Challenging Acid Rain

By Makoto Matsumura

Acid rain—rain with an acidity of 5.6 or less in terms of hydrogen-ion concentration (pH)—is currently causing widespread damage in the middle-latitudes of the northern hemisphere. Europe, the United States, Canada and China have all been affected.

Acid rain degrades crops. Forests wither as trees lose their leaves and the soil turns acidic, forcing out nutritive elements and suppressing the activity of soil bacteria. In lakes, swamps and rivers with acid rain runoff, fish volumes decline.

This hurtful rain is believed to be caused by the dissolution of pollutants in the atmosphere: primarily sulfur oxides (SO_x) and nitrogen oxides (NO_x) released by the combustion of fossil fuels. Acid rain—returning these suspended pollutants to earth in "tainted" drops of rain—often falls thousands of kilometers away from the original sources of the SO_x and NO_x, turning the rain into an international problem. There are already cross-border disputes over acid rain involving Europe and the United States.

In Japan, rain similar to or even more acidic than the acid rains in the United States and Europe has already been observed. So far, however, there has not been any critical damage to Japan's forests, lakes and soil. Some scientists attribute this to different soil conditions, although much remains to be learned about all the ways in which acid rain affects the environment.

As acid rain is caused by the effluents from burning fossil fuel, a number of measures could help alleviate the problem:

(1) Using natural gas, nuclear power and other energy sources which do not emit air pollutants, or using energy sources that emit them in relatively small volumes.

(2) Desulfurizing the fuel oil produced in petroleum refineries.

(3) Restraining NO_x generation in the process of fuel combustion.

(4) Desulfurizing and denitrifying flue gas.

Energy resources are scarce in Japan, forcing it to rely on imports for most of its requirements. Yet this traditional "handicap" is also an advantage: Japan can choose among energy sources with relative freedom. At present, the nation is dependent on natural gas and nuclear power for about 20% of its total energy needs, hydroelectric and geothermal energy for another 5%, and petroleum for 56%. Coal, the biggest source of acid rain in the United States, Europe and China, accounts for only 18% of Japan's total energy requirement.

Not surprisingly, the nation's measures against acid rain center particularly on the desulfurization of petroleum-derived fuels. Other areas of work include the abatement of NO_x emissions in the combustion process, and flue-gas desulfurization and denitrification by wet processes. Japan's petroleum industry began desulfurizing heavy fuel oil as early as 1967, and by 1988 there were 41 fuel-oil desulfurization plants in the country. Today, the heavy fuel oil marketed in Japan contains on average only 1.08% sulfur.

Meanwhile, the government has revised its regulations for NO_x reduction four times since 1973 to cover a wider range of facilities and reduce emission levels. Many boilers and other combustion facilities have now been equipped with two-stage combustion equipment designed to reduce NO_x emission, as well as low-NO_x burners.

Stringent government regulations have fueled rapid progress in technology for desulfurization and denitrification of flue gas. The first flue-gas desulfurization plant was built in 1972. Since then, elec-

Table 1 Flue Gas Desulfurization Units in Japan

	Total number of units		Processing capacity (1,000 Nm^3/h)
FY1970	102		5,351
1971	183	(81)	9,334
1972	323	(140)	18,001
1973	543	(220)	28,849
1974	768	(225)	42,678
1975	994	(226)	79,489
1976	1,134	(140)	103,812
1977	1,192	(58)	110,535
1978	1,227	(35)	114,844
1979	1,266	(39)	117,489
1980	1,329	(63)	122,016
1981	1,362	(33)	126,517
1982	1,366	(4)	127,163
1983	1,405	(39)	129,051
1984	1,583	(178)	133,353
1985	1,741	(158)	154,544
1986	1,758	(17)	154,974
1987	1,789	(31)	169,176
1988	1,810	(21)	

Note: Figures in parentheses denote increase in number of units during the year.
Source: A study by the Environment Agency

Table 2 Flue Gas Denitrification Units in Japan

	Total number of units		Processing capacity (1,000 Nm^3/h)
FY1972	5		106
1973	10	(5)	406
1974	20	(10)	1,242
1975	45	(25)	4,309
1976	71	(26)	8,187
1977	93	(22)	13,677
1978	109	(16)	22,153
1979	122	(13)	28,426
1980	140	(18)	39,051
1981	175	(35)	63,566
1982	188	(13)	71,721
1983	231	(43)	95,142
1984	253	(22)	103,534
1985	305	(52)	109,887
1986	323	(18)	125,867
1987	348	(25)	138,056
1988	379	(31)	

Note: Figures in parentheses denote increase in number of units during the year.
Source: A study by the Environment Agency

tric power plant companies, chemical producers, pulp makers, steel mills and fiber firms have become major users. There are now 1,810 flue-gas desulfurization plants in Japan, about 10% of the worldwide capacity for removing SOx from flue gas (Table 1). Another 379 denitrification plants are in service, with large-capacity units located in electric power stations. Other major users are steel makers, petroleum refiners and petrochemical producers (Table 2).

Appreciating that acid rain is a serious problem for the global environment, Japan is working on many fronts to meet this important challenge.

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Approach to Tropical Forest Restoration

By Satoru Shimazaki

The rapid and dramatic disappearance of large portions of the world's tropical forests has triggered a host of disruptive secondary catastrophes, such as floods and water shortages. These phenomena are now exacting a tragic toll on the lives of millions of people in developing countries. Equally as disturbing, tropical deforestation has begun to affect the global climate in potentially dangerous ways.

In response to these disturbing trends, many nations around the world are beginning to develop strategies to cope with both the local and potentially disastrous global impacts caused by tropical deforestation. Japan is one of the countries that is dealing most forcefully with these issues. At the request of many developing countries, it has undertaken a number of cooperative efforts, involving both technology transfer and financial aid.

In the area of technological cooperation, Japan has recently implemented 15 comprehensive projects with 12 developing nations that face deforestation crises. In the projects, Japanese forestry experts are sent to these countries to study the problem and to help devise strategies of response; equipment is offered on a grant basis; and foreign trainees are invited to Japan to learn sophisticated forest management techniques. The projects cover such wide areas as maintenance and creation of tropical forests, development or improvement of forestry management, and research into forest ecosystems.

Altogether, some 80 Japanese forestry specialists have received long-term assignments in developing countries that face deforestation problems, and 100 foreign trainees are being invited to Japan each year for higher training at a comprehensive forestry institute and other institutions affiliated with the Forestry Agency of the Ministry of Agriculture, Forestry and Fisheries.

As part of these cooperative projects, Japan also offers various forms of financial aid, including the donation of equipment and facilities needed for forestry training and study, together with cooperation in feasibility studies for establishing strong forest management programs in the host countries.

As the same time, Japan contributes funds to the Food and Agriculture Organization (FAO) and the International Tropical Timber Organization (ITTO) to help finance projects dealing with deforestation problems.

The Forestry Agency also conducts a variety of cooperative projects on its own, including surveys of tropical forests using the *LANDSAT* earth observation satellite; the implementation and diffusion of forestation (i.e., tree planting) technology in tropical areas; and research on how forestation technology might be used to combat "desertification," or the transformation of forests into deserts.

Tropical deforestation is a highly complex problem for which there probably exists no simple, purely technological solution. Nor are Japan's aid programs aimed at finding such a quick "technofix." Instead, Japan is committed to understanding and approaching the problem at the level of the root cause, which involves not only scientific and technological problems but a web of political, economic, so-

Japanese experts check on newly planted trees in a tropical rain forest.