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AIR POLLUTION CONTROL

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ABSTRACT

Air pollution is an important issue nowadays, and combustion plants have a significant contribution in this regard. In this paper we are going to present some of the techniques that can be used to avoid creating pollutants or cleaning effluents before they are released into the atmosphere. All these will lead to withholding of pollutants and maintaining the harmony between human activity and nature.

KEYWORDS: air pollution, emission control, cleaning effluents, electrostatic filter

1. Particles removal

Physical particles removal, by attracting them into a trap made of porous cotton clothing, glass or as best fibers cellular allows air to pass through it, but it retains the solid particles. The efficient collection is relatively intensive depending on: the type of fuel, fly ash composition, particle size and electrical properties. Filters are, generally, designed as giant vessels from 10 to 15 m high and 2 or 3 m wide.

The gas which flows is left at the bottom of the container and then it exits through holes (Fig. 1). After a few days or weeks the containers are cleaned of dust.

These filters are normally much cheaper to install than electrostatic filters.

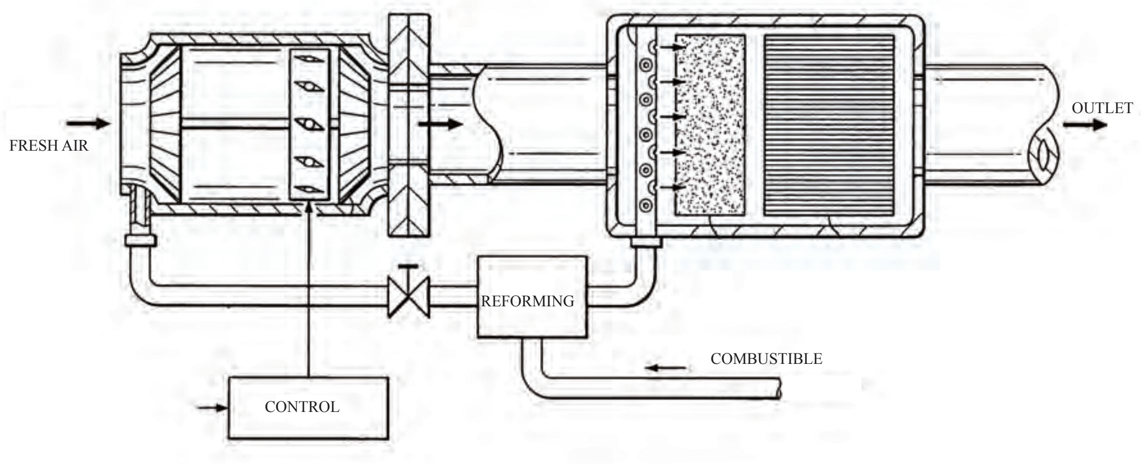

***Fig.1**. Typical devices of emissions control.*

Electrostatic filters are the most common methods of control in power plants.

Fly ash particles raise an electrostatic charged surface, while they pass through the electrodes on leakage current.

This causes particle migration and accumulation in the collector plate. These filters consume a large amount of electricity, but their maintenance is relatively simple and efficient, the collection is up to 99%. The performance depends on particle size, chemistry, electric field strength and acceleration of gas flow.

The ash collected by these techniques is a solid waste (often dangerous because of heavy metals and other components traces of coal ash or other sources) that must be buried in solid waste disposal sites.

2. Removing sulfurs

The sulfur oxide is one of the most dangerous air pollutants in terms of human and ecosystem health. It is important to reduce the sulfur loading. This can be done either by using low sulfur fuel or by removing the sulphide emissions.

3. Fuel changing and cleaning

A method may be a shift from a coal with high sulfur coal with low sulfur content, thus can significantly reduce the sulfur emission. The change of fuel, such as natural gas or nuclear energy can eliminate sulfur emissions, particles and heavy metals. Natural gas is more expensive and difficult to transport and store than coal; however, many people prefer the risk of pollution caused by coal plants than nuclear threats.

Alternative energy sources such as solar power could also be a solution. In the interim period, coal can be crushed and washed to remove sulfur and metals prior to combustion; this improves heat content and combustion properties, but does not replace air pollution and solid waste and does not solve water pollution problem. Coal gasification can also reduce sulfur emissions.

4. Limestone injection and combustion flow fluidization

Sulfur emissions can be reduced by up to 90% by mixing crushed limestone with coal, before being introduced into the combustion plant. Calcium from limestone reacts with sulfur and produces calcium sulfate $CaSO_3$, calcium sulfate $CaSO_4$ or gypsum $CaSO_4 * 2H_2O$. In ordinary ovens, this procedure creates slag which reduces the combustion efficiency.

