	NORTH CAROLINA DEPARTMENT OF LABOR	No. 33-1
	OSH DIVISION	Date: 10/2009
	OSHNC INDUSTRIAL DATA REPORT	Pages: 6

Industry: **Primary Metal Industries**	Sub-Group: **Blast Furnaces and Steel Works**
SIC: **3312**	NAICS: **331111**

PROCESS DESCRIPTION: The purpose of the blast furnace in the initial stages of the manufacture of steel is to remove slag and oxygen from the basic raw materials such as iron ore or from materials to be smelted such as pig iron, scrap iron and steel scrap. This removal of impurities is possible through three entirely different processes called Hydrometallurgy, Electrometallurgy and Pyrometallurgy. The process of pyrometallurgy will be followed here with reference to the alternatives when necessary. In this process, the raw material input is mineral or native ore, either raw or processed by screening, dressing or washing.

The blast furnace itself is up to 100 feet high and 30 feet in diameter, built of steel and fire-brick. It my be fired by wood, coke, oil, gas, powdered coal or electricity. The most common fuel is coke. The furnace is charged (feed/loaded), generally through automatic processes, using such equipment as cranes and "skip cars." Layers of limestone and ore are added to the fuel. The ore is then heated to a molten state and tapped off at various times as the temperature of the furnace is varied for the specific gravity of the metal desired. Samples are laboratory tested, based on these analyses, additives are fed into the furnace in shovel sized amounts, again through the use of cranes and skip cars. Generally, slag and oxygen are separated from the iron by burning the fuel at between 450 and 1,000 degrees F, although temperatures of 2800 and 3200 degrees F are reached in the furnace interior.

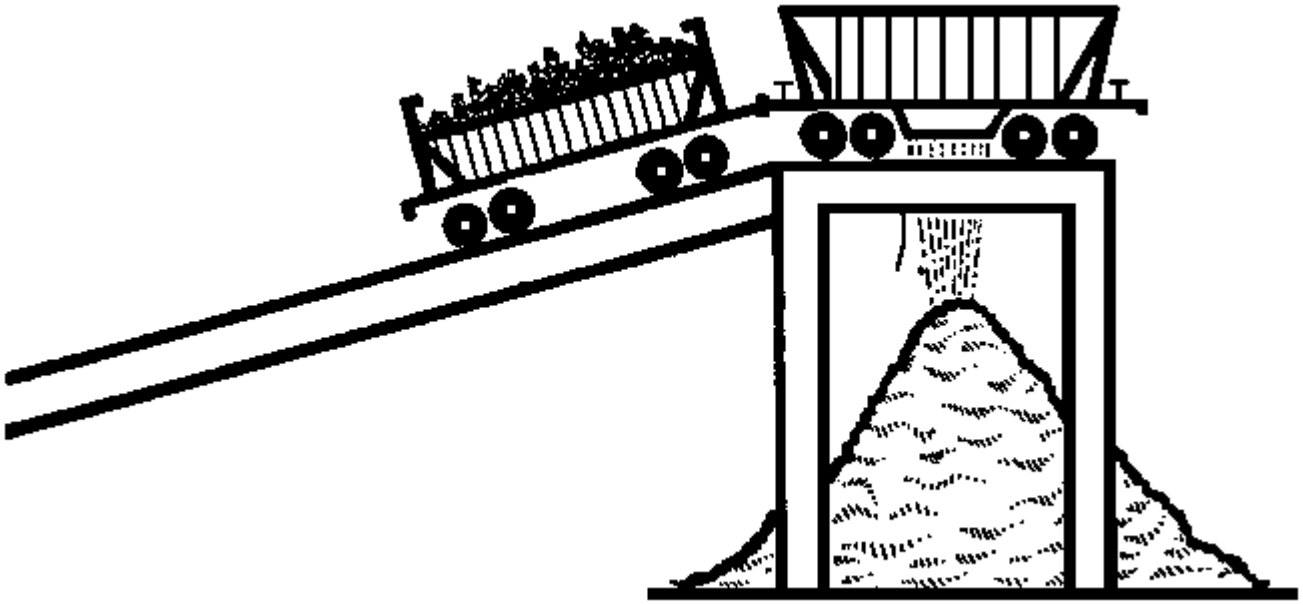
Slag is removed from the molten iron by a drawing-off process before the iron is poured into ladles. Just prior to pouring, the melt is oxidized by the introduction of oxygen through a pipe submerged into the molten metal. The oxygen combines with impurities which form the slag on the surface that is skimmed/drawn off through a door in the side of the furnace. The molten iron is poured into ladles mounted on railroad cars or suspended from overhead cranes. It is then transported to the location where it is to undergo the "Bessemer process" to turn it into steel or where it is poured into sand forms or molds to become "pigs" or "ingots (blooms)".

