Pollution in Sponge Iron Industry

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Sponge iron process will dominate Indian steel sector very soon. But its manufacturing process, based on coal, is highly polluting. The repercussions are already visible near sponge iron factories. Public rage is widespread.

Steel making using sponge iron - electric arc furnace route is a cheaper alternative to conventional route. It needs lower capital investment and easily available cheap raw materials. Conventional steel making using blast furnace is though most preferred process across the globe, in India it is sponge iron route. Since 2002, we are the largest sponge iron producer in the world. For production of nearly 20 MTPA of sponge iron, nearly 400 sponge iron plants are currently operating in India. Surprisingly, most of the plants are not accounted in government records. The sponge iron route of steel making is set to dominate the steel industry in a couple of decades. In this situation, the biggest problem ahead is to turn this industry sustainable.

The first coal based sponge iron process, Stelco-Lurgi/Republic-National (SL/RN), was developed in Canada in 1964. However, India commercially adopted coal-based sponge iron process in 1980, initial growth began post liberalization in the 1990s when the price of scrap skyrocketed and sponge iron became the preferred input for steel making. Rising prices of coke, abundance of non-coking coal, lower investment and cheaper labour helped this process to grow in India. A number of small-scale sponge iron plants mushroomed thereafter. The compound annual growth rate (CAGR) of sponge iron production was as high as 24 per cent between 2005 and 2010 as against 8.2 per cent for total steel sector. In 2010-11, the country produced above 25 million tonnes of sponge iron, out of which above 19 million tonne was from coal based process.

