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Environmental and Human Health Hazards Due to Foundries

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Abstract: The main sources of the pollution that causes the environmental degradation are urbanization and industrialization. There is rapid growth in the development of manufacturing industries associated with the Foundry plants. Especially, Steels and Iron manufacturing industries tends to produce a lot of pollutants in the environment. Advancements in several polluting materials have been made in manufacturing over the past decades and that the environmental impact has gradually shifted to so-called dispersed sources of pollution. Nonetheless, production processes in the industries always make up a significant share of India's total emissions, and further that their exposure to' non-sustainability' is very necessary. In these methods, production and extraction of metals from ores by different metallurgical processes and processes for melting, moulding and casting, etc. are followed by noise, heat, fly-ash, dust particles, nitrogen oxides, metals and sulphur evolution. There exists a need for development of a coke-less cupola furnace that avoids the harmful emission of gases which pollutes the environment and causes health issues for human beings.

Keywords: Foundries, Molten metal, Pollution, Health hazard, Environment, Emissions, Safety, Risk.

INTRODUCTION

The process of casting has been widely carried out in the manufacturing industries in India. There has been enormous amount of growth in foundries production in India. In order to increase their efficiency and the adverse effect on environmental research, similar work is being carried out at IITs to expand, develop and improve the foundry cycle [1]. Although the foundry industry were introduced the Harappa age, a remarkable growth of foundries has occurred in the most independent century. As per available data, in India there are about 4000 foundries with a production capacity of about 27.16 lakhs per year, with the ferrous foundry contributing 94 percent of total units [2]. Fig. shows the foundry of molten metal pouring.

Fig.1: Foundry Molten Metal Pouring (Courtesy: Science Photo Library)

The major stages in production comprises of: (i) "raw material processing", (ii) "metal melting", (iii) "mold preparing", (iv) "casting" and (v) "finishing" (along with tumbling and fettling). To melting metals like iron, "electric induction furnaces" are used. In coke-fire or gas cupola furnaces, large foundries which produces components of car and some small foundries melt iron and use induction furnaces for engine block aluminium components. Cupola furnaces ' melting capability typically ranges

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between 2 and 24 metric tons per hour (t / hr). Zinc, nickel, and brass foundries also use induction furnaces. Generally in stainless steel and sometimes in copper foundries, electric arc furnaces are used. For the purpose of melting the non-ferrous metals, flame ovens are used that burns the fossil fuels [3].

The casting process typically uses green sand molds that consist of powder, soot and clay (or water glass) that are not reusable. The sand is wrapped around a pattern in every half of the mold, which is then extracted. The mold's two halves are fused together and the whole mold is packed with molten metal using ladles or other pouring tools [4]. Huge Foundries often have automatically controlled pouring furnaces. The mold has channels to introduce and distribute the metal. The mold is built with a core for hollow casting. Cores must be extremely durable and therefore use good bonding agents for both the core and the moulds themselves [5].

The molds created with chemically bonded sand and the sand cores are often handled with water-based or spirit-based blacking to improve surface characteristics Finishing processes like fettling involve removing gating system casting, fins (burrs) and quite often feeders. Through blasting, chiselling, grinding and cutting, this process can be achieved [6]. Fig.2: shows the various impurities and pollution in foundry actions.

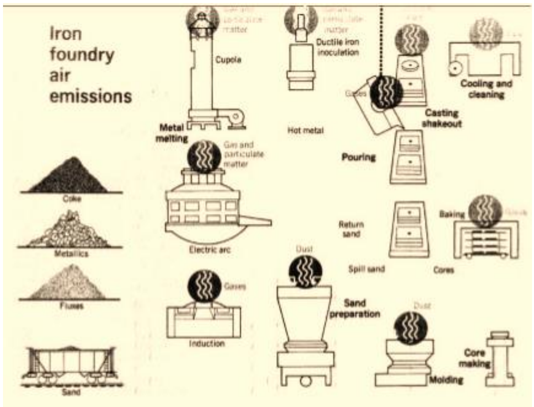

Fig.2: Various Sources of Pollution in Foundry Activities

"Particulate matter" (PM) pollutants from melting and refining of molten metal as well as from the manufacturing of molds, shakeout, washing and after-treatment are typically of major concern. Depending on factors such as scrap quality, foundries generally produce 9 kg of dust per ton of molten metal, with a range of 4–29 kg / t. Flame ovens and "Induction furnaces" (2 kg / t of molten metal emissions) tend to decrease air emissions than electric arc furnaces (EAFs) and cupolas. Major air emission contaminants comprise particulate matter of the order of 800 mg / Nm3 [7].