In the latter instance, the sand forming the molds is shaken off, so that the "pigs" or "Blooms" may be transported to another plant using the "Bessemer process" or the processes which are usually found in the rolling mills and which are covered in a separate data sheet. In the event the "Bessemer process" is utilized at the plant being inspected, the following is a basic and brief process description of that method of turning pig iron into steel. "Bessemer process" is utilized at the plant being inspected the following is a basic and brief process description of that method of turning pig iron into steel.

The principle involved is, once again, the oxidation of the impurities in the iron. In this instance the oxygen of the air is blown through the molten iron. The heat of oxidation raises the temperature of the mass and keeps it molten during the operation. The process is carried on in a large container made of steel with a lining of silica, clay or dolomite, called the "Bessemer Converter". Its capacity is from 8 to 30 tons of molten iron, but the usual charge is 15 to 18 tons. The converter is egg shaped. On the narrow (upper) end it an opening through which the iron to be treated in introduced and through which the finished product is poured out. The wide end or bottom has a number of openings (tuyerers) through which the air is forced upward through the converter during operation. The converter is resting on pivots (trunnions) so that it can be tilted to receive the charge, turned upright during the "blow" and tilted again for the pouring of the molten steel. Meanwhile, chemical changes occur inside the converter, depending on its lining, but these changes are basically chemical/metallurgical in nature and are not pertinent to this data sheet. Basically these changes determine or are determined by whether the phosphorous in the steel is removed. Upon completion of the process (usually 15 to 20 minutes) the molten steel is poured into molds, with the slag remaining. Bessemer steel is used in making such common items as machinery, tools, wire, nails and is the essential modern structural steel used in steel-framework buildings.

PROCESS FLOW:

Receipt of raw materials: Ore, Fuel (Coke, Coal), Flux (Limestone) and Pig Iron, Scrap Iron and Steel scrap.

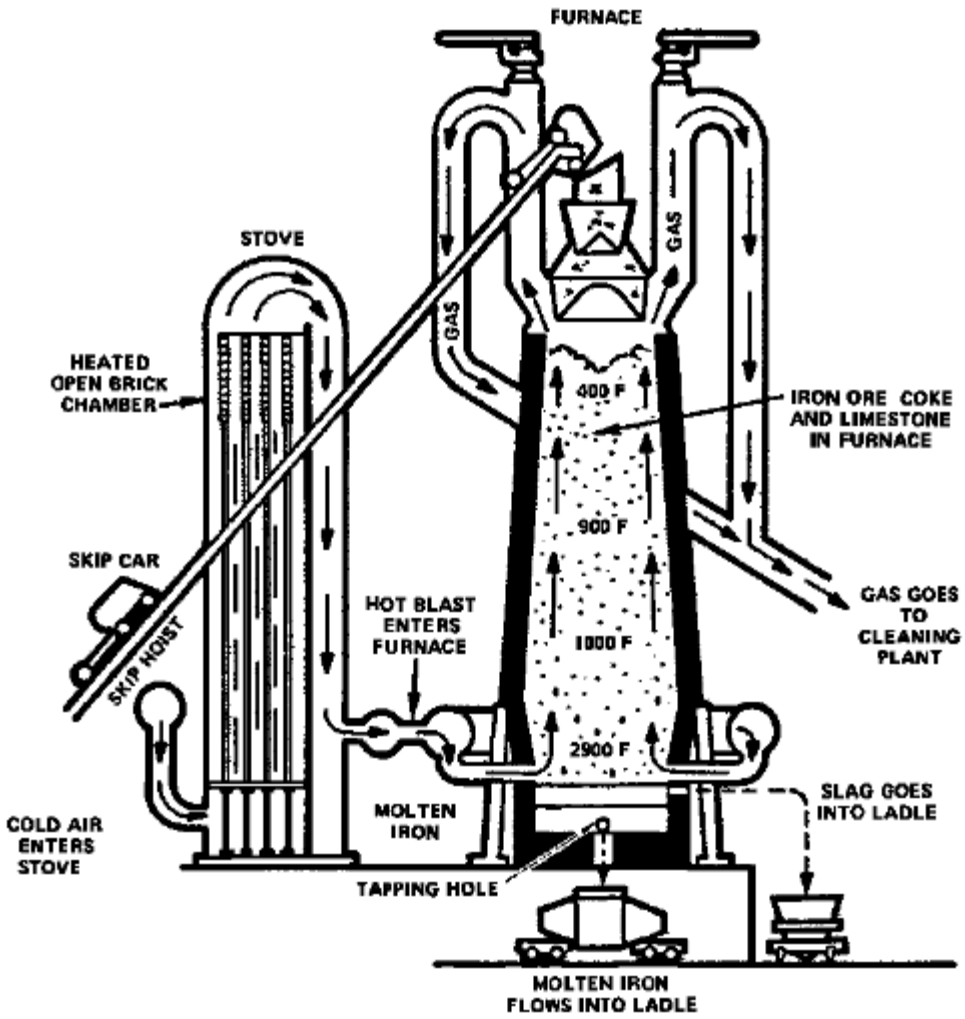


Material handling: Handling equipment –Cranes, backloaders, etc.