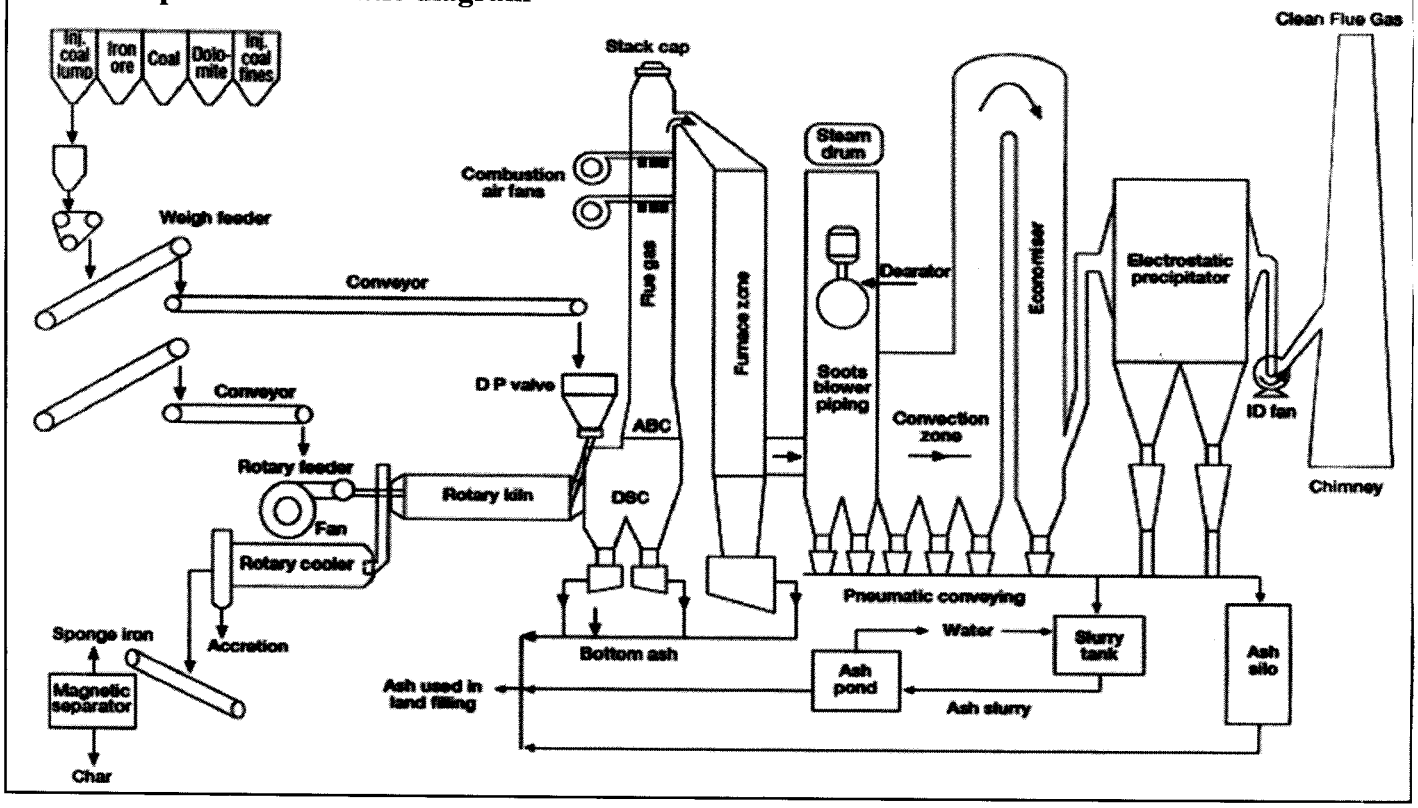
Pic 1. A coal based sponge iron kiln

However the process flourished as a cheaper option, it also had disadvantage of being a highly raw material intensive and polluting. In a coal based sponge iron making process, a rotary kiln is used to reduce iron ore with non-coking coal as an energy source and reducing agent. In a natural gas process, natural gas plays this role of coal in a shaft furnace instead of a rotary kiln. Natural gas based process is not only cleaner but also energy and water efficient but the process could not flourished in India. Only 3 natural gas based sponge iron pants are operating in India; Essar Steel- Hazira, JSW-Ispat Industries Limited- Dolvi and Welspun Maxsteel Limited- Salav.

In the coal based process, non-coking coal and the lump iron ore (both of size 5-20 mm) are fed into kiln. Flux agents such as limestone or dolomite are also added to remove the Sulphur from coal. Combustion air is fed at the discharge end. The product appears in the form of spheroids with sponge like appearance. The reaction gases coming out from the kiln is burnt in an after burning chamber (ABC) for removing traces of carbon monoxide. The flue gases are finally passed through an electrostatic precipitator (ESP) to capture the dust before release through the stack. The process has high pollution potential.

Natural gas availability, rising prices and lack of government support restricted the natural gas based sponge iron makers. Most of the existing players are adopting coal based operations. No such new plants are planned in India.

Coal DRI process schematic diagram



Water pollution is not a major issue in sponge iron plants. It is needed only for indirect cooling in kiln cooler, around 1.1-1.5 cubic meter per tonne sponge iron. In most plants, this kiln cooler water is reused for dust suppression purposes.

In the entire operation, sources of pollution are many.

Major pollution potential is in the form of air emission and solid waste disposal. Pollution starts right from raw material handling & processing in the form of fugitive emission. During operation, the major air pollution is from kiln exhaust gases and dust from cooler discharge and product separation bin areas. Huge quantity of solid wastes generation is a big problem.

Size of the plant does matter for pollution. As most of the sponge iron plants are smaller, they are settled in cluster which burgeon the overall pollution. At the same, due to lower capital, their investment on pollution control and cleaner technology is grossly inadequate. The higher the kiln capacity, lower is the pollution for the same output. It is also more economical in terms of investment in installation and operation of advanced air pollution control equipments. Rotary kilns of 100-500 tonne per day capacity are mostly available in India. Due to stability issues, a maximum 500 TPD kiln is the biggest size available globally. A typical 500TPD kiln has maximum 0.15MTPA capacity. This clearly indicates 6-7 such kilns are required to produce 1 MTPA sponge iron. A natural gas based module is larger in size, In India 1.6 MTPA capacity sponge iron module is available.

The sponge iron plants that have steel making facilities, electric arc furnace and/or induction furnace, multiply the pollution horribly. Their steel making plants do have similar status of pollution and its control. To comply the norm for stack emission from steel melting shop (SMS), plants let the fugitive emission release through roof, knowing the fact that fugitive emission norm does not exist in SMS area. One can easily imagine the extent of pollution from sponge iron based steel industry, provided that more than half of steel production in the country comes through this route only.

Pic 2. Fugitive emission from a sponge iron based steel plant

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Pollution starts right from raw material handling

Industry needs to handle raw materials as much as 4 to 5 times of the production. Raw materials transport, unloading, storage and transfer in the plant premise are highly prone to fugitive emission. Mostly unskilled daily wage labours are employed in these areas.

