GOVERNMENT OF DUBAI

Trakhees

Guidelines – Iron and Steel Works

Issued by: Inspection Department – Operations Section

1.0 Introduction

1.1 The iron and steel industry covers an enormous range from small, simple processes such as foundries, metal working and finishing, to very large integrated iron and steel works where many major ancillary processes are operated, such as ore beneficiation, coke ovens, gas producers, tar and hydrocarbon distilleries, lime plants, by-product recovery, fabrication, tempering, hardening, etc. in the advanced industry, modern processes have replaced many of the traditional iron and steel processes such as clamp calcinations, cupolas, open hearth furnaces, etc. although they are still used elsewhere.

Instead, sinter plants, electric furnaces of various kinds, direct ore reduction and Basic oxygen Steel furnaces are now being used. The steel industry was revolutionized in the early 1950s by the availability of tonnage oxygen for refining iron and making steel, thus reducing the time of batch turn-round from about 12 hours to 30 minutes with its fierce rate of reaction. At the same time, it introduced a new problem with the intense brown fumes of iron oxide, which were liberated and had to be prevented because of the nuisance they created. The first oxygen-steel making process was developed in Austria and was known as L-D process, which quickly gave way to variations.

1.2 Iron and steel works are defined as “works” in which:

a. Iron or iron ores and other materials for production of iron are handled, stored or prepared; or

b. Iron ores for the production of iron are calcined, sintered or pelletized; or

c. Iron or Ferro-alloys are produced in a blast furnace or by direct reduction; or

d. Iron or steel is melted in electric furnaces; or

e. Steel is produced, melted or refined; or

f. Air or oxygen or air enriched with oxygen is used for the refining of iron or for the production, shaping or finishing of steel; or

g. Ferro-alloys are made by methods giving rise to dust or fume; or

h. Iron or Ferro-alloys produced in any process described in sub-paragraphs (c), (d) or (g) of this paragraph are desulphurized by methods giving rise to dust or fume.

1.3 In the context of these notes, "works" includes not only all the processes in the lessee's site but also the unloading and loading of materials on ships PCFC harbors and their conveyance to and from the processing site.

2.0 Raw Materials Handling and Preparation

2.1 The solid raw materials normally handled in iron and steel works are iron ore, coke and lime or limestone, together with smaller amounts of additives to adjust final composition of the product, or the liquidity of the slag. It is unlikely that coke ovens and lime kilns will be used in Jebel Ali steel works, but that coke and lime will be imported ready for use. Similarly, it is unlikely that low quality iron ore will be beneficiated in site, and that any pre-treatment will have been done elsewhere to produce a high quality ore.

2.2 Solid raw materials arriving by ship in bulk will be discharged by grab onto conveyors or road trucks and be delivered to the storage areas on site. All these handling operations, including material recovery, have to be conducted without any significant visible sign of dust emission. Conveyors shall be fully enclosed to prevent wind-whipping and shall be fitted with effective means for keeping the underside of the return belt clean. Transfer points shall be enclosed and be fitted with dust collection and arrestment units.

2.3 Consideration should be given to the effect of wind-whipping of raw materials from stockpiles and blending beds, where dust suppression may be needed.

2.4 Minor mix components shall normally be delivered and stored under cover.

2.5 When the ore has to be prepared by sintering or polarization, the plant shall be enclosed and all points where dust is likely to be emitted shall be equipped with dust collection and arrestment plant.

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2.7 Storage bunkers for sinter return fines shall be enclosed and vented to air though suitable dust arrestment plant.

2.8 The disposal of collected fines shall be carried out in a manner which prevents the generation of airborne dust, including suppression techniques.

2.9 The concentration of particulate matter in emissions to atmosphere from arrestment plant shall not exceed one hundred fifty (150) mg./m^3.

2.10 The heights of chimneys shall be determined after discussion between managements and the Authority and shall be based on the maximum mass rate of emission of pollutants concerned, taking account of local circumstances.