A relatively new technique for burning is called the combustion flow fluidization; this provides several advantages in pollution control. In this procedure a mixture of crushed coal and limestone particles with a depth of approx. 1 m is scattered into a perforated distribution net in the combustion chamber (Fig. 2).

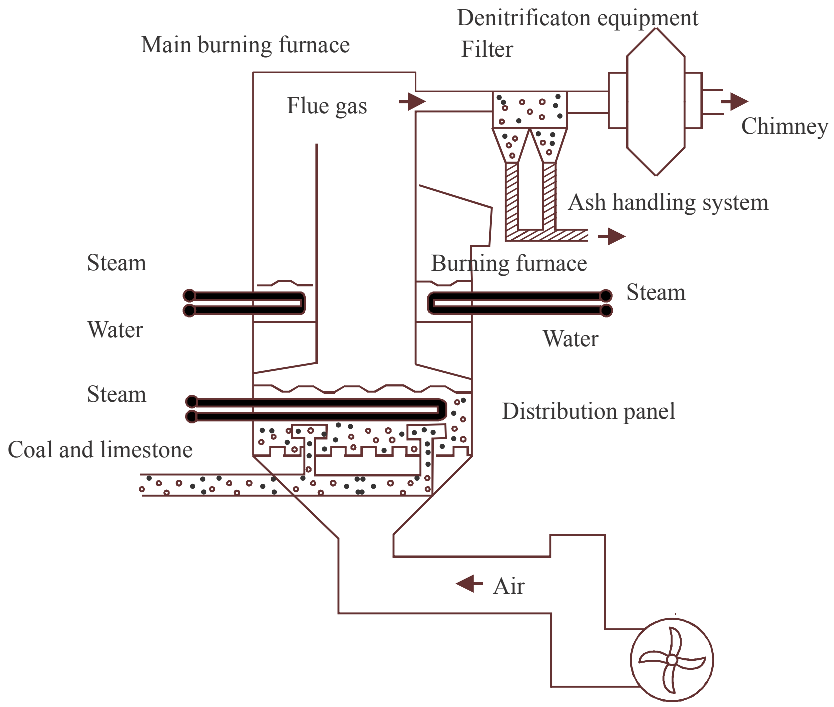

Fig. 2. *Combustion flow fluidization: the fuel is raised by powerful jets of air from the bottom of the shell. The efficiency is good for a wide variety of fuels, and SO_2, NO_x and CO emissions are much lower than conventional combustion.*

When the air with great power is forced to enter the room, the fuel surface rises up to a meter and results a hot fluid with particles jumping up and down. The oil is sprayed in suspended mass in order to start burning. During the operation, the fresh coal and the limestone are continuously fed at the flow surface, while the ash and slag are drawn to the bottom. The fresh air supply and the constant movement in the burning room, lead to efficient burning and prevent the construction of slag deposits.

Steam generating pipes are integrated directly into the fluid flow and heat exchange is more effective than in the walls with water of a conventional boiler. More than 90% of SO_2 is captured by the limestone particles, and NO_x formation is reduced by maintaining a temperature of 800^0C instead of dual-temperature in other boilers. These low temperatures exclude also the slag formation. The efficient combustion in the case of this process makes possible the use of the cheaper fuel such as lignite or dirty coal, instead of high-priced coal.

5. Flue gas desulphurization

The crushed limestone, calcium oxide or alkaline (sodium carbonate or bicarbonate) may be injected into a chimney in order to remove sulfide after combustion. This process is called scrubbing of gas combustion. The spraying of alkaline wet solution or of limestone oxide is relatively cheap, but its maintenance can be difficult. The hard rock plaster and ash layers from coal existing in spray chamber must be maintained regularly. The corrosive solutions from sulfates, chlorides and fluorides erode metals surface. Electrostatic filters do not work well because of the electrodes increase and decrease after wet washing. A hybrid procedure, called dry spraying was successfully tested in a pilot experiment in a factory. In this process, a limestone oxide which was sprayed is atomized into a gas flow. The spray rate and droplet size are carefully controlled, the sprayed water evaporates and thus, a dry granular filter is produced. A large power plant produces one million tones of waste per year.

6. The sulfur recovery process

In case of the waste manufacture, sulfur can be removed from flue gases by processes that delay the use of the product, such as elementary sulfide, sulfuric acid. The catalytic converter is used in these recovery processes to oxidize or reduce sulfur and to create chemical compounds that can be collected and sold. The contamination with fly ash must be reduced as much as possible.