A coal based plant operation requires more than 2 tonne iron ore and equally non-coking coal to produce one tonne sponge iron. This clearly indicates that to produce 1 tonne of sponge iron, a plant would require to handle, store and process more than 4 to 5 tonnes of raw materials. As only one tone of final product would be coming out, remaining 4 tonnes of materials will be generated as pollutant, by-product and waste material. A natural gas based process requires lesser raw material and no coal at all, which easy out raw material handling for them. Raw material requirement in natural gas process is comparatively less as it does not need coal. It requires only 1.5-1.6 tonnes of iron ore to produce one tonne sponge iron. Hence, extent of fugitive emission during raw material handling is less.

Using pellet (agglomerated iron ore fines) in place or iron ore fines and lump, plant can reduce the raw material consumption. This practice, not only reduces coal requirement, it improves productivity and product quality along with kiln life. When raw materials requirement get reduced, chances of material loss and pollution is less.

The extent of fugitive emissions from the raw material handling area depends on initiatives taken for prevention of dust generation & control, amount of fine materials being handled and also local meteorological conditions such as wind speed and humidity. Where the large scale land based steel plant uses better raw material handling operations such as material transport through railway wagons, unloading using enclosed wagon tipplers, majority of the sponge iron plants do not have this system. They get the raw material through uncovered trucks and unload it through truck tipplers in open. This leads to high fugitive dust generation as well material loss.

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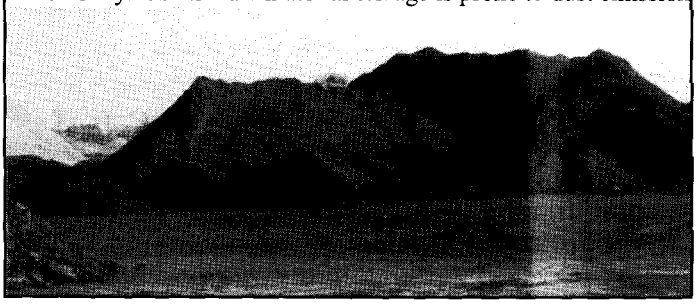
Raw material storage area is mostly un- systematic, un-paved and without any cover, wind curtain, effective dust suppression system, proper green belt, boundary wall and run-off collection system. During high wind fugitive emission is inescapable in this condition. Whereas some of the large scale Indian steel makers have these systems in place, most of the coal based sponge iron makers have not. One can frequently observe raw materials lying haphazardly in open without any cover and dust suppression system which allows raw materials to get airborne with high winds. In some of the plants where water sprinkling is used for dust suppression, it does not alleviate fugitive emission during trucks movement on unpaved roads.

Pic 3. Unsystematic raw material storage is prone to dust emission



In monsoon, the water pollution problem replaces air emission in this area. During rain, runoff from raw material stockpiles, oil and chemical storage area contaminates nearby surface water source. Impervious surface also allows leaching of contaminants into ground water.

Transfer of raw material within premise generally happens through open conveyors having no enclosed transfer points and dust control measures. A large number of these plants use bucket elevators for raw material transfer instead of stacker reclaimer, covered transfer points with dust suppression system. This sub-standard practice only supplement dust emission chances for which control practices are nil. The monetary loss of raw material in this practice is one factor which is unaccounted as it remains insignificant against the investment needed to control it.

Material processing has high fugitive emission potential

Raw material sizing and segregation are highly dust emitting operations. Crushers and screeners are grossly observed mismanaged in the plant.

Crushers and screeners needed to size and screen the raw materials to be used in kiln, are among the highly dust emitting source. These facilities should be equipped with proper enclosures, air suction system with bag filter and dry fog dust system for fugitive emission control. Many of the crusher and screener houses are not even equipped such systems. In the plants, mostly large scale, where these systems are available, remain non-operating due to high

electricity costs in operation. Huge fugitive dust emissions are observed in these areas across the plant. Poor housekeeping and labours with no personal protection equipments (PPEs) are usually observed in these plants. Fugitive dust control in raw material handling and processing area is majorly neglected.