3.0 Blast Furnaces Operational Controls

3.1 Blast furnaces are larges vertical furnaces for extracting iron from its ores by reduction of the iron oxide with coke at high temperatures. A large, modern, blast furnace will contain thousands of tins of the burden at any one time and the raw materials have to bear this enormous weight without disintegrating into fines. That is why the ore has to be sintered to form hard lumps and hard coke lumps have to be used, together with lump limestone to form a molten slag. The coke serves two purposes, to provide heat and take part in the chemical reaction f reducing iron oxide to iron. Pre-heated air enters near the boron of the furnace and the hot waste gases containing carbon monoxide leave at the top. These dirty gases are used to pre-heat the combustion air in two sets of regenerators, called “Cowper Stoves”, used alternately. Periodically, the iron and slag are tapped from the blast furnace, which once started, operates continuously for about seven years.

3.2 Blast furnaces operate under pressure and there are two safety valves at the top known as “bleeders” which open and emit dirty gas when the pressure is too high. High pressure usually results from uncontrolled “slips” of the hot burden and these can be prevented by regular, controlled slips by manipulating the air blast so as not to open the “bleeders”.

3.3 The primary source of blast furnace emissions is the casting operation. Particulate emissions are generated when the molten iron and slag contact air above their surface. Casting emissions also are generated by drilling and plugging the taphole. The occasional use of oxygen lance to open a clogged taphole can cause heavy emissions. During the casting operation, iron oxides, magnesium oxide and carbonaceous compounds are generated as particulate.

3.4 Casting emissions at existing blast furnaces are controlled by evacuation through retrofitted capture hoods to a gas cleaner, or by suppression techniques.

3.5 Emissions controlled by hoods and an evacuation system are usually vented to a bag house. The basic concept of suppression techniques is to prevent the formation of pollutant by excluding ambient air contact with the molten surfaces. New furnaces have been constructed with evacuated runner cover systems and local hooding ducted to a bag house.

3.6 Another potential source of emissions is the blast furnace top. Minor emissions may occur during charging from imperfect bell seals in the double bell system. Occasionally, a cavity may form in the blast furnace charge, causing a collapse of part of the burden (charge) above it. The resulting pressure surge in the furnace opens a relief valve to the atmosphere to prevent damage to the furnace by the high pressure created and referred to as a “slip”.

4.0 Control of Emissions

4.1 During normal operation, all blast furnace gas which is not used as fuel, but is bled to atmosphere shall be burnt and shall pass through a gas cleaning system to reduce the particulate matter to below one hundred fifty (150) mg/m^3.

4.2 The emissions from chimneys serving combustion processes shall be maintained free from visible smoke and in any case not more than one hundred fifty (150) mg/m^3.

4.3 Collection and arrestment of fume arising from furnace tapping, iron and slag runners and transfer of iron and slag to ladles or other receivers is required. The concentration of particulate matter in emissions to atmosphere from arrestment systems shall not exceed one hundred fifty (150) mg/m^3.

4.4 Where associated processes (e.g., desulphurization, iron or slag processing, raw materials handling) give rise to particulate emissions, collection and arrestment are required to a standard of not more than one hundred fifty (150) mg/m^3.

4.5 Water used of slag quenching osr for slag or iron granulation shall be free from suspended or dissolved substances, such as ammonium compounds, which give rise to odorous or harmful emissions. Slag quenching can give rise to odorous emissions of hydrogen sulfide which are difficult to prevent.

5.0 Direct Reduction

5.1 Water used of slag quenching osr for slag or iron granulation shall be free from suspended or dissolved substances, such as ammonium compounds, which give rise to odorous or harmful emissions. Slag quenching can give rise to odorous emissions of hydrogen sulfide which are difficult to prevent.

5.2 The iron ore feed in the form of pellets and the prevention of dust and gas emissions is similar to that of the blast furnace. All dust producing points have to be collected and arrestment plant fitted to give a dust emission of not more than one hundred fifty (150) mg/m^3.