7. Control of nitrogen oxide

The best way to prevent nitrogen oxide pollution is to avoid creating it. A substantial quantity of these emissions is associated with mining, and energy production should be eliminated through conservation. The combustion, where the air and fuel flow are carefully controlled can reduce nitrogen oxide formation up to 50%. This is true for both internal combustion engines and industrial boilers. The fuel is first burned at a high temperature in a poor oxygen medium, where NO_x can not be formed. Waste gases then pass through a column in which more air is added and the final combustion takes place in a medium with much air, less fuel and low temperature, fact that reduces also the formation of NO_x. Stratified charged engines and new engines of cars use this principle in order to meet emissions standards without catalytic converters. The approach adopted by the U S A in terms of car manufacturers to reduce NO_x was the use of selective catalysts to change pollutants into harmless substances. The three-way catalytic converter uses platinum catalyst - palladium and radium in order to remove a large amount of NO_x, hydrocarbons, carbon monoxide at the same time (Fig. 3). Unfortunately, this approach is not used for diesel engines, power plants, foundries or other sources of pollution because of problems caused by pressure, the lifetime of the catalyst, corrosion and the occurrence of unwanted side products such as ammonium sulphate (NH_4SO_4), which cheat the system. RapreNox (rapid removal of nitrogen oxide) is a new technique for removing nitrogen oxide which has been developed by the Department of Energy Laboratory in Livermore, USA, California. The emitted gases are passed through a container of acid, non-toxic cyanide. When heated to 350^0C, hydrogen cyanide gas releases an isocyanic acid, which reacts with NO_x to produce CO, CO_2, H_2O and N_2. In a small-scale test, this includes diesel engines; this system has eliminated 99% of NO_x. It is to be seen whether this application will work on a large scale, particularly in the waste gas contaminated with fly ash.

8. Hydrocarbons control

Hydrocarbons and volatile organic compounds are produced by incomplete combustion of fuels or evaporation of solvents from chemical plants, paints, plastics and other industrial processes that use a variety of volatile organic chemicals. Closed systems that prevent the escape of gases can reduce many of these emissions. In automobiles, for example, crankcase engine ventilation (PCV), the system which collects the oil escaping from the piston and from unburned fuel and directs it to the engine for combustion. The change of the carburetor and fuel system prevents fuel evaporation (Fig. 3).

After-combustion is often the best way for the destruction of volatile chemicals from industrial exhaust chimneys. The high rate of air-fuel from automobile engines and other combustions minimizes hydrocarbons and carbon dioxide emissions, but also causes the production of nitric oxide in excess. Careful monitoring of the air-fuel of the inlet and exhaust gas oxygen level can minimize all these pollutants.

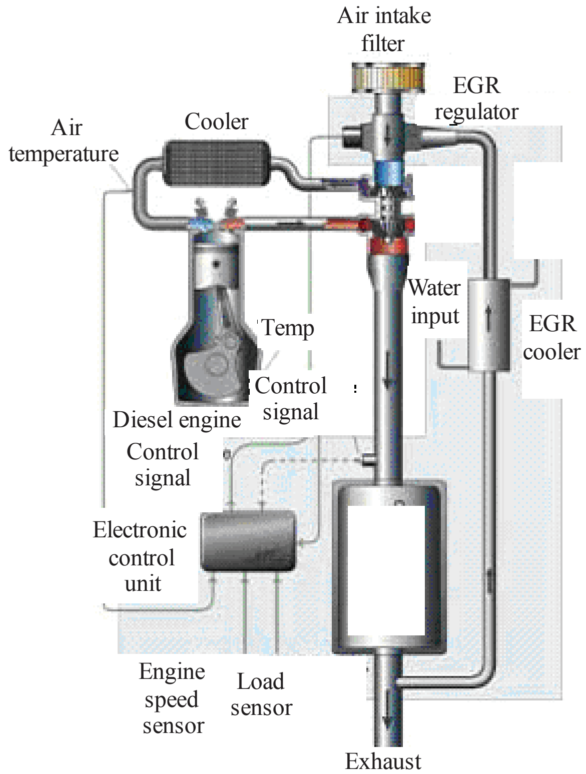

Fig.3. *Emission control system elements of a modern car. A closed loop, an electronically controlled carburetor or fuel injector which carefully measures the fuel / air rate for combustion optimization. Exhaust air sensor measures the combustion fuel level.*

9. Conclusions

The best way to reduce pollution is prevention. Because we cannot be sure that pollution does not produce, it is necessary to eliminate the possible emissions and, not lastly, to examine the causes and prevent it to increase.

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