None of the sponge iron plants are able to meet work zone area fugitive dust emission norm (within 10 m of source) of CPCB at 2000microgram (□g)/normal cubic metre (Nm3). Most of the plants opt a safer side indicating Factory Act norm of 10,000 mg/Nm3. Due to inadequate monitoring & control and regulatory enforcement, fugitive emission control in the industry is very poor. This is equally true for gas based operations as well.

Air emissions from stacks are not in control

Point source emissions of particulate matter are mainly from two major stacks – the kiln exhaust stack and de-dusting stack of cooler discharge and product separation bin area. Kiln exhaust is having ESP whereas cooling discharge and bin separation area has bag filter for emission control. However the operation of these equipments has high electricity cost so preferred to keep non-operational many times. Inadequate design and maintenance of the equipments are common problems, which fail equipments in emission control.

The national norm has been specified for this is 100 mg/Nm3 whereas some state pollution control boards (SPCBs) have stipulated stricter norm of 50 mg/Nm3. On the ground compliance to this is zero. Fugitive dust emissions have been reported as high as 480 mg/Nm3 in some plants. Inspection reports from SPCBs indicate absolute non-compliance across the industry. Except a few large scale steel makers, most of the players do not have continuous online monitoring system in stack, this gives ample scope of contemptible inspection, monitoring and reporting on stack emission. Public complaints and repeated show cause notices, directions and closure notices issued by regulators are ordinary for these plants.

Pic 4. Stack emissions from a coal based sponge iron plant

Green Rating Project study released in 2012 discloses that regulatory inspection and monitoring for large number of sponge iron plants is non-existent in some states. In many cases their inspection reports are either not credible or even not available.

ABC Cap opening is a common impish practice

Bypassing ESP saves electricity cost to the plant but geometrically amplify the cost to environment

Air emissions get worsen further when ESP is bypassed and emissions are released directly to the atmosphere through ABC cap of the kiln. Generally plant is required to open ABC cap during shutdown and light-up for kiln maintenance due to periodic accretion, normally for 24 -48 hours. Nonetheless, this is often repeated for monetary savings. Bypassing the flue gas saves electricity cost of running ESP in the plant. Many non-compliance cases for high emission through ABC cap opening are observed in plants.

The plants that have installed waste heat recovery boilers to extract flue gas heat for steam generation, ABC cap opening is in-fact a loss of incentive. Therefore emission from ABC cap opening is not a serious problem with them. The flue gas from a 350 TPD capacity kiln can produce up to 7 MW power. This is a good practice which not only helps in pollution control but also gives electricity as incentive.

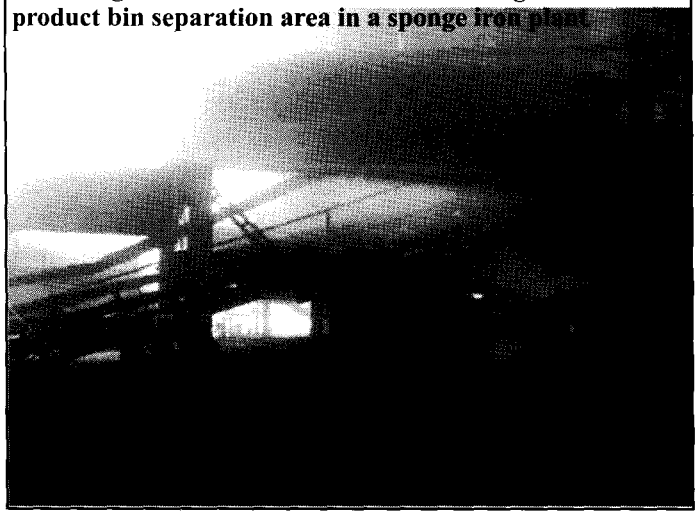
Fugitive emission during operation is all time high

Fugitive dust emissions at cooler discharge end and product bin separation area are common.

During sponge iron release from rotary kiln and cooler and separation from char, fine char particles get air-borne resulting in high fugitive emission. Suction hoods and bag filters are provided to capture dust emission in these areas, but often fugitive emission is found beyond the limit. In some cases suction hood and bag filter designs are found inadequate whereas in other cases operation & maintenance is found faulty. Leakage from kiln is another such fugitive emission in the plant. When these fugitive emissions are not captured, it may show lower emission through stack but augments work zone emission concentration.

