

4.8 PROCESS CONTROL AND MONITORING

Air pollution control efforts by federal, State, regional, and municipal agencies and by industry have expanded tremendously within the past few years. That this increased effort is a reflection of elevated public understanding of the problem and rising public insistence upon action is inescapable.

Through all media of mass communication, through the efforts of public service organizations, and through the actions and pronouncements of public officials at all levels of government, the popular desire for better control of air pollution is being expressed with mounting frequency and increasing impact.

To generating an unprecedented expansion in control activity, requires that communication between the individuals and agencies responsible for air pollution control and the citizen, to whom this responsibility is owed, be open, comprehensive, and forthright.

Any other response to the need for public information and education concerning the problem of air pollution must in the long run seriously jeopardize the air pollution control effort.

- ✚ There are various air pollution control technologies and land-use planning strategies available to reduce air pollution.
- ✚ At its most basic level, land-use planning is likely to involve zoning and transport infrastructure planning.

Land-use Planning

In most developed countries, land-use planning is an important part of social policy, ensuring that land is used efficiently for the benefit of the wider economy and population, as well as to protect the environment.

- Efforts to reduce pollution from mobile sources includes

1. Primary regulation (many developing countries have permissive regulations),

2. Expanding regulation to new sources (such as cruise and transport ships, farm equipment, and small gas powered equipment such as string trimmers, chainsaws, and snowmobiles),

3. Increased fuel efficiency (such as through the use of hybrid vehicles),

4. Conversion to cleaner fuels (such as bio ethanol, biodiesel, or conversion to electric vehicles).

- Titanium dioxide has been researched for its ability to reduce air pollution.
- Ultraviolet light will release free electrons from material, thereby creating free radicals, which break up VOCs and NO_x gases. One form is super hydrophilic.
- In 2014, Prof. Tony Ryan and Prof. Simon Armitage of University of Sheffield prepared a 10 meter by 20 meter-sized poster coated with microscopic, pollution eating nano particles of titanium dioxide.
- Placed on a building, this giant poster can absorb the toxic emission from around 20 cars each day.

SO_x Control :

General Methods for Control Of So₂ Emissions

➤ Change to Low Sulfur Fuel

- ✚ Natural Gas
- ✚ Liquefied Natural Gas
- ✚ Low Sulfur Oil
- ✚ Low Sulfur Coal

➤ Use Desulfurized Coal and Oil Increase Effective Stack Height

- ✚ Build Tall Stacks
- ✚ Redistribution of Stack Gas Velocity Profile
- ✚ Modification of Plume Buoyancy
- ✚ Use Flue Gas Desulfurization Systems
- ✚ Use Alternative Energy Sources, such as Hydro -Power or Nuclear-Power

Flue Gas Desulfurization

➤ Classification

SO₂ scrubbing, or Flue Gas Desulfurization processes can be classified as: –

- ✚ Throwaway or Regenerative, depending upon whether the recovered sulfur is discarded or recycled.
- ✚ Wet or Dry, depending upon whether the scrubber is a liquid or a solid.

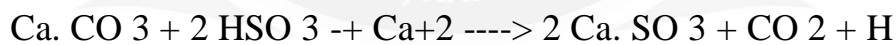
➤ Flue Gas Desulfurization Processes

The major flue gas desulfurization (FGD), processes are :

- ✚ Limestone Scrubbing
- ✚ Lime Scrubbing
- ✚ Dual Alkali Processes
- ✚ Lime Spray Drying
- ✚ Wellman-Lord Process

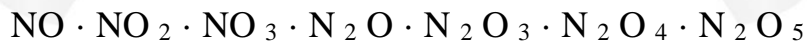
➤ Limestone Scrubbing

Limestone slurry is sprayed on the incoming flue gas. The sulfur dioxide gets absorbed. The limestone and the sulfur dioxide react as follows :



NO_x Control :

Background on Nitrogen Oxides . There are seven known oxides of nitrogen :



