*Journal of Environmental Sciences* Vol. 5, No.3, pp. 373–380, 1993 ISSN 1001-0742

# Current status and strategy of hazardous waste management in China

Cai Jinlu, Chen Dingmao, Gao Dazhi

Research Center for Eco-Environmental Sciences, Chinese Academy of Sciences, Beijing 100085, China

**Abstract**— This paper deals briefly with the pollution caused by hazardous wastes in China, the hazardous waste management at present and the strategy that should be taken for hazardous waste management in the future. Hazardous waste problem has become one of the important environmental concerns in China. Hazardous waste have resulted in ecological and environmental destruction, caused damage to human health, and restricted economic development. Although a great effort has been devoted to the management of hazardous wastes, there remain many issues in legislation, experience, technology and finance to be solved. Some recommendations are made on the strategic measures for improving the hazardous waste management in China, particularly relating to legislation, technical development and international cooperation.

**Keywords:** hazardous waste pollution; environmental concerns; strategic measures.

## 1 Hazardous waste pollution in China

The environmental effects of hazardous wastes, particularly solid hazardous wastes, including the damage to the environment and threat to human health, have become one of the global issues which are increasingly concerned by the governments and the public in the world. This is also true in China.

As compared with developed countries, China started rather later its development of modern industry, having a history of less than 40 years only. However, due to the rapid development of economic construction and the improvement of people life standard in the past decade and the deficiency in experience for environmental management, the generation and accumulation of hazardous wastes tend to increase rapidly, causing the environmental pollution problem to be getting more obvious.

It was roughly estimated that, in China at present, industrial solid waste alone is generated at a rate of 600 million tons per year or more, and the accumulated solid wastes have been more than 6 billion tons in total which occupy more than 60000 ha of land area. In addition, over 10 million tons of industrial solid wastes every

year are dumped into various waters, including rivers, lakes and seas. Hazardous wastes are mainly from chemical, smelting, petrochemical, pulping and paper-making, and other industries. The status of generation, treatment and utilization of industrial solid wastes in China in recent years are shown in Table 1.

**Table 1 Industrial solid wastes in China (The China's Environment Yearbook 1990)**

| | 1980 | 1986 | 1987 | 1988 | 1989 | 1990 | 1991 |
|---|---|---|---|---|---|---|---|
| Generation, million tons/a | 430 | 604 | 529 | 561 | 572 | 578 | 588 |
| Treatment or disposal, | | | | | | | |
| million tons/a | 79 | 324 | 316 | 338 | 364 | 369 | 117 |
| % | 18.4 | 54 | 59.7 | 60 | 63.7 | 63.9 | 18.6 |
| Comprehensive utilization, | | | | | | | |
| million tons/a | | 147 | 137 | 147 | 162 | 169 | 223 |
| % | | 24 | 25.9 | 26 | 28.2 | 29.3 | 36.6 |
| Dumping, million tons/a | 24 | 133 | 87 | 86 | 53 | 48 | 34 |
| Dumping into water bodies, | | | | | | | |
| million tons/a | | 10 | 15.2 | 12.5 | 12.64 | 11.6 | 11.81 |
| Area of land occupied, | | | | | | | |
| million $m^2$/a | | 672 | 570 | 538 | 554 | 584 | 521 |
| Area of farmland occupied, | | | | | | | |
| million $m^2$ | | 82.25 | 41.63 | 38.22 | 35.74 | 40.4 | 52.1 |
| Total accumulation, million tons | 5300 | 7420 | 6340 | 6590 | 6750 | 6430 | 5960 |
| Fund for pollution control, | | | | | | | |
| RMB Yuan 100 million/a | | 3.0 | 4.0 | 43 | 4.0 | 5.1 | 6.7 |

Due to the lack of technology, fund and experience for the management of hazardous wastes in China, the events of damage caused by hazardous wastes have taken place. Dumping of wastes in a large amount has not only occupied a large area of land but also caused serious pollution. For example, in the Yunxi Corporation in Yunnan Province, there have been more than 100 million tons of tin mine tailings containing arsenic and radioactive substances dumped and piled in 21 sites, covering together more than 8 million square meters of land area. The resident area in the vicinity of dumping sites has become the area with high incidence of cancer.

The slags, smelting and chemical residues which contain chromium, thallium, arsenic, antimony, beryllium, trichlorobenzene and others have also caused serious damage. There are more than 10 firms of the factories producing chromate. The Red Star Chemical Factory in Qingdao City is one of them. This factory alone has dumped and piled about 300000 tons of chromium containing residue generated from its production process for more than 20 years, forming a hill of chromate slag to

which about 10000 tons of the slag a year are still added that makes the slag hill constantly grow up to an extent difficult to deal with.

Another example is the Jinzhou Iron Alloy Factory in Jinzhou City, Liaoning Province. This factory dumped and piled its chromate slag in 1950s. Several years later, it was found that the underground water within a 20 square kilometer area surrounding the dumping site was heavily contaminated by chromium (VI), causing the water from 1800 wells in 7 villages to be undrinkable (Shi, 1986). For this reason, the factory had to spend RMB Yuan 650000 for constructing a set of water supply facility special for the affected peasants in order to solve their drinking water problem. On the other hand, in order to reduce the accumulation of chromate slag, the factory invested an additional RMB Yuan 3.6 million fund for building a brick manufacturing plant which used the chromate slag as raw materials. However, the bricks produced thus can not be used as building materials because of high leachability of Cr (VI) from the bricks. Finally, the factory had to invest a further RMB Yuan 4.6 million fund for building a seepage proof wall deep down to the bedrock surrounding the dumping site to enclose it. Nevertheless, there remains a need for making long-term monitoring and observation to determine how effective the seepage proof wall can be.