6.0 Electric Arc Furnaces

6.1 The iron ore feed in the form of pellets and the prevention of dust and gas emissions is similar to that of the blast furnace. All dust producing points have to be collected and arrestment plant fitted to give a dust emission of not more than one hundred fifty (150) mg/m^3.

6.2 Primary collection and arrestment are required on all furnaces. Secondary collection and arrestment are also required on any individual furnace exceeding twenty (20) tons capacity. The concentration of particulate matter in emissions from arrestment system shall not exceed one hundred fifty (150) mg/m^3 from combined arrestment systems.

6.3 Limits for emissions of non-ferrous metals or compounds, e.g. lead, zinc, may need to be applied in particular circumstances by the Authority.

6.4 During normal operations and with the furnace roof in position, the primary extraction system shall be capable of collecting all the emissions generated, including the oxygen blow period, and of minimizing emissions of carbon monoxide by burning in the off-take duct.

6.5 The aim of secondary collection systems shall be the total collection of adventitious emissions throughout the complete operating cycle of charging, melting, refining, slagging or tapping.

6.6 When two or more furnaces are served by a single secondary collection and arrestment system, their operations shall be so coordinated as to avoid exceeding the designed collection capability of the secondary system.

6.7 The operations which generate emissions during the electric arc furnace steelmaking process are melting and refining, charging scrap, tapping steel and dumping slag. Iron oxide is the predominant constituent of the particulate emitted during melting.

6.8 During refining, the primary particulate compound emitted is calcium oxide from the slag. Emissions from charging scrap are difficult to quantify because they depend on the grade of scrap utilized. Scrap emissions usually contain iron and other metallic oxides from alloys in the scrap metal. Iron oxides and oxides from the fluxes are the primary constituents of the slag emissions. During tapping, iron oxide is the major particulate compound emitted.

6.9 Emission control techniques involve an emission capture system and a gas cleaning system. Five emission capture systems used in the industry are fourth hold (direct shell) evacuation, side draft hood, combination hood, canopy hood and furnace enclosures. Direct shell evacuation consists of ductwork attached to a separate or fourth hole in the furnace roof which draws emissions to a gas cleaner. The fourth hole system works only when the furnace is up-right with the roof in place. Side draft hoods collect furnace off gases from around the electrode holes and the work doors after the gases leave the furnace. The combination hood incorporates elements from the side draft and fourth hole ventilation system. Emissions are collected both from the fourth hole and around the electrodes.

6.10 An air gap in the ducting introduces secondary air for combustion of CO in the exhaust gas. The combination hood requires careful regulation of furnace interval pressure. The canopy hood is the least efficient of the four ventilation system, but it does capture emissions during charging and tapping. Many new electric arc furnaces incorporate the canopy hood with one of the other three systems. The full furnace enclosure completely surrounds the furnace and evacuates furnace emissions through hooding in the top of the enclosure.

7.0 Basic Oxygen Steel Plants

7.1 Basic Oxygen Steel plants (BOS) are essentially vertical furnaces receiving hot iron, or hot iron and scrap, onto the surface of which tonnage oxygen is blown from a retractable lance. A violent reaction takes place producing large amounts of iron oxide fume and carbon monoxide, and generating exit gas temperatures of 2,000°C. The waste gas may then be treated on one of two ways. Either it is burnt at the mouth of the vessel and the gases have to be cooled by heat exchange or water sprays before passing through arrestment plant. Or the vessel is close hooded to prevent ingress of air and the burning of carbon monoxide, and the smaller volume of gas is cooled and passed through arrestment plant. The clean gas is then burned usefully or flared. The turn-round time for a batch by this process is about 30 minutes.

7.2 The concentration of particulate matter in emissions to atmosphere from arrestment plant serving all processes carried out in, or associated with, BOS plants shall not exceed one hundred fifty (150) mg/m^3.

7.3 Limits for emissions of non-ferrous metals or compounds may need to be applied in particular circumstances e.g. lead, zinc.

