AIR POLLUTION CONTROL MEASURES IN STEEL INDUSTRY

By

DINESH K. S,

ENVIRONMENTAL ENGINEER,

KSPCB, DO-PALAKKAD

AIR POLLUTION CONTROL MEASURES IN STEEL INDUSTRY

- Usually Electric Induction Furnaces are used in secondary steel industry in India, where sponge iron, shredded steel melting scrap, old cans and coated steel sheet cuttings.
- There are several types of induction furnaces available, but all operate by utilizing a strong magnetic field created by passing an electric current through a coil wrapped around the furnace.
- The magnetic field in turn creates a voltage across, and subsequently an electric current through, the metal to be melted.
- They consume less power comparing EAF's. Expenditure on electrode is nil.

- They use lesser quantity of refractory. Initial investment is less on plant and equipment Thus, there are economic advantages in making steel through Induction Furnaces route.
- The environmental pollution in case of EAF is much more than Induction furnaces.
- **Preparation of raw material and Charging to the furnace**
- Raw material of various types is mixed into desired proportions to get the final product. Raw material is taken near the furnace floor with the overhead crane. Raw material is either fed manually to the furnace from the top or fed by the overhead crane.

- The furnaces of southern region engaged in the manufacturing of MS ingots are mainly using dirty scarp including dusty, rusty, painted, galvanized and oily scarp to the tune of 60 -85% with 15 -40 % as sponge iron.
- The smaller capacity furnaces engaged in the manufacturing of castings are mainly using clean scrap to the tune of 60 -80 % with remaining 20-40 % as pig iron.

- **Melting and Refining**
- Once the first batch is fed into the furnace, electric current is given and by magnetic induction, the material gets melted. Once the material is melted, second batch of raw material is added into the liquid metal in the furnace. Some alloying elements and lime are added for adjustment of composition and for slag formation. Slag is removed from the top of the furnace.
- **Refining in Ladle Furnace**
- The furnaces having batch capacities 16 T-22 T are providing Ladle furnaces for adjustment of the chemistry of the bath. In smaller capacity furnaces, the refining is done itself in induction furnace.

- **Tapping/Pouring in Moulds**
- After a cycle time of 90-120 minutes, the liquid metal is poured into the moulds for the manufacturing of Ingots, Billets etc. Bigger plants have provided continuous casting

- **Nature of Emissions:**
- Since no coal or fuel is burned in the induction furnace and no refining procedures are executed, the emissions solely depend on the cleanliness and the composition of the charged material. Two major categories of emissions can be distinguished.
- The first, and major, category relates to the charge cleanliness, e.g. rust, dirt, foundry sand, paint, oil, galvanized or soldered metal, all of which are elements which give rise to the emission of dust and fumes(organic or metallic).

- The second category relates to chemical reactions at high temperatures,(e.g. while holding or adjusting the metal composition), which can give rise to metallurgical fume due to oxidation.

- Additionally the refractory lining (acidic-S102, neutral-Al 203 , or basic-Mg0) may add a small amount of dust particles to the emission. It is difficult to obtain average emission data since the charge cleanliness, which is the dominant contributor to emissions, varies from unit to unit to a great extent.

- Emission rate from an induction furnace depends upon the charge material which againdepends upon the product being made from that furnace
- If the product being made is a good quality casting then emissions are of the order of 1 to 2 kg/tonne metal charge but if it is ingot which then emission rates of the order of 10 to 20 kg/tonne metal charge are normal.
- The highest emission rates occur during charging and at the beginning of the melting cycle.

- Particle sizes range from 1— 100 micrometer, with more than 50 % being smaller than 10-20 micrometer.
- Charging oily scrap or borings in a cold furnace will lead to the presence of organic vapours in the exhaust gases.

