

1.4 Global environmental problems

1.4.1 Introduction

As global environmental problems concerning air, we have global warming, depletion of the ozone layer and acidification of the tropospheric air (so-called acid rain). It was when the public at large were confronted with these problems that they started to be aware of global environmental problems in general.

1.4.2 Global warming

Global warming is the phenomenon in which, as human activities have expanded, some components of the air existing in extremely small quantities (such as carbon dioxide generated in consumption of fossil fuels, methane, ozone and fluorocarbons) have increased so much that they have come to trap and accumulate more heat within the atmosphere than the old green-house gases (so called because they prevent heat from escaping out into space by absorbing infrared rays reflected from the earth's surface, like the glasses of the green house) including vapor did formerly, resulting in increased atmospheric temperatures on the average. The Intergovernmental Panel on Climate Change, (IPCC), forecasts that, if the new green-house gases continue to increase at the current rate, the average air temperature of the earth will rise by about 3°C by the end of the 21st century. Fears are entertained that this will translate into various unfavorable effects upon environment including the rising surface of the sea and less rain/drought in some regions of the earth. In addition to these global problems, it is apprehended that the rise in air temperatures will produce effects seriously affect the civic life such as aggravation in air pollution by photochemical ozone¹⁾. It can be said that its effects will be truly variegated.

Among the extremely small components of the air contributing to global warming, the most problematic is carbon dioxide (CO₂) generated when fossil fuels are burned. Methane and nitrous oxide (N₂O) follow. Recently, it has been pointed out that ozone within the troposphere is also important. Fluorocarbons, therefore, play a significant role in causing not only the problem of the stratospheric ozone layer but global warming. Although such miscellaneous tiny components of the air as methane are in lower concentrations in comparison with vapor or carbon dioxide, they have nonetheless high capacities for enhancing global warming because they absorb infrared rays of other wavelength ranges than that absorbed by vapor or carbon dioxide (so-called window ranges). However, more researches should be necessary because, even when narrowing down to carbon dioxide alone, there are still other problems whose effects upon concentration of the substance are yet to be clearly determined, such as deforestation and the problem of CO₂ absorptivity of the sea, than the burning of fossil fuels.

As major part of international efforts to cope with global warming, IPCC mentioned above has issued this latest finding about forecasts, assessed effects and measures to be taken: measures to counter global warming, therefore, have been given the scientific basis. Also in 1992, the "United Nations Framework Convention on Climate Change" was concluded to promote international measures to check global warming. For the purpose of stabilizing the concentration of green-house gases in the air, the signatory powers to the convention have been saddled with the responsibility for preparing inventories of emissions/absorptions of green house gases, formulating and

executing a state program of coping with global warming and so on.

1.4.3 Depletion of the stratospheric ozone layer

The ozone layer in the stratosphere has been brought into existence as oxygen, which has since ancient times been produced by plants through their photosynthesis and accumulated in the air, has shown photochemical reactions in the stratosphere. It has served as a precious barrier protecting living things on earth against high-energy ultraviolet rays. That this ozone layer is in danger of being depleted by chlorine atoms produced as fluorocarbons, which are emitted by human beings, undergo photolysis in the air was pointed out for the first time in 1974 by Molina and Rowland²⁾. Later when it was ascertained that the ozone hole above the Antarctic Zone had occurred and expanded as the result of this reaction of ozone, people on the earth were all shocked. Fears have since been entertained that, when the ozone layer above is depleted, ultraviolet rays of shorter wavelengths that have higher energy should be poured straightly down, not only affecting human bodies directly by increasing the incidence of cutaneous cancer and cataract but damaging all animals and plants in the region seriously.

International endeavors to seek to protect the ozone layer started relatively early. In 1985 the "Vienna Convention for the Protection of the Ozone Layer" was concluded and in 1987 the "Montreal Protocol on Substances that Deplete the Ozone Layer" was adopted. This protocol contained regulatory measures such as the one to cut productions of substances depleting the ozone layer. However, it was reviewed three times later in 1990, 1992 and in 1995 because it came to be known that depletion of the ozone layer was progressing at a rate greater than initially expected as evidenced by, for example, the rapid expansion of the ozone hole. The regulations have been strengthened by stages, consequently, with new entries having been made in the list of substances to be regulated and the regulation schedule having been accelerated. Recently, it has been observed that under these regulations concentration of fluorocarbons in the air has been on the decrease.

1.4.4 Acidification of the tropospheric air (acid rain)

While increasing quantities of fossil fuels have been consumed on the earth, also expanding quantities of sulfur oxides, or SO_x, and nitrogen oxides, or NO_x, as part of the exhaust gas from the burning fuels have been emitted into the air. Also, as NO_x and hydrocarbon species, which have been emitted together, have shown photochemical reaction, radicals, ozone and other active species called oxidants have been generated that are very highly oxidizing. By oxidizing sulfur dioxide and NO_x in the air, they have generated sulfuric acid and nitric acid. Consequently, the tropospheric air has become very much more acid than before the industrial revolution. When these acid substances dissolve in water drops in the air and fall onto the earth as rain, it is the phenomenon of the so-called acid rain. It is considered that acid rain has acidified rivers, lakes and marshes, damaging aquatic life living in them, and that it has also affected forests and cultural properties and other artificial constructions.

Of the substances causing the acidification of the air, SO_x originate in sulfuric contents of coal and heavy oil. Therefore, measures to reduce their emissions can be comparatively realistic. However, in countries such as China where huge quantities of coal are used and where it is not easy to switch to low-sulfur light oil or natural gases, a