

old cars and other mobile vehicles which emit higher level of SO₂ and NO_x.

- * Provision of subsidy in technological control of emission like desulphurization of fuel oil, coal and diesel fuel before combustion.
- * Desulphurization of fuel during combustion by limestone injection or by additive processes and flautist bed combustion.
- * Development of technology based emission standards for SO₂ and NO_x from existing sources.
- * Capture of sulfur after combustion by flue gas treatments such as wet limestone scrubbers, fluidized bed combustion etc.
- * Make Asian countries agree on certain binding protocols, like that of European countries, between the nations that are likely to be threatened in near future due to acid rain.

What an individual can do?

The thrust area is to check sources that emit SO₂, and NO_x. An individual can also do a lot in containing these emissions by following means:

- * Use of energy efficient appliances.
- * Consider installing compact fluorescent lights (CFL) instead of high-wattage incandescent bulbs.
- * Use fuel efficient and catalytic converter based automobiles.
- * Share ride with a friend or coworker whenever possible to reduce fuel consumption.
- * Tune the engine of vehicle properly and maintain optimum air fuel ratio.
- * Avoid unnecessary idling of engine.
- * Drive at moderate speed.
- * Take train, bus or other mass transport vehicle on long trip rather than personal vehicle.
- * Don't accelerate abruptly or step hard on an accelerator.
- * Maintain proper tyre pressure.
- * The power plant companies need to pay attention and take steps to reduce the SO₂, emission problem. These plants may use coal with low sulfur content or the sulfur contents can be trapped and removed from the plants emission.
- * Installation of sulfur cleaning scrubbers in factories, washing of coal before use and use of less sulphur coal in thermal power plants can help to reduce SO₂.

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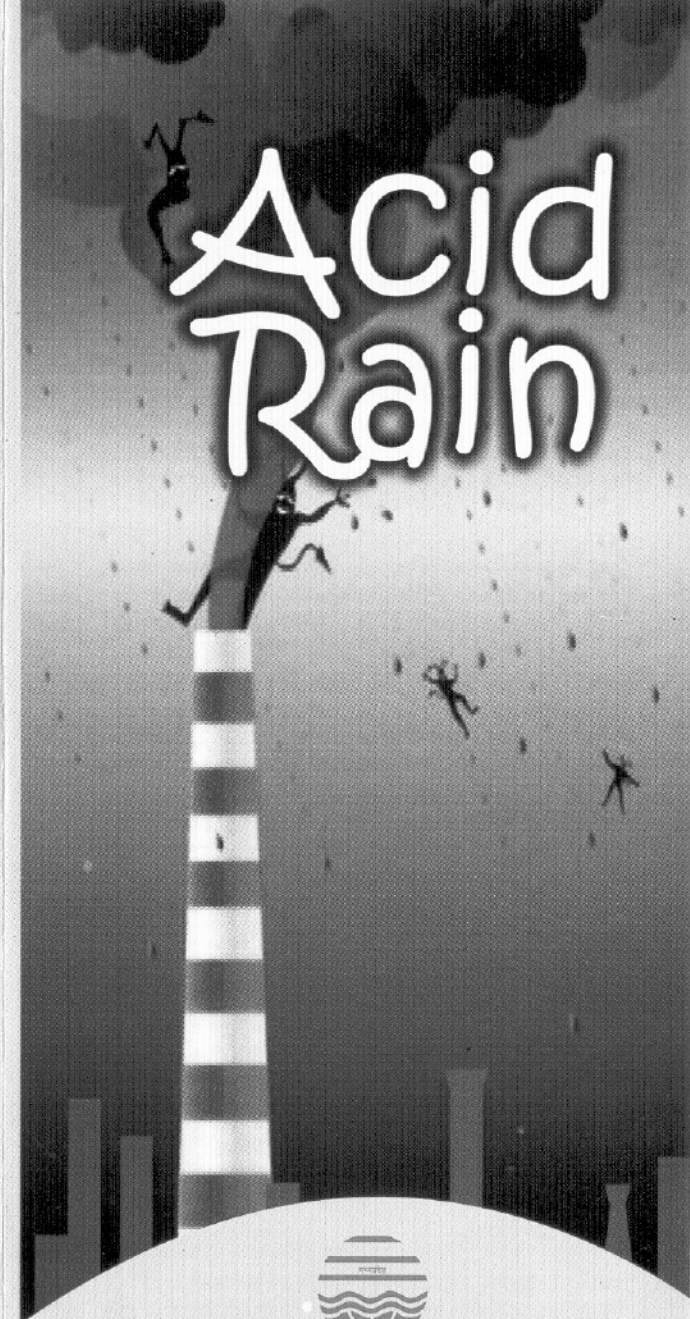
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Preamble

Environmental change is one of the major problems at global level that world countries are facing today. The problem issues addressed at various international forums include global warming, ozone layer depletion, climate change, biodiversity, acid rain etc. Not an individual but the whole world community is responsible for all these gigantic problems. The acid rain, a contemporary world problem, is one of the most dangerous and wide spread form of pollution. Acid rain is rain, snow or fog that has been acidified by air pollutants such as sulfur dioxide (SO₂) and Nitrogen oxides (NO_x). This acidic nature is basically due to the presence of pollution like oxides of sulfur and nitrogen in the droplets. In the recent past it has become common in many parts of the world to experience acidic rain due to pollution problem.

