INDUSTRIAL DUST AND AIR POLLUTION -- II

Mechanism of air pollution by particulate matters (Fine and Coarse Dust particles) – ‘Fine particles’ are less than 2.5 micron in size and require electron microscope for detection, however, they are much larger than the molecules of Ozone etc., and other gaseous pollutants, which are thousands times smaller and cannot be seen through even electron microscope.

Fine particles are formed by the condensation of molecules into solid or liquid droplets, whereas larger particles are mostly formed by mechanical breakdown of material or crushing of minerals. ‘Coarse particles’ are between 2.5 to 10 micron size, and cannot penetrate as readily as of Fine particle; however, it has been seen these are responsible for serious health hazards. The severity of the health hazards vary with the chemical nature of the particles.

The inhalation of particles has been linked with illness and deaths from heart and lung disease as a result of both short- and long-term exposures. People with heart and lung disease may experience chest pain, shortness of breath, fatigue etc., when exposed to particulate-matter pollutants. Inhalation of particulate matter can increase susceptibility to respiratory infections such as Asthma, Chronic Bronchitis. The general medical term given for such lung diseases is ‘Pneumoconiosis’.

Emissions from diesel-fuel combustion in vehicles / engines / equipments; Dusts from cement plants, power plants, chemical plants, mines are a special problem, specially for those individuals breathing in close proximity to such atmosphere. Cars, trucks and off-road engines emit more than half a million tones of diesel particulate matter per year.

3.1. Controlling Airborne Particulate Matters – Airborne particulate matters (PM) emissions can be minimized by pollution prevention and emission control measures. Prevention, which is frequently more cost-effective than control, should be emphasized. Special attention should be given to mitigate the effects, where toxics associated with particulate emissions may pose a significant environmental risk.

Measures such as improved process design, operation, maintenance, housekeeping, and other management practices can reduce emissions. By improving combustion efficiency in Diesel engines, generation of particulate matters can be significantly reduced. Proper fuel-firing practices and combustion zone configuration, along with an adequate amount of excess air, can achieve lower PICs (products of incomplete combustion). Few following steps should be adhered to control PM:

a. Choosing cleaner fuels – Natural gas used as fuel emits negligible amounts of particulate matter.

b. Low-ash fossil fuels contain less noncombustible, ash-forming mineral matter and thus generate lower levels of particulate emissions.

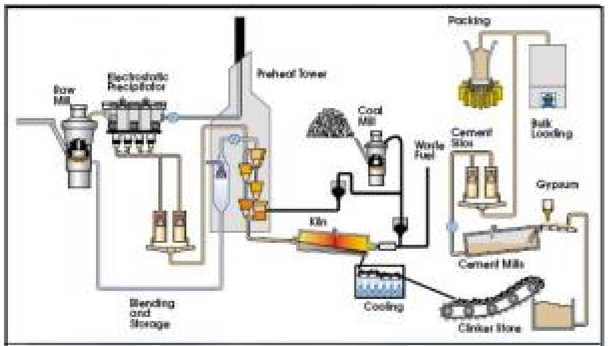
c. Reduction of ash by coal cleaning reduces the generation of ash and Particulate Matter (PM) emissions by up to 40%.

d. The use of more efficient technologies or process changes can reduce PIC emissions.

e. Advanced coal combustion technologies such as coal gasification and fluidized-bed combustion are examples of cleaner processes that may lower PICs by approximately 10%.

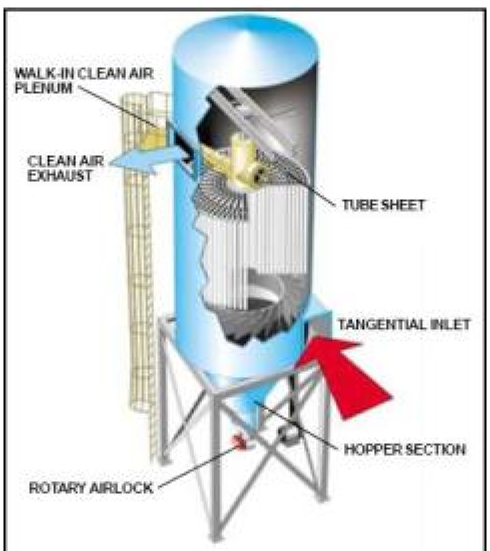
f. A variety of particulate removal technologies, are available – these are (a) Inertial or impingement separators, (b) Electrostatic precipitators (ESPs) , (c) Filters and dust collectors (baghouses), (d) Wet scrubbers that rely on a liquid spray to remove dust particles from a gas stream.

4.0. Dust in cement industry – Its prevention and collection enhances environment standard : The manufacturing of cement involves mining; crushing and grinding of raw materials (mostly limestone and clay); calcinating the material in rotary kiln; cooling the resulting clinker; mixing the clinker with Gypsum; and milling, storing and bagging the finished cement. The cement manufacturing process generates lot of dust, which is captured and recycled to the process. Gasses from clinker cooler are used as secondary combustion air. The process, using pre-heaters and pre-calciners, is both economically and environmentally preferable to wet process because of techno-economic advantages of the energy saving dry system over wet. Certain other solids such as pulverized fly ash from power plants, slag, roasted pyrite residue and foundry sand can be used as additives to prepare blended cement.