Emission – Charging

Emission – Melting

- **Containment system**
- Most of the furnaces engaged in the manufacturing of MS billets and SS billets have provided low canopy hoods for the containment of emissions being generated during melting of the raw materials in the furnace
- The furnaces located in the southern region engaged in the manufacturing of MS billets have provided pivot arrangement for swiveling the hood for serving both the crucibles on the pouring side of the furnace with underground ducting to the APCD.
- This arrangement was found to be effective as it provides no hindrance to the movement of overhead crane on theplatform.

Swivel arrangement with underground ducting

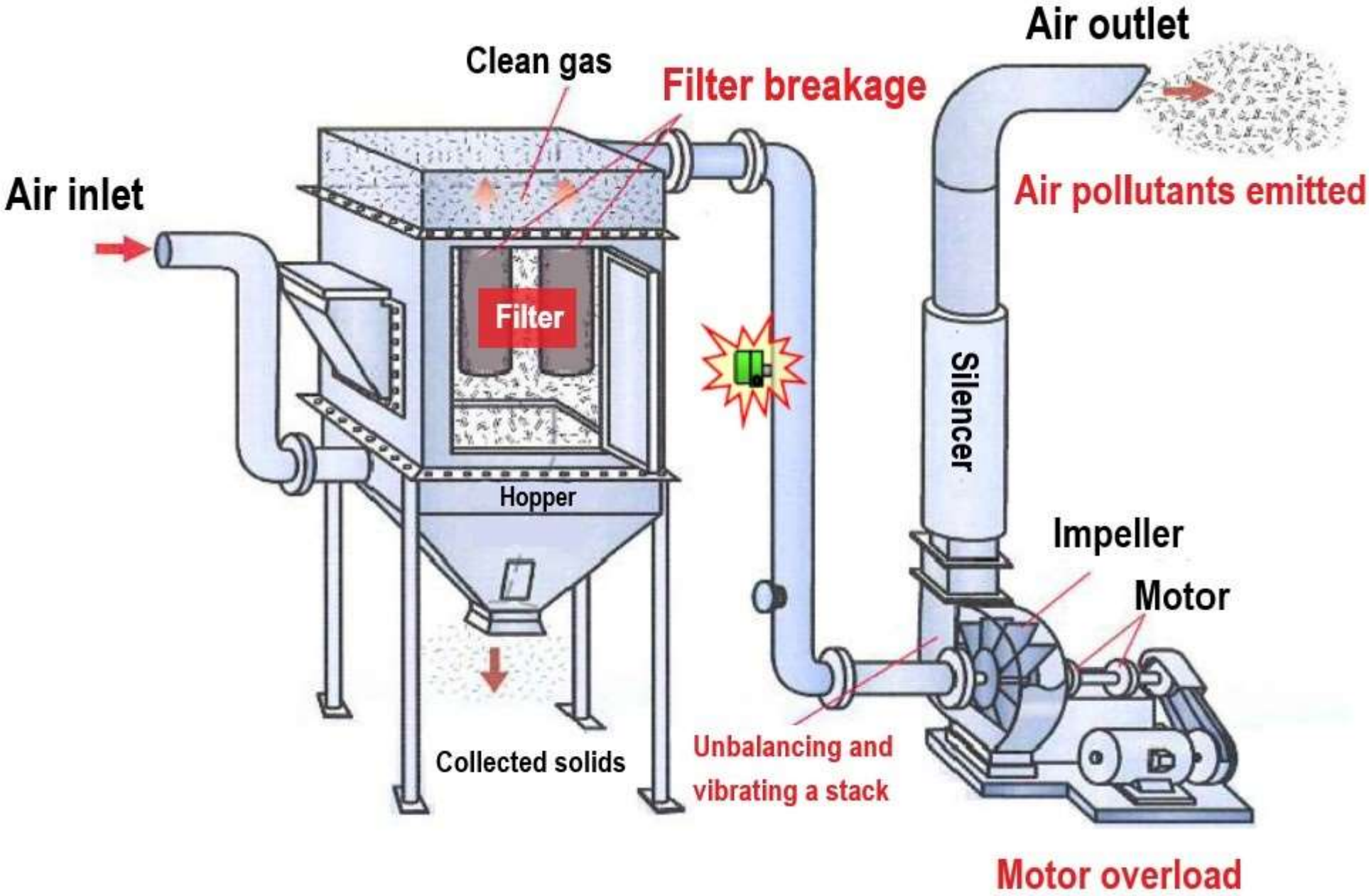
- **Cooling of the Flue Gases**
- Where as the industries located in southern region have provided gas coolers to bring down the temperature of the flue gases.
- **Air Pollution Control System**
- The industries have provided mechanical shaking bag filters, pulse jet bag filters, cyclonicscrubbers and venturi scrubbers for the control of suspended particulate emissions.