7.4 Oxygen lacing shall be carried out in a manner which minimizes “boil-over”.

7.5 Slag shall be disposed of in a manner which prevents the generation of airborne dust.

7.6 The most significant emissions occur during the oxygen blow period. The predominant compounds emitted are iron oxides, although heavy metals and fluorides are usually present. Charging emissions will vary with the quality and quantity of scrap material charged to the furnace and with the pour rate. Tapping emissions include iron oxides, sulfur oxides and other metallic oxides, depending of the grade of scrap used. Hot metal transfer emissions are mostly iron oxides.

7.7 Basic oxygen furnaces must be equipped with a primary hood capture system located directly over the open mouth of the furnaces to control emissions during oxygen blow periods. Two types of capture systems are used to collect exhaust gas as it leaves the furnace mouth: closed hood (also known as an off gag) or open, combustion-type hood. A closed hood fits snugly against the furnace mouth, ducting all particulate and CO to a wet scrubber gas cleaner. CO is flared at the scrubber outlet stack. The open hood design allows dilution air to be drawn into the hood, thus combusting the CO in the hood system.

Charging and tapping emissions are controlled by a variety of evacuation systems and operating practices. Charging hoods, tap side enclosures and full furnace enclosures are used in the industry to capture these emissions and send them to either the primary hood gas cleaner or a second gas cleaner.

8.0 Health Effects

There are a variety of metallic hazardous air pollutants contained in the particulate matter emitted from iron and steel manufacturing processes. These include primarily manganese and lead, with much smaller quantities of antimony, arsenic, beryllium, cadmium, chromium, cobalt, mercury, nickel and selenium. Organic hazardous air pollutant compounds are released in trace amounts from the sinter wind box exhaust and include polycyclic organic matter such as polynuclear aromatic hydrocarbons and chlorinated dibenzodioxins and furans and volatile organics such as benzene, carbon disulfide, toluene and xylene. These hazardous air pollutants are associated with a variety of adverse health effects including chronic and acute disorders of the blood, heart, kidneys, reproductive system and central nervous system.

Manganese and lead comprise the majority of the metal hazardous air pollutant emissions. Health effects in humans have been associated with both deficiencies and excess intakes of manganese. Chronic exposure to low levels of manganese in the diet is considered to be nutritionally essential in humans with a recommended daily allowance of 2-5 milligrams. Chronic exposure to high levels of manganese by inhalation in humans results primarily in central nervous system (CNS) effects. Visual reaction time, hand-steadiness and eye-hand coordination will be affected in chronically-exposed workers. Manganism, characterized by feelings of weakness and lethargy, tremors, a mask-like face, and psychological disturbances, may result from chronic exposure to higher levels. Impotence and loss of libido have been noted in male workers afflicted with manganism attributed to inhalation exposures.

Trace quantities of organic hazardous air pollutant, such as chlorinated dibenzodioxins and furans (CDD/F) and benzene, have been detected in the wind box exhaust at sinter plants. Exposure to CDD/F mixtures causes chloracne, a severe acne-like condition, and has been shown to be extremely toxic in animal studies. Dioxin itself is known to be a developmental toxicant in animals, causing skeletal deformities, kidney defects and weakened immune responses in the offspring of animals exposed during pregnancy. Human studies have shown an association between dioxin and soft-tissue sarcomas, lymphomas and stomach carcinomas.

Acute inhalation exposure of humans to benzene may cause drowsiness, dizziness, headaches, as well as eye, skin, and respiratory tract irritation, and, at high levels, unconsciousness. Chronic inhalation exposure has caused various disorders in the blood, including reduced numbers of red blood cells and aplastic anemia, in occupational settings. Reproductive effects have been reported for women exposed by inhalation to high levels, and adverse effects on the developing fetus have been observed in animal tests. Increased incidence of leukemia (cancer of the tissues that form white blood cells) has been observed in humans occupationally exposed to benzene.