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Environmental Pollution Problems Associated with Energy Production for High Demand

Surendra Kumar Yadav

*University Department of Engineering & Technology (SCRIET),
CCS University, Meerut-250004, India.*

Abstract

The usage of energy resources in industry leads to environmental damages by polluting the atmosphere. Pollutants like sulphur dioxide (SO_2), nitrous oxide (NO_X) and carbon monoxide (CO) emissions from boilers and furnaces, chlorofluro carbons (CFC) emissions from refrigerants use, etc are very harmful for ecosystems. In chemical and fertilizers industries, toxic gases are released. Energy conservation and pollution reduction go hand-in-hand, as the power plants that generate your electricity often release arsenic, mercury, other metals and acid gases that threaten human health and the environment.

Keywords: Energy; pollution; environment; climate change, mitigation.

1. Introduction

Human activities [1-2], particularly the combustion of fossil fuels, have made the blanket of green-house gases (water vapour, carbon dioxide, methane, ozone etc.) around the earth thicker. The resulting increase in global temperature is altering the complex web of systems that allow life to thrive on earth such as rainfall, wind patterns, ocean currents and distribution of plant and animal species. Life on earth is made possible by energy from the sun, which arrives mainly in the form of visible light. About 30 percent of the sunlight is scattered back into space by outer atmosphere and the balance 70 percent reaches the earth's surface, which reflects it in form of infrared radiation. The escape of slow moving infrared radiation is delayed by the green house gases. Air pollution comes from both natural and human-made (anthropogenic) sources. However, globally human-made pollutants from combustion, construction, mining, agriculture and warfare are increasingly significant in the air pollution equation [3]. Motor vehicle emissions are one of the leading causes of air pollution [4-6]. China, United States, Russia, India [7], Mexico, and Japan are the world leaders in air pollution emissions.

2. Air Pollution

A variety of air pollutants have known or suspected harmful effects on human health and the environment. These air pollutants are basically the products of combustion from fossil fuel use. Air pollutants from these sources may not only create problems near to these sources but also can cause problems far away. Air pollutants can travel long distances, chemically react in the atmosphere to produce secondary pollutants such as acid rain or ozone. In both developed and rapidly industrializing countries, the major historic air pollution problem has typically been high levels of smoke and SO_2 arising from the combustion of sulphur-containing fossil fuels such as coal for domestic and industrial purposes. Smogs resulting from the combined effects of black smoke, sulphate / acid aerosol and fog have been seen in European cities until few decades ago and still occur in many cities in developing world. In developed countries, this problem has significantly reduced over recent decades as a result of changing fuel-use patterns; the increasing use of cleaner fuels such as natural gas, and the implementation of effective smoke and emission control policies. In both developed and developing countries, the major threat to clean air is now posed by traffic emissions. Petrol- and diesel-engined motor vehicles emit a wide variety of pollutants, principally carbon monoxide (CO), oxides of nitrogen (NOx), volatile organic compounds (VOCs) and particulates, which have an increasing impact on urban air quality. In addition, photochemical reactions resulting from the action of sunlight on NO_2 and VOCs from vehicles leads to the formation of ozone, a secondary long-range pollutant, which impacts in rural areas often far from the original emission site.

Acid rain is another long-range pollutant influenced by vehicle NOx emissions. Industrial and domestic pollutant sources, together with their impact on air quality, tend to be steady-state or improving over time. However, traffic pollution problems are worsening world-wide. The problem may be particularly severe in developing countries with dramatically increasing vehicle population, infrastructural limitations, poor engine/emission control technologies and limited provision for maintenance or vehicle regulation. The principle pollutants produced by industrial, domestic and traffic sources are sulphur dioxide, nitrogen oxides, particulate matter, carbon monoxide, ozone, hydrocarbons, benzene, 1,3-butadiene, toxic organic micropollutants, lead and heavy metals. Brief introduction to the principal pollutants are as follows: Sulphur dioxide is a corrosive acid gas, which combines with water vapour in the atmosphere to produce acid rain. Both wet and dry deposition have been implicated in the damage and destruction of vegetation and in the degradation of soils, building materials and watercourses. SO_2 in ambient air is also associated with asthma and chronic bronchitis. The principal source of this gas is power stations and industries burning fossil fuels, which contain sulphur. Nitrogen oxides are released into the atmosphere mainly in the form of NO, which is then readily oxidised to NO_2 by reaction with ozone. Elevated levels of NO_x occur in urban environments under stable meteorological conditions, when the air mass is unable to disperse. Nitrogen dioxide has a variety of environmental and health impacts. It irritates the respiratory system and may worsen asthma and increase susceptibility to infections. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone. Nitrogen oxides combine with water vapour to form nitric acid. This nitric acid is in turn removed from the atmosphere by direct deposition to the ground, or transfer to aqueous droplets (e.g. cloud or rainwater), thereby contributing to acid deposition.