NO and NO₂ are the most common of the seven oxides listed above. NO_x released from stationary sources is of two types .NO_x control can be achieved by:

- ✚ Fuel Denitrogenation
- ✚ Combustion Modification
- ✚ Modification of operating conditions
- ✚ Tail-end control equipment

- ✚ Selective Catalytic Reduction
- ✚ Selective Non - Catalytic Reduction
- ✚ Electron Beam Radiation
- ✚ Staged Combustion

i) Fuel Denitrogenation

- One approach of fuel denitrogenation is to remove a large part of the nitrogen contained in the fuels.
- Nitrogen is removed from liquid fuels by mixing the fuels with hydrogen gas, heating the mixture and using a catalyst to cause nitrogen in the fuel and gaseous hydrogen to unite. This produces ammonia and cleaner fuel.
- This technology can reduce the nitrogen contained in both naturally occurring and synthetic fuels.

ii) Combustion Modification

Combustion control uses one of the following strategies: ·

- Reduce peak temperatures of the flame zone. The methods are :
 - ✚ Increase the rate of flame cooling
 - ✚ Decrease the adiabatic flame temperature by dilution
- Reduce residence time in the flame zone. For this we change the shape of the flame zone
- Reduce Oxygen concentration in the flame one. This can be accomplished by:
 - ✚ Decreasing the excess air
 - ✚ Controlled mixing of fuel and air
 - ✚ Using a fuel rich primary flame zone

iii) Modification of Operating Conditions

The operating conditions can be modified to achieve significant reductions in the rate of thermal NO_x production. the various methods are:

- ✚ Low-excess firing

- ✚ Off-stoichiometric combustion (staged combustion)
- ✚ Flue gas recirculation
- ✚ Reduced air preheat
- ✚ Reduced firing rates
- ✚ Water Injection

Carbon Monoxide Control:

Formation Of Carbon Monoxide due to insufficient oxygen

- Factors affecting Carbon monoxide formation:
 - ✚ Fuel-air ratio
 - ✚ Degree of mixing
 - ✚ Temperature
 - ✚ Control carbon monoxide formation.

Note :

CO & NO_x control strategies are in conflict

1. Stationary Sources

- ✚ Proper Design
- ✚ Installation
- ✚ Operation
- ✚ Maintenance

2. Process Industries

- ✚ Burn in furnaces or waste heat boilers.

Carbon Dioxide Control:

1. Sources of Carbon Dioxide

(i) Human-Related Sources

- ✚ Combustion of fossil fuels: Coal, Oil, and Natural Gas in power plants, automobiles, and industrial facilities

- + Use of petroleum-based products
- + Industrial processes: Iron and steel production, cement, lime, and aluminum manufactures

(ii) Natural Sources

- + Volcanic eruptions
- + Ocean-atmosphere exchange
- + Plant photosynthesis

2. Methods For Control of CO₂ Emissions

- Reducing energy consumption, increasing the efficiency of energy conversion
- Switching to less carbon intensive fuels
- Increasing the use of renewable sources
- Sequestering CO₂ through biological, chemical, or physical processes

Mercury Emissions

- Mercury exists in trace amounts
 - + Fossil fuels such as Coal, Oil, and Natural Gas
 - + Vegetation
 - + Waste products
- Mercury is released to the atmosphere through combustion or natural processes.
 - + It creates both human and environmental risks.
 - + Fish consumption is the primary pathway for human and wildlife exposure.

United states is the first country in the world to regulate mercury emissions from coal-fired power plants

Control Technologies for Mercury Emissions

Currently installed control devices for SO₂, NO_X, and particulates, in a power plant, remove some of the mercury before releasing from the stack.

1. Activated Carbon Injection:

Particles of activated carbon are injected into the exit gas flow, downstream of the boiler. The mercury attaches to the carbon particles and is removed in a particle control device

2. Thief process for the removal of mercury from flue gas:

It is a process which extracts partially burned coal from a pulverized coal-fired combustor using a suction pipe, or "thief, " and injects the resulting sorbent into the flue gas to capture the mercury.

