Pellet Process - Uses and Exposures

1 PROCESS - MANUFACTURING & USES [1]

1.1 Manufacturing of pellets [2]

Pellets are formed from the raw materials − fine ores and additives of < 0.05 mm - into 9-16 mm spheres using very high temperatures and this is mainly carried on at the site of the mine or its shipping port. In the EU 15 there is only one integrated steel works, which includes a pelletisation plant (in the Netherlands). Sweden has four stand-alone pelletisation plants.

Pellet production in the five EU plants mentioned above was 15.1 Mt in 1996. In 1995 total pellet consumption in the EU 15 was about 35 Mt.

The pelletisation process consists of grinding and drying or de-watering, balling and induration followed by screening and handling (see figure)

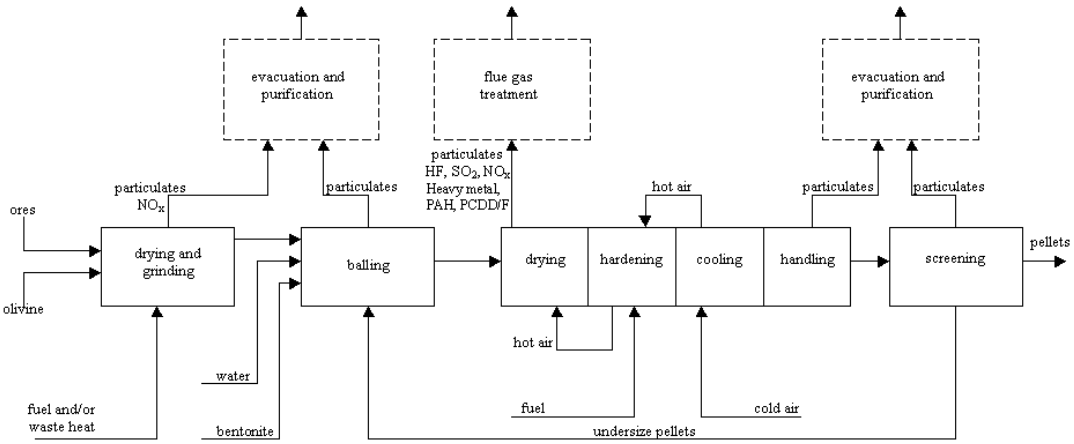

Figure: Schematic of a pelletisation plant - [BREF]

Grinding and drying/de-watering

At the Swedish plants, grinding is a wet process. In the Dutch plant grinding is carried out at relatively high temperatures (approx. 100°C). In the wet process additives (olivine, dolomite and/or limestone depending on the end product) are ground and then added to the ore slurry, typically at a level of 3 to 3.5%, before de-watering. In the other process after hot grinding the material is re-wetted in paddle-type mixers and combined with additives. In both cases the moisture content is adjusted to 8–9%.

Green ball preparation

De-watered or re-wetted pellet feed is mixed with additives and then processed in the (green) ball preparation plant. This is typically equipped with 4 to 6 balling circuits consisting of a feed bin, balling drum, roller screens and conveyors for circulating the materials. The balling drum is inclined 6 to 8° to the horizontal plane. To obtain a well defined green ball size, typically in the range 9 to 16 mm, under- and oversized fractions are screened off and re-circulated.

[1] Part of Chemical Safety report, Part B, Chapter 2. Manufacture and Uses

[2] This written process along with the flow diagram is taken as a base reference from the European Commission Integrated Pollution Prevention and Control draft reference document on the best available techniques for Product of Iron and Steel July 2009 (BREF).

Induration

Induration, which means thermal treatment, consisting of drying, heating and cooling. It can be carried out by using two different systems; in 'straight grate' or 'grate kiln' systems. During thermal treatment magnetite is almost completely oxidised to hematite. This contributes to the large amounts of heat needed to operate the process.

Handling & Screening

At the end of the induration strand, the pellets are screened. Undersize or broken pellets can be recycled.

1.2 Transport & Storage

Transport on site takes place by conveyor belt or truck.
Storage techniques used are either open air stockpiles or in (covered) bunkers.
Transport to the final customer can take place by truck, rail and ship.
The loading and unloading of pellets can be done by crane, wheel loader, shovel, conveyor belt, etc.
During transport the pellets can be screened. Undersize or broken pellets and pellet screenings are often sold as Pellet Fines [also known as Pellet Screenings or Pellet Chips] e.g. as feedstock for sinter plants.

1.3 Charging the blast furnace/ BOS plant

Pellets are primarily used in blast furnaces and are also used in DR-plants. Occasionally pellets are used in the steel process.

Pellets are stored in bunkers before charging to the blast furnace.

The mixture of iron bearing materials (iron ore rubble, sinter and/or pellets) and additives (flux material) are known collectively as the "burden". The burden and the accompanying coke are charged into the top of the furnace either via skips or mechanical conveyor belts. It enters into the furnace via a sealed charging system, which isolates the furnace gases from the atmosphere.

As for all blast furnace material (coke, sinter, pellets and lump ore) a final screening takes place at the blast furnace site. Undersize pellets can be recycled.

The pellets for the BOS plant are stored in bunkers. Transport in the BOS plant can take place by truck or conveyor belt.