- It has been observed that most of the air pollution control devices provided by these industries are locally fabricated with provision of local made ID fans. The suction efficiency of these systems was found to be inadequate because of leakages in the bag filter and poor design of ID fans w.r.t. air handling capacity and pressure.

Problems observed in the APCD are as follows

- Some of the furnaces especially engaged in the manufacturing of castings have provided bag filters, the bags of which are being made from the local available clothes with poor stitching. This would result in poor filtration.
- Most of the industries are not disposing off the dust from the bag filters on regular intervals resulting in excessive pressure drop across the bag filter leading to poor suction efficiency.
- No instruments like manometers were provided to check the pressure drop across the bag filter so as to identify the leakages/ chockage of the bag filters.

- No maintenance schedules for checking the bag filters/scrubbers, ID fans are being followed.
- Most of the industries do not have any record regarding their dust generation from the air pollution control systems. This may due to the fact that either they are not operating the system regularly or not having dedicated man power to operate and maintain the system.


Air outlet
Clean gas
Filter breakage
Air inlet
Air pollutants emitted
Filter
Silencer
Hopper
Impeller
Motor
Collected solids
Unbalancing and
vibrating a stack
Motor overload

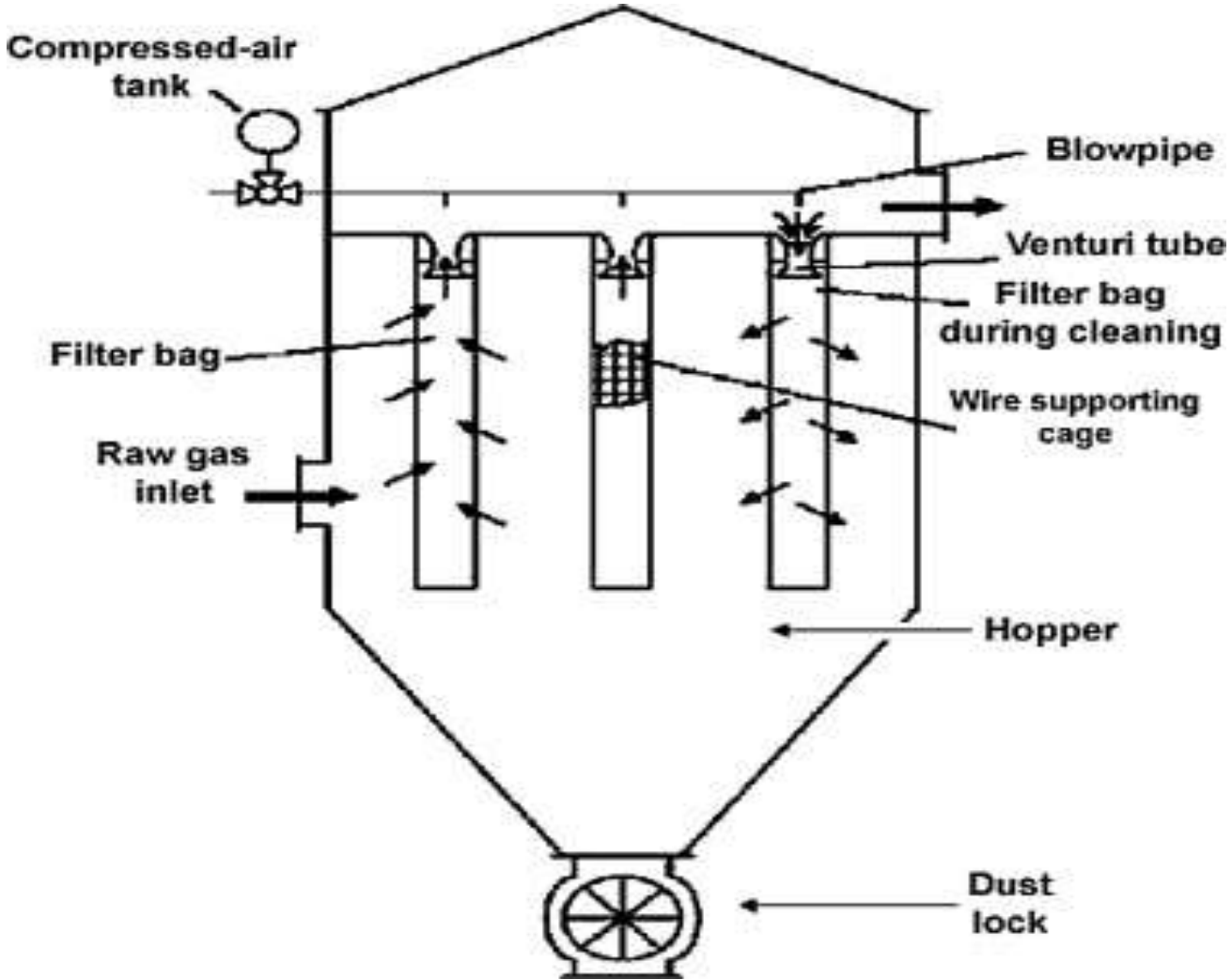
- The Bag Filter is a dust control device whose purpose is removing the dust contained in the exhaust gases from industrial process.