Acidification of water bodies and soils, and the consequent impact on agriculture, forestry and fisheries are the result of the re-deposition of acidifying compounds resulting principally from the oxidation of primary SO_2 and NO_2 emissions from fossil fuel combustion. Deposition may be by either wet or dry processes, and acid deposition studies often need to examine both of these acidification routes. Airborne particulate matter varies widely in its physical and chemical composition, source and particle size. PM_{10} particles (the fraction of particulates in air of very small size (<10 µm)) are of major current concern, as they are small enough to penetrate deep into the lungs and so potentially pose significant health risks. In addition, they may carry surface-absorbed carcinogenic compounds into the lungs. Larger particles, meanwhile, are not readily inhaled, and are removed relatively efficiently from the air by settling. A major source of fine primary particles are combustion processes, in particular diesel combustion, where transport of hot exhaust vapour into a cooler exhaust pipe can lead to spontaneous nucleation of "carbon" particles before emission. Secondary particles are typically formed when low volatility products are generated in the atmosphere, for example the oxidation of sulphur dioxide to sulphuric acid. The atmospheric lifetime of particulate matter is strongly related to particle size, but may be as long as 10 days for particles of about 1mm in diameter. Concern about the potential health impacts of PM_{10} has increased very rapidly over recent years. Increasingly, attention has been turning towards monitoring of the smaller particle fraction $PM_{2.5}$ capable of penetrating deepest into the lungs, or to even smaller size fractions or total particle numbers. Carbon monoxide (CO) is a toxic gas, which is emitted into the atmosphere as a result of combustion processes, and from oxidation of hydrocarbons and other organic compounds. In urban areas, CO is produced almost entirely (90%) from road traffic emissions. CO at levels found in ambient air may reduce the oxygen-carrying capacity of the blood. It survives in the atmosphere for a period of approximately 1 month and finally gets oxidised to carbon dioxide (CO_2). Ground-level ozone (O_3), unlike other primary pollutants mentioned above, is not emitted directly into the atmosphere, but is a secondary pollutant produced by reaction between nitrogen dioxide (NO_2), hydrocarbons and sunlight. Ozone can irritate the eyes and air passages causing breathing difficulties and may increase susceptibility to infection. It is a highly reactive chemical, capable of attacking surfaces, fabrics and rubber materials. Ozone is also toxic to some crops, vegetation and trees. Whereas nitrogen dioxide (NO_2)

participates in the formation of ozone, nitrogen oxide (NO) destroys ozone to form oxygen (O_2) and nitrogen dioxide (NO_2). For this reason, ozone levels are not as high in urban areas (where high levels of NO are emit-ted from vehicles) as in rural areas. As the nitrogen oxides and hydrocarbons are transported out of urban areas, the ozone-destroying NO is oxidised to NO_2, which participates in ozone formation.