Acid rain, also called as acid deposition, may be wet or dry. The wet deposition refers to acidic rain, fog and snow. This acidic water affects plants and animals when it flows over and through the ground. Dry deposition refers to acidic gases and particles that fall back on the Earth. The wind blows these acidic particles and gases to various places. These dry deposits can also be washed from trees and other surfaces by rainstorms making the falling rain more acidic. The SO₂ and NO_x are the major precursors and primary causes of acid rains. The acid rain occurs when these gases react in the atmosphere with water, oxygen and other chemicals to form various acidic compounds viz., sulfuric acid and nitric acid.

Causes of acid rain

Such rains are caused by a chemical reaction that begins when compounds like sulfur dioxides and nitrogen oxides are released into the air. These substances can rise very high into the atmosphere where they mix and react with water, oxygen and other chemicals to form acidic pollution, known as acid rain. The SO₂ and NO_x dissolve very easily in water and can be carried very far by wind. As a result these compounds can travel long distance where they become part of rain, sleet, snow or fog.

Human activities are the major cause of generation of SO₂ and NO_x and hence are responsible for the problem of acid rain. Power plants release much of SO₂ and NO_x during the process of burning of fossil fuel. SO₂ is also generated as stack emission and as by-product of various industrial processes. NO_x is also generated by combustion of fuel, electrical utilities, transport sector, combustion of gasoline in automobiles, combustion of coal and oil in power plants. In addition, the major source of these gases is exhaust

emission from automobiles which ultimately goes in the local atmosphere. Industrial sector is also one of the major sources that contribute to emission of these gases.

Apart from anthropogenic sources there are natural causes as well, viz. fires, volcanic eruptions, bacterial decomposition and lightening etc. that greatly increase the amount of NO_x.

Effects of Acid Rain

Acid rain is an extremely destructive form of pollution and the environment and mankind suffer squarely from its serious effects. It causes acidification of lakes and streams and damages trees and soils. It accelerates decay of building materials, paint, statues and sculptures and contributes to visibility degradation and adverse health effects. Major effects of acid rain are as follows:

- * It damages leaves and needles, inhibits plant germination and reproduction. It depletes supplies of nutrients from soil, thus affecting the growth of trees.
- * The acid rain leaches calcium and magnesium from forests soils. These minerals are essential for plants growth and help in buffering or neutralizing acids. If the soil chemistry is changed this way it will take much longer time to recover. Trees exposed to acid rain find difficulty in withstanding droughts, diseases, insects, pests and cold weather etc.
- * The ecological effects of acid rain are most clearly seen in the aquatic environment. The acid rain may reduce fish population, completely eliminate fish species from water body and decrease biodiversity. Acid rain affects the planktonic life of water body. Many sensitive marine species disappear and the ones those survive in acidic water suffers stresses in number of ways.
- * The acid rain affects and damage the automotive paint and other coatings. This damage is usually permanent and requires repaint.
- * The acid rain causes visibility reduction problem. The SO₂ and NO_x emissions contribute to visibility impairment thus one can not see as far or as clearly through the air. The sulphate compounds account most for this problem.
- * The acid rain contributes to the corrosion of metals and deterioration of stone, i.e. marble, limestone etc., thus reducing their value. Dry deposition of acidic

compounds can increase the maintenance cost of buildings and materials.

- * The acid rain, and the pollutants (SO₂, NO_x) that cause acid rain, affects human health too. These gases form fine sulfate and nitrate particles which are transported to long distance and are inhaled by human beings causing problem of bronchitis, asthma, heart and lung disorders etc.

Need to Act

Although there has been major progress in controlling acid-forming emission in some countries but the global threat from acid rain is still there. Much damage has been done to forests, lakes, streams and ecosystems. What is needed primarily is to protect the vulnerable ecosystem from further damage and recover the acid damaged area soon.

International Scenario

Acid rain does not respect national borders, rather it spreads through out the world. It requires joint forces to reduce overall global emission of SO₂ and NO_x. Steps have already been initiated on this line. In 1979 the convention on Long-range Trans-boundary Air Pollutants was signed by most of the European countries and they have agreed to cooperate to reduce their emission of acidifying substances.

In 1985, "Helsinki Protocol" set out measures to reduce the discharge volume of SO₂. Total 22 parties signed this protocol. This was followed by "Sophia Protocol" in 1988 which declared a freeze on the discharge volume of nitrogen oxides. This was signed by 30 parties. In 1994 "Oslo Protocol" was signed by 27 countries and reduction target for the discharge of SO_x was set in each country. In 1999, "Gothenburg Protocol" was signed by 31 countries which sets the emission limit of several substances including sulfur and nitrogen. India, being developing country, was not party to any of the above international protocols.

What Government can do?

- * Heavy dependence on coal as a major energy source need to be reviewed and alternate sources are to be stressed upon as this is one of the major sources of SO₂ emission.
- * Promotion of nuclear power plants as an alternate to coal fired power ensuring fool-proof safety system.
- * Induct promotional policy to switch to natural gas.
- * Encourage policies that lead to rapid replacement of