- It is applied to the various applications with different temperature and type of gasses by selecting the filter media accordingly.

- The advantage of Bag house bags over the cyclone collector is that it can collect the submicron particles.

- The baghouse or fabric filter can be safely operated only within the temperature range specified by the manufacturer. Fluctuation outside of these limits even for a small period, can damage the bags. The upper limit is determined by the permissible temperature of bags filter material, while the lower one depends on the dew point the resulting range of the flue gas temperature at the baghouse inlet is relatively small.
- Particles in steel plants and foundries is generated in different process of operation, air pollution control which may contain mineral oxides, metals particles (Aluminium , Cadmium, Copper, Lead, Nickel, chromium, Zinc, manganese) and metal oxides.

- Melting and refining activities
- • Heating and remelting furnaces
- • Mechanical action (e.g. scarfing, grinding and sand blasting)
- • Materials handling (e.g. raw materials, additive, recycled and waste materials, and by-products)
- • Coal storage, conveying, charging, coking, pushing, and quenching
- • Continuous casting (transfer of molten steel to the mold and cutting of the final product by oxy-fuel torches)


Compressed-air tank
Blowpipe
Venturi tube
Filter bag during cleaning
Filter bag
Wire supporting cage
Raw gas inlet
Hopper
Dust lock

- The Baghouse Filter separates dust from the exhaust gas by collecting them with the filter media. The dust is accumulated on the surface of filter media. And the filter media is cleaned by reverse airflow called backwashing (pulse-jet).
- The filter bag has a selection of filter media. The materials from which the filter is made varies from polyester, heat-resistant nylon to glass fiber. It is selected depending on the conditions such as characteristics of gas or dust.
- The filter media is consumable parts. When it is damaged or worn, the dust may leak outdoors.