There are two main groups of hydrocarbons of concern: volatile organic compounds (VOCs) and polycyclic aromatic hydrocarbons (PAHs). VOCs are released in vehicle exhaust gases either as unburned fuels or as combustion products, and are also emitted by the evaporation of solvents and motor fuels. Benzene and 1,3-butadiene are of particular concern, as they are known carcinogens. Other VOCs are important because of the role they play in the photochemical formation of ozone in the atmosphere. Benzene is an aromatic VOC, which is a minor constituent of petrol (about 2% by volume). The main sources of benzene in the atmosphere are the distribution and combustion of petrol. Of these, combustion by petrol vehicles is the single biggest source (70% of total emissions) whilst the refining, distribution and evaporation of petrol from vehicles accounts for approximately a further 10% of total emissions. Benzene is emitted in vehicle exhaust not only as unburnt fuel but also as a product of the decomposition of other aromatic compounds. Benzene is a known human carcinogen. 1,3-butadiene, like benzene, is a VOC emitted into the atmosphere principally from fuel combustion of petrol and diesel vehicles. Unlike benzene, however, it is not a constituent of the fuel but is produced by the combustion of olefins. 1,3-butadiene is also an important chemical in certain industrial processes, particularly the manufacture of synthetic rubber. It is handled in bulk at a small number of industrial locations. Other than in the vicinity of such locations, the dominant source of 1,3-butadiene in the atmosphere are the motor vehicles. 1,3 Butadiene is also a known, potent, human carcinogen. TOMPs (Toxic Organic Micropollutants) are produced by the incomplete combustion of fuels. They comprise a complex range of chemicals some of which, although they are emitted in very small quantities, are highly toxic or and carcinogenic. Compounds in this category include: PAHs (PolyAromatic Hydrocarbons), PCBs (PolyChlorinated Biphenyls), Dioxins and Furans etc.

Particulate metals in air result from activities such as fossil fuel combustion (including vehicles), metal processing industries and waste incineration. There are currently no emission standards for metals other than lead. Lead is a cumulative poison to the central nervous system, particularly detrimental to the mental development of children. Lead is the most widely used non-ferrous metal and has a large number of industrial applications. Its single largest industrial use worldwide is in the manufacture of batteries and it is also used in paints, glazes, alloys, radiation shielding, tank lining and piping. As tetraethyl lead, it has been used for many years as an additive in petrol; with the increasing use of unleaded petrol, however, emissions and concentrations in air have reduced steadily in recent years.

3. Climate Change

A thicker blanket of greenhouse gases traps more infrared radiation and increase the earth's temperature. Greenhouse gases makeup only 1 percent of the atmosphere, but they act as a blanket around the earth, or like a glass roof of a greenhouse and keep the earth 30 degrees warmer than it would be otherwise - without greenhouse gases, earth would be too cold to live. Human activities that are responsible for making the greenhouse layer thicker are emissions of carbon dioxide from the combustion of coal, oil and natural gas; by additional methane and nitrous oxide from farming activities and changes in land use; and by several man made gases that have a long life in the atmosphere. The increase in greenhouse gases is happening at an alarming rate. If greenhouse gases emissions continue to grow at current rates, it is almost certain that the atmospheric levels of carbon dioxide will increase twice or thrice from pre-industrial levels during the 21st century. Even a small increase in earth's temperature will be accompanied by changes in climate-such as cloud cover, precipitation, wind patterns and duration of seasons. In an already highly crowded and stressed earth, millions of people depend on weather patterns, such as monsoon rains, to continue as they have in the past. Even minimum changes will be disruptive and difficult. Carbon dioxide is responsible for 60 percent of the "enhanced greenhouse effect". Humans are burning coal, oil and natural gas at a rate that is much faster than the rate at which these fossil fuels were created. This is releasing the carbon stored in the fuels into the atmosphere and upsetting the carbon cycle (a precise balanced system by which carbon is exchanged between the air, the oceans and land vegetation taking place over millions of years). Currently, carbon dioxide levels in the atmospheric are rising by over 10 percent every 20 years.