When cooling water, process water and scrubber water are not regulated, foundries can produce up to 18 m3 of sewage per metric ton of molten metal. Untreated wastewater may consists of high levels of total suspended solids, copper (0.8 mg / l), lead (2.4 mg / l), chromium (2.4 mg / l), nickel (0.24 mg / l) and grease and oil. The discharge conditions would depend on the type of metal used as feed for the process and the nature of scrap. Solid waste is processed at a molten metal rate of 200–300 kg / t. Heavy metals such as chromium, arsenic, and nickel can be present in scales and sludge's [8].

In Foundry, i.e., the main contaminants are released from different work areas. Design market, preparing of clay, moulding and core producing, drying and heating of mold and ladle, cupola, furnace of electric arc, cooling of pouring and moulding, fettling, knockout, heat treatment, etc. In the manufacture of steel and by-products, pollutants are also emitted in sintering, refractories, palletisation, coke-oven plants, rolling mills, etc. For example, the Coke fired cupolas in Agra, Firozabad glass making units, and more than 200 foundries around Kolkata, Howrah urban metropolitan complex reported producing huge amounts of particulate matter and gaseous matter in the atmosphere [9].

Health hazards from foundries:

The impact of the pollutants coming in contact with the body can generate various health hazards such as: Headache; Eye irritation; irritation in throat and nose; dehydration and fatigue caused due to high temperature; Irritability of respiratory tract; Gases like ammonia, hydrogen sulphide, and mercaptans at low concentrations cause odour nuisance; diseases like asthma, and bronchitis which are the type of chronic pulmonary diseases are aggravated by NO2, SO2, photochemical smog and particulate matter; the haemoglobin in the blood gets contaminated with the carbon monoxide and will results in increasing of stress for those who are suffering from pulmonary and cardiovascular diseases; various types of respiratory diseases are caused due to dust particles such as asbestosis, silicosis, etc., there may be chances of getting cancer due to the "Carcinogenic" agents like Cr(VI), PAH's, Cd, etc.; Mottling of teeth and the fluorosis disease can be caused due to Hydrogen fluoride; Many heavy metals, such as gold, cadmium, chromium, mercury, copper, manganese, and so on, enter the body by inhalation, skin absorption, and food chain. It can cause chronic and severe poisoning [10].

In addition to the health hazards mentioned above, certain specific health hazards are usual among workers in the Iron & Steel and other manufacturing industries' foundries and forges. Sand, SPM, sound and gaseous emissions pose a potential danger to employees ' safety in the local industrial sectors and communities. Dust also absorbs gasses and is a more serious health hazard due to synergism in such a combination. Recently, SO2 absorbed on sub microscopic particles has been shown to penetrate deep into the lungs and this is a greater health hazard. Fire and explosion risks happen during treatment of fluid metal and the nearness of combustible synthetics and fluid fuel. Iron foundry slag might be profoundly receptive if calcium carbide is utilized to de-sulphuric the iron.

Air Emissions:

Dust pollution management systems include cyclones, scrubbers (with recirculating water), baghouses, and electrostatic precipitators (ESPs). Scrubbers are also utilized to control mists, amines and acidic gases. "Gas flame" is utilized in core production gas incineration. Target values are usually around 9mg/Nm3 (dry) for emissions passing through a fabric filter. PM emissions from furnaces (including die casting machines) should not exceed 0.2–0.4 kg/t of molten metal, depending on the nature of the PM and the plant's melting capacity. Fig.3 shows the wet scrubber for air filteration.

Fig.3: Wet Scrubber for Air Filtration

Wastewater Treatment:

Recirculate sedimentation or centrifugation of tumbling water accompanied by filtering (using ultra filters or sand filters); isolate oil from surface water. Adjustment of pH value and recirculation of water to precipitate metals in the very rare cases where scrubbers are used. Using sodium hydroxide or lime, precipitate metals in wastewater. Recirculation of hot waters and disposal of untreated storm water until discharge [11].

Remedies to prevent pollutions:

Utilization of Induction Furnace is more preferable than cupola furnaces. Using clean and selected scrap to decrease the emission of pollutants to the environment. More specifically the quality of feed should be improved. Heat the scrap before, along with the afterburning of exhaust gases. To avoid the contamination of storm water, the scrap is stored under cover. The hoods are provided for the doghouse enclosures or the cupolas for induction furnaces and EAFs. Instead of using scrubbers, using methods of dry collections are more preferable. Utilization of continuous casting is preferred for finished and semi-finished products where it is likely to be feasible. The chemicals are stored in such a manner when that spills, it is possible to collect it easily. By recirculating the cooling water after the treatment, the water consumption can be controlled. Utilization of

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natural gas as a fuel and Low nitrogen oxide burners will decrease the emissions of nitrogen oxide. After removing the binders, it is preferred to reclaim the sand.