Cranes use scoop/shovel type of handling devices as well as electromagnets and slings for lifting heavy pieces of scrap iron and steel.

Conveyors are also used in raw material storage area for shifting ore, flux and fuel stores, as well as for loading crane buckets and "skip cars" are used in the charging of the furnaces.

Furnace charging: "Skip cars" and cranes carry fuel (coke, coal), flux (limestone) to the top of the furnace and charge it by layering fuel, raw material (ore) and flux. In some instances of re-smelting, pig iron and scrap iron or scrap steel may be added through the use of electromagnets on the cranes which lift the scrap metal and drop it in the mouth of the furnace.



Furnace operation: Once the furnace is charged and fired, most of the process is internal until the slag is drawn off and the molten metal is poured off into ladles.

Drawing off: Slag is drawn (skimmed off the top of the molten metal) through a special opening or door in the side of the furnace. The slag is hot and therefore placed in ladle-like containers mounted on railroad cars or suspended from overhead cranes. The slag is removed from the furnace site for disposal or shipping from the plant.

Pouring: After the slag has been drawn off and the purity of the melt is assured the melt is poured into ladles for immediate movement to the area. The ladles are pivoted on suspension vehicles. In order to prevent premature cooling, movement from the furnace to the mold pouring site is immediate.

Pouring into molds: Molds formed of sand and binding agents are arranged for easy access and convenience and located adjacent to the railroad spur where the vehicles carrying ladles of melt are positioned. Pouring takes place from the ladles directly into the molds. In the event the ladles are crane mounted, pouring is simplified by manipulating the ladle directly above the molds.

Shaking: After the molten metal in the molds has cooled and solidified the molds are transported by direct roller conveyors to the shaker system where the sand mold is shaken and broken off the metal. The sand is

captured under the shaker for re-use. The metal ingots (blooms) are captured at the end of the shaker and relocated by cranes for storage and/or shipment.

Hazards Analysis

Major Hazards			Other Hazards		
Location	**Item**	**Hazard**	**Location**	**Item**	**Hazard**
Ore and scrap metal receipt and storage	Overhead operations Material handling equipment	Falling materials Strike/crush hazards	Ore and scrap metal	Dust and flying Unstable, high stock-piling of ore and scrap metal	Inhalation of dust and silicates at unloading sites Crushing, cuts and lacerations from protruding jagged edges
Furnace charging and operations	Overhead operations Ovens Radiant heat	Falling objects Heat stress, dust exposure, smelting fumes Burns and eye injuries, heat stress	Furnace charging	Dust, flying particles of silicates	Inhalation, foreign objects in eyes
Slag draw-off and metal pouring	Flying hot materials Slag and smelt Carbon monoxide	Burns, eye injuries Gases, fumes and vapors Asphyxiation	Furnace area	Ladders and catwalks Walking and working surfaces	Falls Slips, trips and falls
Ingot pouring	Hot particles from mold failure/overfilling Smelt contact with mold	Burns and eye injuries First contact releases gases and fumes	Slag draw-off and melt pouring	Handling equipment Overhead operations	Crush limbs Falling objects and crushing by undetected movement

Shake out	Molds	Dust and silicate inhalation	Ingot	Handling equipment	Movement of molds and ladles pose crush hazards by handling equipment
Ingot movement	Material handling	Crushing from handling equipment an dropped ingots	Shaking	Noise Guard rails	Hearing loss Falls into shaker system and subsequent crushing by ingots (blooms)
Throughout	Noise Mechanical power transmission apparatus	Hearing loss Amputation and crushed limbs	Ingot movement	Overhead operations, Cranes	Crushing injuries
			Throughout	Housekeeping Powered Industrial Trucks	Slips, trips and falls Carbon Monoxide exposure, accidents

Key OSHNC Standards

Reference	29 CFR 1910 — General Industry Standards
Subpart D	Walking and working surfaces
Subpart E	Means of Egress
Subpart I	Personal protective equipment
Subpart O	Machinery and machine guarding
Subpart S	Electrical
1910.95	Occupational noise exposure
1910.110	Storage and handling of liquefied petroleum gases
1910.178	Powered industrial trucks
1910.179	Overhead and gantry cranes
1910.252	Welding, general requirements
1910.1000	Air contaminants
1910.1025	Lead
1910.1200	Hazard Communication

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Inspection Analysis

Due to the size and extent of steel plants and their unique hazards in every area of operations, the inspection of each area should be treated as a distinct entity. At best, the inspection of a steel plant-blast furnace combination will be a multi-day operation for any one or group of safety officers.

Other Pertinent Comments: Depending upon type of scrap materials used, consider possibility of lead exposure.