1.4 Other activities

Cleaning

Cleaning operations in the pellet plant (floors and walls) take place by using brushes and shovels, bobcats and suction (vacuum removal). Occasional cleaning of machinery takes place before maintenance activities.

Maintenance

Planned or unplanned maintenance can take place in all the above mentioned area's.

Sampling

Sampling is carried out at several places in the manufacturing process.

2 EXPOSURE & RISK MANAGEMENT MEASURES

Activities in the above areas could all produce exposure due to areas of built up dust from the process.

2.1 Exposure

Production

The production process takes place in a closed system, which is under pressure. Only where the chance for dust release is low (coarse materials/ wetted materials), open belts are used to transport the substance mix. The dust, which is taken by local exhaust ventilation or by the combustion gas, is recycled into the production process.

Due to the pellet process being semi automatic there is generally a minimal numbers of employees on the plant during operation and when this does occur it is only for short periods of time.

Transport & Storage

Transport of pellets takes place in open air. The exposure of pellet dust is low.

Cleaning

Cleaning operations in the production area can potentially create the highest exposures due to the mechanical disturbance of dust, using brushes and shovels, bobcats and suction (vacuum removal). If possible the cleaning will be done wet to avoid agitation of the dust. Cleaning is a daily activity.

Maintenance

Depending on the location and type of maintenance the amount of dust disturbance can vary from low to high. Depending on the machinery and type of maintenance the machinery will be cleaned before maintenance starts.

Sampling

The sampling is carried out automatically. The collecting of samples only takes a short period of time.

Key areas of exposure are:

- Production area's
  - Grinding and drying/de-watering
  - Induration

Key activities of exposure are:

- Cleaning

2.2 Risk Management Measures

Pellet dust contains respirable crystalline silica [RCS]. The concentration of RCS is to such a low extent that the pellet dust cannot be classified as toxic. Therefore the risk to human health presented by the dust is not due to the chemical composition / toxic effects of the dust but solely related to the concentration of dust in the air. The higher the concentration of dust the greater the risk of irritation to the respiratory system. In general certain risk management measures (RMM) should be applied when airborne concentrations of the dust is likely to be high. The recommended RMM for human health are dust suppression techniques either by wetting or vacuum and the mechanical collection of the dust instead of close contact human collection. As a last resort the wearing of suitable and approved respiratory protective equipment if airborne concentrations are likely to be high. Ori-nasal respirators fitted with a P3 filter may be used when dust levels are high, directions for use must be followed. The RMM for environment should mirror what is written in the Iron and Steel BREF (2009) as referenced above.

2.3 Exposure data

In order to establish a general overview of potential exposure to RCS a series of exposure monitoring tasks were carried out along with obtaining some historical data. The exposure data collected from several European and International pelletizing plants for the RCS-content showed that results were below 0,04 mg/m^3 for personal exposures. The Occupational Exposure Limits (OELs) in the EU-member states vary from 0,05 - 0,3 mg/m^3. Overall from this exercise it is clear that under normal working conditions personnel working in pelletizing plants are not exposed to excessive amounts of RCS.

3 EXCLUSIONS

In this process we want to focus solely on the use and exposure of pellets and its constituents.
For example this will not include certain emissions such as Dioxins through the stack emissions. A list of other examples of similar emissions are written down and included in the European Commission Integrated Pollution Prevention and Control draft reference document on the best available techniques for Product of Iron and Steel July 2009.

Sector Use (SU)	Preparation Category (PC)	Process category (PROC)	Env Release Categories (ERC)	Operational conditions	Physical form of substance	Physical form of exposure	Fugacity	Route of exposure
SU14 – Manufacture of basic metals	PC7 – Base metals and alloys PC19 - Intermediate	PROC 2[3] PROC 8b[4] PROC 14[5] PROC 22[6] PROC 26[7] (see footnotes for descriptors)	ERC1: Manufacture of substances	Large volume continuous 24 hours / day Temperature: ambient to 1500ºC Semi closed system Semi automated operation Transported via conveyor and bunkers	Powder / dust to massive	Dust	Powder/dust: High Massive: Low	Human Inhalation Environment Water (waste stream) Air

Pellet Process – Uses and Exposure (SU, PC and PROC taken from Guidance on Information requirements and chemical safety assessment Chapter R.12 Use Descriptor system 2009)

3 PROC 2 - Use in closed process, no likelihood of exposure - Continuous process but where the design philosophy is not specifically aimed at minimizing emissions. It is not high integrity and occasional expose will arise e.g. through maintenance, sampling and equipment break-ins

4 PROC 8b - Transfer of substance or preparation (charging/discharging) from/to vessels/large containers at dedicated facilities

5 PROC 14 - Production of preparations or articles by tabletting, compression, extrusion, pelettisation

6 PROC 22 - Potentially closed operations with minerals/metals at elevated temperature - Activities at smelters, furnaces, refineries, coke ovens. Exposure related to dust and fumes to be expected. Emission of direct cooling may be relevant.

7 PROC 26 - Handling of solid inorganic substances at ambient temperature - Transfer and handling of ores, concentrates, raw metal oxides and scrap; packaging, un-packaging, mixing/blending and weighing of metal powders and other minerals