Old slag pile	X				X	
Holcim (US) Inc.	Birmingham (Fairfield), AL ⁶	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 ⁸	do.		X	X			
Do.	Sparrows Point, MD	Foreign sources and RG Steel, LLC ⁷		X				
Do.	Cleveland (Cuyahoga Co.), OH ⁴	ArcelorMittal USA	X					
Do.	Lordstown, OH	Old slag pile		X			X	
Do.	McDonald, OH	do.		X				
Do.	Salt Springs (Youngstown), OH	do.		X				
Do.	West Mifflin (Duquesne), PA	United States Steel Corp. (ET Works)	X					
Do.	Seattle, WA	Foreign		X				
Do.	San Francisco, CA	do.		X				
Lehigh Hanson, Inc.	Cementon, NY	do.		X				
Do.	Evansville, PA	do.		X				
Lehigh Hanson Slag Cement, Inc.	Cape Canaveral, FL	do.		X				
Mountain Materials, Inc.	Ashland, KY ⁴	AK Steel Corp.		X				
Phoenix Services LLC	Riverdale, IL	ArcelorMittal USA		X			X	
Do.	Indiana Harbor, East Chicago, IN ⁹	ArcelorMittal USA (“East” and “West” sides)		X			X	
Do.	Burns Harbor, IN	ArcelorMittal USA		X			X	
Do.	Wilton, IA	Gerdau Longsteel North America		X			X	
Do.	Sparrows Point, MD	RG Steel, LLC ⁷		X			X	
Do.	Cool Springs/Steubenville, OH	Old slag pile		X			X	
Do.	Marion, OH ⁹	Nucor Corp.		X			X	
Do.	Warren, OH	RG Steel, LLC ⁷		X				
Do.	Johnstown, PA	Old slag pile		X				
Do.	Latrobe, PA	Latrobe Specialty Steel Co.		X			X	
Do.	Georgetown, SC	ArcelorMittal USA		X			X	
Do.	Vinton (El Paso), TX	do.		X			X	
Do.	Roanoke, VA	Steel Dynamics, Inc.		X			X	
Do.	Weirton, WV	Old slag pile		X			X	
Recmix of PA, Inc.	Ghent, KY	North American Stainless		X			X	
Do.	Sarver (Brackentridge), PA	ATI Allegheny Ludlum		X			X	

See footnotes at end of table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2012

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
St. Marys Cement Group							X	
Detroit, MI	Foreign							
Decatur (Trinity), AL ⁵	Nucor Corp.						X	
Alton, IL	Alton Steel, Inc.						X	
Granite City, IL ⁴	United States Steel Corp.	X			X			
Sterling, IL	Sterling Steel Co., LLC						X	
Ashland, KY ⁴	AK Steel Corp.	X			X			
Canton, OH	Republic Steel						X	
Cleveland, OH ⁴	ArcelorMittal USA	X			X			
Lorain, OH	Republic Steel	X			X			
Mansfield, OH	AK Steel Corp.						X	
Warren, OH	Warren Steel Holdings LLC						X	
Coatsville, PA	ArcelorMittal USA						X	
Rancho Cucamonga, CA ¹⁰	Gerdau Longsteel North America						X	
Axis, AL	SSAB Americas						X	
Birmingham, AL	Nucor Corp.						X	
Tuscaloosa, AL	do.						X	
Mesa, AZ	CMC Steel						X	
Fort Smith, AR	Gerdau Special Steel North America						X	
Rancho Cucamonga, CA ¹⁰	Gerdau Longsteel North America						X	
Claymont, DE	Evrax Inc. NA						X	
Cartersville, GA	Gerdau Longsteel North America						X	
Kankakee, IL	Nucor Corp.						X	
Peoria, IL	Keystone Steel & Wire Co.						X	
Gary, IN	United States Steel Corp.					X		
Portage, IN	NLMK Indiana						X	
Ashland, KY	Kentucky Electric Steel LLC						X	
Jackson, MI	Gerdau Special Steel North America						X	
Monroe, MI	do.						X	
St. Paul, MN	Gerdau Longsteel North America						X	
Jackson, MS	Nucor Corp.						X	
Norfolk, NE	do.						X	
Perth Amboy, NJ	Gerdau Longsteel North America						X	
Sayreville, NJ	do.						X	
Auburn, NY	Nucor Corp.						X	
Marion, OH ⁹	do.						X	
Middletown, OH	AK Steel Corp.				X			
Mingo Junction, OH	RG Steel, LLC ⁷	X			X			
Youngstown, OH	V&M Star						X	
McMinnville, OR	Cascade Steel Rolling Mills, Inc.						X	
Braddock, PA	United States Steel Corp.						X	

See footnotes at end of table.

TABLE 4—Continued
PROCESSORS OF IRON AND STEEL SLAG IN THE UNITED STATES IN 2012

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
Tube City IMS, LLC—Continued								
Do.	Bridgeville, PA	Universal Stainless & Alloy Products, Inc.					X	
Do.	New Castle, PA	Ellwood Quality Steels					X	
Do.	Park Hill (Johnstown), PA	Old slag pile	X				X	
Do.	Pricedale, PA	do.				X		
Do.	Reading, PA	Carpenter Technology Corp.					X	
Do.	Cayce, SC	CMC Steel					X	
Do.	Darlington, SC	Nucor Corp.					X	
Do.	Jackson, TN	Gerdau Longsteel North America					X	
Do.	Knoxville, TN	do.					X	
Do.	Beaumont, TX	do.					X	
Do.	Jewett, TX	Nucor Corp.					X	
Do.	Lone Star, TX	United States Steel Corp.					X	
Do.	Longview, TX	Joy Global Inc. (former LeTourneau Technologies, Inc.)					X	
Do.	Seguin, TX	CMC Steel					X	
Do.	Plymouth, UT	Nucor Corp.					X	
Do.	Petersburg, VA	Gerdau Longsteel North America					X	
Do.	Saukville, WI	Charter Steel					X	
Uniserve LLC	Newport, AR	Arkansas Steel Associates, LLC					X	
Do.	Gallatin, TN	Hoeganaes 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 on site to make ground granulated blast furnace slag—commonly now referred to as “slag cement.” “Domestic” implies grinding of 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, Inc. was responsible for the cooling, but the processing and marketing were handled by Beelman Truck Co. (Granite City, IL), Lafarge North America Inc. (Cleveland, OH), and Mountain Materials, Inc. (Ashland, KY).

⁵The processing contract at Decatur, AL, was transferred to Stein, Inc. in August 2012.

⁶For granulated slag, Fritz Enterprises, Inc. operated the granulator but Holcim owned the apparatus and marketed the slag.

⁷RG Steel, LLC filed for bankruptcy on May 31, 2012, and steel production ceased at all sites. The Sparrows Point, MD, and Mingo Junction, OH, facilities were sold to liquidators in August 2012 and were expected to be scrapped; however, grinding of granulated slag at Sparrows Point was expected to continue, using granules sourced elsewhere. The Warren, OH, complex was sold in August to a holding company that was to seek an operational buyer for all or part of the facilities; however, no such buyer had been found as of yearend 2012.

⁸Lafarge North America Inc. ground some of the granulated slag from East Chicago, IN, at various of its cement plants located elsewhere.

⁹The processing contract at Marion, OH, was transferred to Phoenix Mill Services LLC at the end of February 2012.

¹⁰The processing contract at Rancho Cucamonga, CA, was transferred to Tervita Corp. in mid-2012.