- The pressure drop, called differential pressure (ΔP) between the clean gas side and the dirty gas side of the baghouse is one of the most important variables that must be considered in baghouse design. Pressure drop through a baghouse is caused due to the air flow's resistance when air passes through the filtering bag and the filter cake.
- The differential pressure is measured by a differential pressure gage (Magnehelic® gauge) or manometer. However, over time the pressure sensing lines can become clogged with dust or damaged by moisture or corrosion, and the gauge can become unreadable. Hence, provision for cleaning the pressure taps is required to prevent premature instrument failure due to clogging.

- A sudden drop in the differential pressure denotes a leak in the system. Whereas a sudden or sharp rise in the differential pressure denotes that the filter bags are becoming blinded or “caked” with particulate. Hence the differential pressure gauge is the best indicator of baghouse’s current operating status, and offers critical information for troubleshooting.

- MATERIALS USED FOR MAKING FABRIC

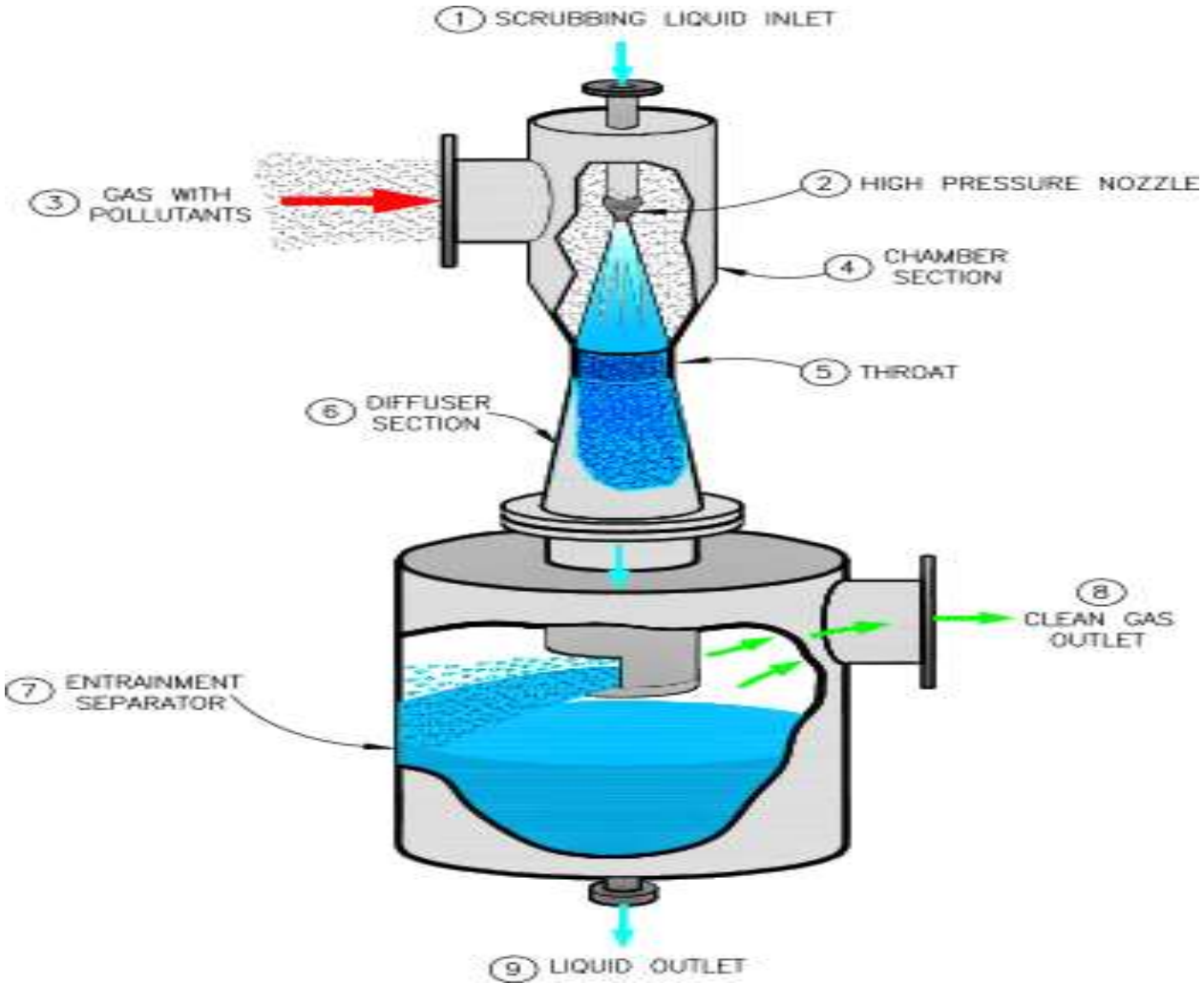
1. Polypropylene
2. Acrylic
3. Polyester
4. PPS [Ryton®]
5. Aramid [Nomex®]
6. Fiberglass (Glass Fibers)
7. Teflon®