4. Climate Change Based Effects

Cyclones, storm, hurricanes are occurring more frequently and floods and draughts are more intense than before. This increase in extreme weather events cannot be explained away as random events. This trend toward more powerful storms and hotter, longer dry periods is predicted by computer models. Warmer temperatures mean greater evaporation, and a warmer atmosphere is able to hold more moisture and hence there is more water aloft that can fall as precipitation. Similarly, dry regions are prone to lose still more moisture if the weather is hotter and hence this leads to more severe droughts and desertification. Even the minimum predicted shifts in climate for the 21st century are likely to be significant and disruptive. Predictions of future climatic changes are wide-ranging. The global temperature may climb from 1.4 to 5.8 degrees C; the sea level may rise from 9 to 88 cm. Thus, increases in sea level this century are expected to range from significant to catastrophic. This uncertainty reflects the complexity, interrelatedness, and sensitivity of the natural systems that make up the climate. The minimum warming forecast for the next 100 years is more than twice the 0.6 degree C increase that has occurred since 1900 and that earlier increase is already having marked consequences. Extreme weather events, as predicted by computer models, are striking more often and can be expected to intensify and become still more frequent. A future of more severe storms and floods along the world's increasingly crowded coastlines is likely. Although regional and local effects may differ widely, a general reduction is expected in potential crop yields in most tropical and sub-tropical regions. Mid-continental areas such as the United States' "grain belt" and vast areas of Asia are likely to become dry. Sub-Saharan Africa where dryland agriculture relies solely on rain, the yields would decrease dramatically even with minimum increase in temperature. Such changes could cause disruptions in food supply in a world is already afflicted with food shortages and famines. Salt-water intrusion from rising sea levels will reduce the quality and quantity of freshwater supplies. This is a major concern, since billions of people on earth already lack access to fresh-water. Higher ocean levels already are contaminating underground water sources in many parts of the world. Most of the world's endangered species (some 25 per cent of mammals and 12 per cent of birds) may become extinct over the next few decades as warmer conditions alter the forests, wetlands, and rangelands they depend on, and human development blocks them from migrating else-where. Higher temperatures are expected to expand the range of some dangerous "vector-borne" diseases, such as malaria, which already kills 1 million people annually, most of them children. Ongoing environmentally damaging activities such as overgrazing, deforestation, and denuded agricultural soils means that nature will be more vulnerable than previously to changes in climate. Similarly, the world's vast human population, much of it poor, is vulnerable to climate stress. Millions live in dangerous places such as floodplains or in slums around the big cities of the developing world. Often there is nowhere else for population to move. In the distant past, man and his ancestors migrated in response to changes in habitat. There will be much less room for migration in future. Global warming almost certainly will be unfair. The industrialized countries of North America and Western Europe, and other countries such as Japan, are responsible for the vast amount of past and current greenhouse-gas emissions. These emissions are incurred for the high standards of living enjoyed by the people in those countries. Yet those to suffer most from climate change will be in the developing world. They have fewer resources for coping with storms, with floods, with droughts, with disease outbreaks, and with disruptions to food and water supplies. They are eager for economic development them-selves, but may find that this already difficult process has become more difficult because of cli-mate change. The poorer nations of the world have done almost nothing to cause global warm-ing yet is most exposed to its effects. Acid rain is caused by release of SO_X and NO_X from combustion of fossil fuels, which then mix with water vapour in atmosphere to form sulphuric and nitric acids respectively. The effects of acid rain are acidification of lakes, streams, and soils; direct and indirect effects (release of metals, for example: Aluminum which washes away plant nutrients); killing of wildlife (trees, crops, aquatic plants, and animals); decay of building materials and paints, statues, and sculptures; health problems (respiratory, burning- skin and eyes).

5. Conclusion

Management of the activities by regulating raw material and energy use, how the site operates and the technology used, emissions into air, water and land, how any waste produced is managed and accident prevention are key issues for a better planning in energy sector to improve strategies for pollution control and mitigation approaches to execute. The responsiveness of emissions makes energy prices a powerful indirect tool for reducing emissions. There is room for substitution toward cleaner input combinations - both toward cleaner fuels and away from energy, toward labor, capital, and materials; and substitution toward cleaner fuels can also be induced without increasing energy prices generally, by increasing the price of the dirtier fuels, thereby reducing the relative price of the cleaner ones.

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Table 1: Increased Energy demand.

Source	**Units**	**1994-95**	**2001-02**	**2006-07**	**2011-12**
Electricity	Billion Units	289.36	480.08	712.67	1067.88
Coal	Million Tonnes	76.67	109.01	134.99	173.47
Lignite	Million Tonnes	4.85	11.69	16.02	19.70
Natural Gas	Million Cubic Meters	9880	15730	18291	20853
Oil Products	Million Tonnes	63.55	99.89	139.95	196.47

Source: Planning Commission BAU:_Business As Usual report