Formation of Acid Rain

Acid rain is formed when rainwater is contaminated by acid. Pure water is a neutral compound and, as such, is neither acidic nor alkaline. However, even natural unpolluted rain is not pure water; it is really a dilute solution of carbonic acid — an acid which forms when atmospheric carbon dioxide dissolves into water vapour in the air.

Many compounds can become incorporated in rain drops and some of them, such as soil particles, can make rainwater more basic or alkaline. Other compounds such as sulphur dioxide and nitrous oxides — two of the combustion products of fossil fuels — can dissolve in rainwater and make it more acidic than normal.

Although all the intricacies of the various chemical reactions which take place in the atmosphere during the formation of acid precipitation are not completely understood at the present time, the end result is that the oxides of sulphur and nitrogen are converted to sulphuric and nitric acids respectively. These are *strong* acids which dissociate almost completely in water and have the ability to lower the acidity of rainwater significantly. In fact, the most acidic precipitation yet recorded fell in Scotland in 1974. It was roughly as acidic as vinegar or dilute acetic acid and over *one thousand times* as acidic as natural rain.

acidification of aquatic ecosystems (environments) but much less is known about its effects on terrestrial or land ecosystems such as forests or agricultural crops.

The direct effects of acid rain on human health have yet to be fully described. There is concern that the sulphur dioxide from which acid rain primarily derives can affect the health of people afflicted with respiratory problems. Acidic water passing through metallic pipes can increase copper and lead concentrations in drinking water and even some natural spring waters from areas which have been exposed to heavy acid rainfall have shown elevated levels of lead, copper, aluminum, mercury and cadmium. All these metals can affect human health but the extent of the effects and their associated health costs have yet to be quantified.

Acidic precipitation can also deleteriously affect human artifacts. It can greatly accelerate erosion processes, causing buildings, roads, paint, sculptures and so forth to be aesthetically and functionally damaged with prolonged exposure. The cost of these damages to the urban environment are estimated to exceed $5 billion annually in North America alone.

B. THE CARBON DIOXIDE QUESTION

As more and more people discover that acid rain is not a new phenomenon, they begin to wonder why they haven't heard of it before now. There are a number of reasons for this but the dominant one is that in our society little effective long-range planning is done and most environmental problems are ignored until they are perceived as having reached serious proportions. This is precisely what the Committee hopes to avoid by planning an energy future which will not produce difficult ecological "surprises" that will have to be dealt with in an *ad hoc* fashion at some future date.

Thus, enter the "Carbon Dioxide Question". The term "question" as opposed to "problem" is used here because the repercussions of the well-documented and steady increase in the concentration of carbon dioxide in the Earth's atmosphere are, at present, contentious. But in the opinion of the Committee, this is no reason they should be ignored. On the contrary, this is even greater reason to investigate the phenomenon thoroughly and to plan an energy future which does not alter historical environmental balances, so that a potential problem of truly global proportions will not have to be grappled with 20 to 50 years from now. Certainly, a long-term perspective is called for in the case of the carbon dioxide question.

Much of the public has not yet heard about the carbon dioxide pollution phenomenon. But measurement of the concentration of CO_2 in the atmosphere made at a variety of locations, and over a time span dating back to 1958, have clearly and unambiguously demonstrated that the concentration of CO_2 in the atmosphere is rising at a rate of about one part per million (1 ppm is 1 milligram in 1 kilogram) per year (Figure 4-1). To put this figure into perspective, the concentration increased 13.8 ppm in the 15 years between 1962 and 1977 — an increase from 316.2 to 330.0 ppm or over 4%. Since 1850 and the beginning of the Industrial Revolution, the increase has been from around 290 to 330 ppm, or approximately 14%. If the trend of the last 20 years continues or accelerates, the CO_2 concentration could well reach 400 ppm by the year 2000 — a concentration which could begin to change the Earth's climate, perhaps irreversibly.

Historically, there is evidence that the atmospheric concentration of carbon dioxide has remained approximately constant for past ages because a balance existed between (1) the amount of CO_2 being turned into solid organic compounds annually through photosynthesis and the amount being released annually through both plant and animal respiration; and (2) the amount of CO_2 dissolving into or escaping from the oceans. However, it should be emphasized that this balance was achieved with a *small but steady net loss* of carbon from