Coke-less cupola:

"Cupola" seems to be a "continuous melting shaft furnace" that has significant advantages over batch melters like rotary or electric furnaces owing to its intrinsic nature. A cupola can accommodate a vast array of raw material. The materials comprises of contaminated, wet and oily scrap which is contaminated. For safety reasons, such materials or substances are not suitable for electric furnaces but its use is frequently restricted due to contamination because of metallurgical reasons. Once settling in the well, there is a degree of refinement in cupola melting as the metal develops droplets during melting [12].

In this method, many pollutants are destroyed or decreased in value, because whatever is in the charge material ends up in the liquid when melting in rotary or electrical furnaces. In comparison, the cupola is a vertical shaft furnace counter flow and provides the high possibility of reasonable melting performance relative to melters of the batch form. The temperature of Low Top gas mean that a significant proportion of the usable heat flows into the metal when losses arise in electric furnaces not only from the metal surface, but at least 24% of the input energy goes into the water in the "induction coil". Low waste gas temperatures in rotary furnaces, even with recoverees, mean high losses.

The waste gas seems to have a less content of CO and in some coke processes, there is only 2 percent until dilution which ensures that the full heat is emitted to the metal equivalent to 11 percent to as much as 19 percent CO which is a significant loss to the plant. Main source of pollution can be eliminated by removing coke and no metallurgical fume is produced as there is no free oxygen present cupola which is coke-less. Particularly with injection and enrichment of the oxygen, some coke cupolas produce considerable volumes of metallurgical fume that then involve large plants of filtration to remove it. Fig.4 shows coke-less cupola.

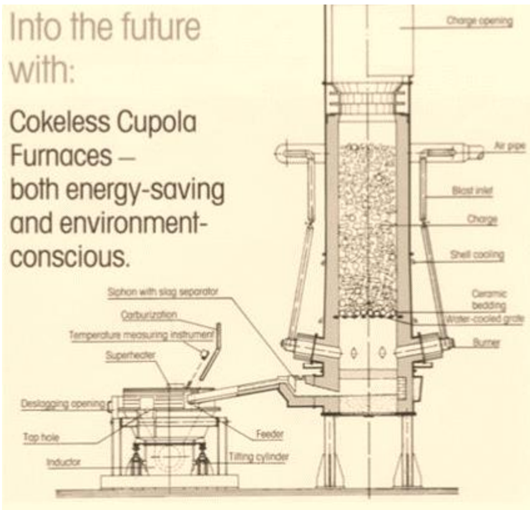

Fig.4: Coke-Less Cupola

LITERATURE REVIEW

Secondary industrial wastes and raw materials are produced in the cycle of cast and pig iron processing. The most common secondary component resulting in these processes is furnace slag. The slag of cupola and blast furnace are the product of burning gangue sections of metal bearing components, removing slag and coke powder. Slag is generally compounds of metallic and non-metallic oxides that form chemical compounds and solutions together and contain small volumes of metals, metal sulphides and gases as well [13].

In people living near the iron foundry in the city of Trieste, North-eastern Italy, researchers measured the risk of lung cancer. Both cases of lung cancer and the associated population were regarded between 1995 and 2009. A deposition model defined SO2's foundry-specific emissions: "nearby," "urban," and "outlay" areas. Price ratios (RRs) were measured as well as average percentage adjustments (APCs) [14].

The complex designs of many automotive parts are the explanation why, from an economic point of view, the use of casting processes to make them is a solution well developed. Current regulatory requirements regarding exhaust fumes emissions force carmakers to reduce the overall weight of their products, as this is a basic precondition for fuel consumption reduction. As a result, newly launched car models contain an ever-increasing proportion of thin-walled casts made of materials that ensure a satisfactory level of service properties [15].

CONCLUSION

Different types of health hazards can be seen in any individual who is working in the environment where numerous pollutants in the form of gaseous, fume, dust, heat, noise in the foundries section of manufacturing industries producing steels and Iron. There exist requirement of a coke-less cupola furnace which is eco-friendly in order to reduce the pollution. Every foundries in the manufacturing industries should follow the Emission standards. Workers safety is also an important aspect in every manufacturing industries. They should be provided better quality of suit, shoes Goggles and gloves that will protect them from harmful pollutants emitted due to the process carried out in foundries and radiation.

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