Bag Failure Mechanisms

- Three failure mechanisms can shorten the operating life of a bag. They are related to thermal durability, abrasion, and chemical attack.
- The most important design parameter is the upper temperature limit of the fabric, or thermal durability
- Fabrics have upper temperature limits which they can withstand continuously. Hence the process exhaust temperature will determine which fabric material should be used for the dust collection.
- Another problem frequently encountered in baghouse operation is abrasion. Bag abrasion can result from bags rubbing against each other and from the type of bag cleaning method.

- Another problem frequently encountered in baghouse operation is abrasion. Bag abrasion can result from bags rubbing against each other and from the type of bag cleaning method.
- Bag failure can also occur from chemical attack to the fabric. Hence proper fabric selection and good process operating practices can help eliminate bag deterioration caused by chemical attack.

VENTURI SCRUBBER



- **How It Works**
- The Jet Venturi utilizes a large scrubbing liquid volume (1) introduced through a special high pressure nozzle (2) to aspirate the pollutant laden gas (3) into the chamber (4) in a concurrent flow pattern. As the gas enters the throat section (5) nozzle formed liquid sheets and droplets are sheared and break up into much smaller sizes due to the high relative velocity difference between the gas and liquid.
- These extremely small droplets create a tremendous amount of surface area for gas absorption and impaction collection of particulate to occur.

- Due to the even distribution and large volume of liquid throughout the throat cross section gases can be scrubbed even at extremely reduced rates with no appreciable decrease in removal efficiency.
- The gas with pollutant containing liquid droplets then proceeds out of the throat into the diffuser section (6) where further scrubbing action occurs
- Droplets are removed from the cleaned gas in the entrainment separator (7) before the cleaned liquid free gas exits the system (8). The liquid with contaminants drains through the outlet (9).

- Studies shows that the the maximum concentration of PM before air pollution control device was observed to be 1874 mg/Nm3 .
- Keeping the sticky and corrosive nature of the dust in view, it is proposed that venturi scrubber is the only technically feasible solution for the control of PM from the induction furnaces especially for the those which are using oily and galvanized scrap.
- The PM levels of 150 mg/Nm3 can be achieved economically with venturi scrubber having performance efficiency of 92%.

- The collection efficiency of the venturi scrubber is 100% for the particles above 4 micron, 97% between 2- 4 micron, 80% between 1 - 2 micron and 65% below 1 micron.
- In the case of venturi scrubbers, pH of scrubbing liquid should be maintained up to 8.5 by adding any alkali like caustic soda or soda ash etc. Then the turbidity, total suspended solids (TSS), chemical oxygen demand (COD), iron etc. will be within the limits.

- **Treatment of Slag**
- Like dust generation, slag forming is an indispensable part of the steel making process and can not be prevented or controlled totally. The slag amounts to about 250-750 kg/ton of steel produced depending upon the raw material to be used.
- The slag has to be crushed, screened and sized for use.
- Depending on the actual composition, the slag can be used for road construction and for making concrete blocks after grinding as a replacement of coarse aggregates


THANK YOU!