SCHEMATIC DIAGRAM OF A CEMENT PLANT

a. Dust generation: Generation of fine particulates and dust are inherent in the process; but most are recovered and recycled. The sources of dust emission include clinker cooler, crushers, grinders and material-handling equipments. Material-handling operations such as conveyors result in fugitive dust emission.

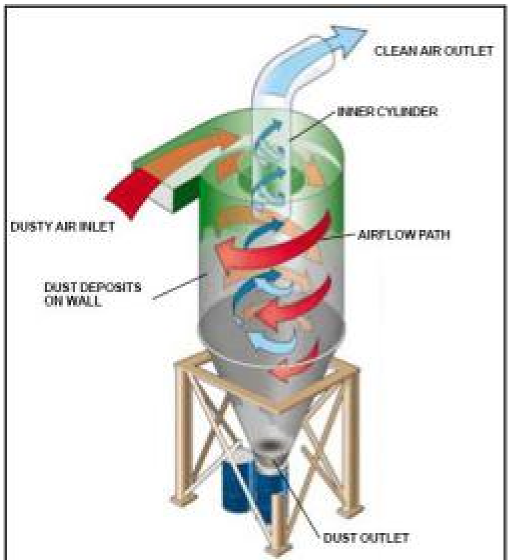


Sectional View of a Dust Collector

b. Prevention and control of dust: The priority in the cement industry is to minimize the increase in ambient particulate levels by reducing the mass load emitted from the stacks, from fugitive emissions, and from other sources. Collection and recycling of dust in the kiln gases in required to improve the efficiency of the operation and to reduce atmospheric emissions. Units that are well designed, well operated, and well maintained can normally achieve generation of less than 0.2 kilograms of dust per metric tonne (kg /t) of clinker, using dust recovery systems. For control of fugitive dust (a) ventilation systems should be used in conjunction with hoods and enclosures covering transfer points and conveyors; (b) Drop distances should be minimized by the use of adjustable conveyors; (c) Dusty areas such as roads should be wetted down to reduce dust generation; (d) Appropriate stormwater and runoff control systems should be provided to minimize the quantities of suspended material carried off site.

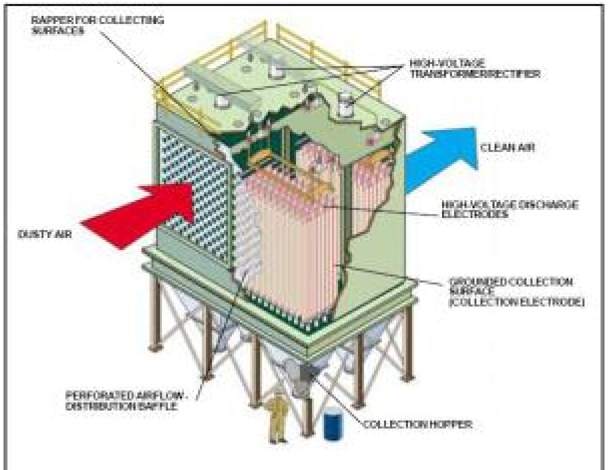
c. Mechanical systems for controlling dust: Several mechanical equipments are used in cement manufacturing plant to control / collect dust. These are:

(i) Dust collector - A dust collector (bag house) is a typically low strength enclosure that separates dust from a gas stream by passing the gas through a media filter. The dust is collected on either the inside or the outside of the filter. A pulse of air or mechanical vibration removes the layer of dust from the filter. This type of filter is typically efficient when particle sizes are in the 0.01 to 20 micron range.



Cyclone Operation

(ii) Cyclone - Dust laden gas enters the chamber from a tangential direction at the outer wall of the device, forming a vortex as it swirls within the chamber. The larger articulates, because of their greater inertia, move outward and are forced against the chamber wall. Slowed by friction with the wall surface, they then slide down the wall into a conical dust hopper at the bottom of the cyclone. The cleaned air swirls upward in a narrower spiral through an inner cylinder and emerges from an outlet at the top. Accumulated particulate dust is deposited into a hopper, dust bin or screw conveyor at the base of the collector. Cyclones are typically used as pre-cleaners and are followed by more efficient air-cleaning equipment such as electrostatic precipitators and bag houses.



Sectional View of an Electrostatic Precipitator

(iii) Electrostatic Precipitator - In an electrostatic precipitator, particles suspended in the air stream are given an electric charge as they enter the unit and are then removed by the influence of an electric field. A high DC voltage (as much as 100,000 volts) is applied to the discharge electrodes to charge the particles, which then are attracted to oppositely charged collection electrodes, on which they become trapped. An electrostatic precipitator can remove particulates as small as 1 µm (0.00004 inch) with an efficiency exceeding 99 percent.

Source : http://saferenvironment.wordpress.com/2009/09/05/industrial-dust-air-pollution-and-related-occupational-diseases/