Fugitive emission during sponge iron air cooling and transfer from shaft furnace, in a natural gas based sponge iron plant, is equally polluting. None of the sponge iron plants satisfactorily meet work zone area fugitive emission norm of 2000μg/Nm3.

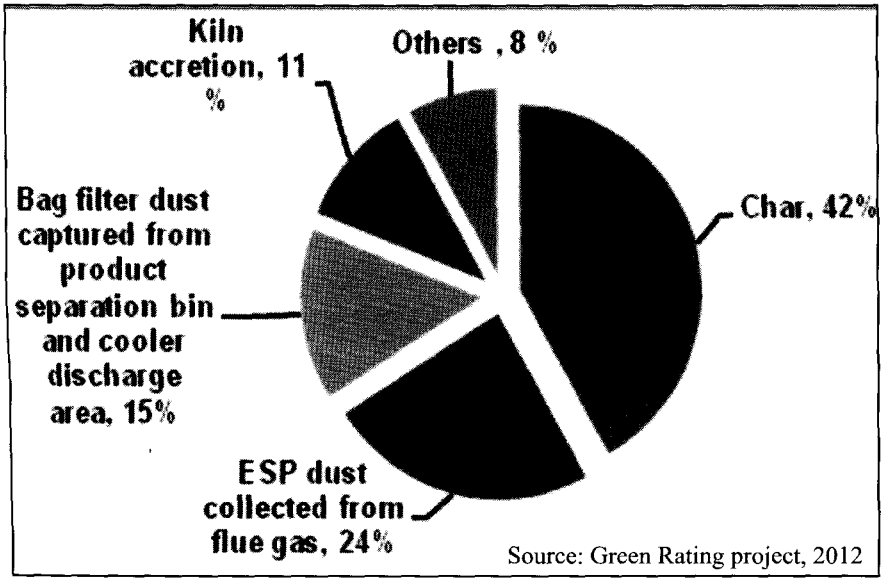
Pic 4. Fugitive emission from cooler discharge and product bin separation area in a sponge iron plant



Solid waste from coal based sponge iron plant

Managing huge quantity of solid wastes is the one of the biggest problem. Industry grossly fails to do it successfully.

Char, dust from cooler discharge and production separation bag filter, ABC dust, ESP dust, kiln accretion waste and waste from dust settling chamber make-up a huge quantity of solid waste. Most of the waste is difficult to recycle and hence are dumped. Nearly 700kg of solid wastes are generated for production of one tonne sponge iron, nearly 40 per cent of it is char alone. Another 40 per cent is the dust collected in ESP and bag filters (Green Rating project, 2012).



Source: Green Rating project, 2012

Solid wastes generation in a coal based sponge iron plant

The higher char discharged from the kiln, the higher the amount of solid waste generation. The high char generation also leads to poorer energy efficiency in the plant, as it contains unburnt carbon. It is a low calorie (nearly 1500 kilo calorie/ kg) fuel; therefore some plants have initiated its reuse in a char fired boiler for steam generation. However many plants claim for this initiative, except some, most of them dump as landfill in and around the premise. In case of integrated steel plants, SMS slag and ash from captive power plants increase solid waste quantity manifold. Dust emission from dump site is one of the big problems for community residing nearby. Run off from dump site contaminates nearby surface water source and agricultural fields. Sponge iron plants frequently get notices and directions from SPCBs for this.

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These sponge iron plants are, mostly, available in clusters across iron ore and coal rich states like Chhattisgarh, Odisha, West Bengal states. As each plant has high pollution potential, the clusters' assault has colossal damage to environment and natural resources. Community rage and government closure notices against the polluting plants are evident and so the repeated offenders. Clearly there is no option other than improvement in the sector and complete makeover of regulatory control.

Regulatory norms, manpower strength and execution need complete makeover. Grossly limited manpower and technology in SPCBs always fail them to do their job properly. Missing pollution norms give offenders a big go to continue pollution. Government has to take note of the real situation a step before being bigheaded for leading the world in sponge iron production. Because, the way it is happening is not a sustainable business. Ways of improvement has to be explored. If new technologies are required, it should be promoted by government. Regulatory system need to be given a boost. New environmental clearances need to ensure cleaner technology and practices for sake of environment and lives.