There are also some additional examples. The Jinan Phosphate Fertilizer Factory in Jinan City, Shandong Province, had dumped and piled 120000 tons of chromate slag. The level of Cr (VI) in water from the wells either within the factory or in the vicinity of the factory was found at a value of 19－79 times higher than the national standards for drinking water when it was monitored in 1979. The Dongfeng Chemical Factory in Chongqing City, Sichuan Province, dumped and piled its 100000 tons of chromate slag on a site at the bank of Jialingjiang River and it was found that the concentration of Cr(VI) in the river water downstream 1 kilometer away from the dumping site was up to 0.08 mg/L.

In addition to chromate slag, there are about 5000 tons of arsenic, more than 500 tons of cadmium and over 60 tons of mercury annually lost from the processes of non-ferrous metal smelting in this country as they were carried by waste (Shi, 1986). Other wastes, such as spent paints, coatings, rubbers, used batteries, waste medicines, pesticides, tar, used oils, spent solvents, sludge from wastewater treatment, residues from chemical production, used electroplating liquor, sludge from electrolytic cells, and others, also cause pollution in different forms when they are discharged into environmental media, such as air, water and soil, resulting in environmental deterioration, threat to human health, and destruction of ecological balance.

As mentioned above, the issue of hazardous wastes in China has become an

important environmental problem which is widely concerned. To solve this problem, in addition to strengthening the management of production process to reduce the generation of wastes, there is a need for taking a series of measures for the management of wastes generated to control the pollution and damage caused by wastes in every link.

## 2 Status of hazardous wastes management in China

The government of China has increasingly paid much attention and attached a great importance to the problem of hazardous wastes. In order to strengthen the pollution prevention and control and the management of solid wastes, in recent years the National Environmental Protection Agency (NEPA) has promulgated a series of relevant regulations and standards (Jin, 1988), including:

- Standards for the control of pollutants in sludge used for agriculture (1984);
- Standards for the pollution control of solid wastes from non-ferrous metal industry (1985);
- Standards for the limitation of radioactive substances in industrial slags used as building materials (1986);
- Standards for the control of pollutants in powdered coal ash for agricultural use (1987);
- Analytical methods for the test and monitoring of hazardous characteristics of solid wastes (Tentative), and so on.

In 1989, the NEPA started to organize the development and formulation of the "Law on the prevention and control of solid waste pollution", the "Regulations on the management of transborder movement of harmful wastes" and the "Regulations on the prevention and control of mine tailings pollution", and to continue the amendment of "Procedures for the management of harmful wastes".

Some jointly legislative actions between the NEPA and concerned ministries have been also taken, such as:

- Tentative procedures for the management of municipal solid wastes, developed jointly by the NEPA, the Ministry of Construction, and the National Patriotic Health Commission;
- Regulations on strengthening the prevention and control of pollution, developed jointly by the NEPA and the Ministry of Chemical Industry; and
- Regulations on the prevention of the environment from pollution by electric power facilities containing polychlorobiphenyls (PCBs), developed jointly by the NEPA and the Ministry of Energy.

Furthermore, several standards are in the process of formulation by the NEPA, for example:

- Standards for the pollution control of cyanides containing wastes;
- Standards for the pollution control of organochlorine containing wastes;
- Standards for the pollution control of organophosphorus containing wastes; and
- Standards for the charges on industrial solid wastes dumping.

In 1989, the Hunan Provincial Government issued a local regulation entitled the "Procedures for the management of solid wastes". Some local governments have also formulated their own policies on the compressive utilization of powdered coal ash.

Since 1989, the comprehensive utilization of solid wastes has been formally included in the National Economy Plan. The State Planning Commission has promulgated the "Several Regulations on Performing Triple Simultaneousness for the Comprehensive Resources Utilization Project and the New or Expanding Construction Project". This means that both types of project shall be designed simultaneously, constructed simultaneously and operated simultaneously. At the same time, the "National development program on comprehensive utilization of resources in 1989－2000" has been enacted and put into effect.

Technical support system has been initiated. In order to promote the technical development of hazardous waste management, the first "International Fair on the Technology for Comprehensive Utilization of Regenerated Resources" was held in Shenzhen on 20－24 November 1989. The manufacturers, research and development institutions, and corporations from about 100 countries or regions attended this international fair to introduce and exhibit their advanced technology and equipments. A number of technologies and equipments exhibited in the fair can be introduced in China for hazardous waste management. The demonstrative project for hazardous waste disposal in Shenyang City, Liaoning Province, was financially supported by the United States Economy and Trade Development Agency and technologically supported by the US Ecological and Environmental Corp ration. A feasibility study of the project has been completed. This project will be the first facility for centralized disposal of hazardous wastes in China, which can deal with 774 kinds of hazardous wastes and 698 kinds of wastewater from 319 factories in this city. It is planning to construct a safe landfill site for annually disposing of 42000 tons of wastes, an incineration plant for annually incinerating 30000 tons of wastes, and a treatment plant for annually treating 20000 tons of waste liquors containing hazardous wastes. Moreover, additional 80000 tons of hazardous wastes will be treated for recovering valuable substances and for utilizing in a comprehensive way in the facility based on

this project.

The agencies for hazardous waste management have been also set up gradually. The NEPA is the agency in charge of the management of toxic chemicals, and established the NEPA's Office for Toxic Chemicals Management on 15 October 1985. The NEPA started in 1989 to organize the development and formulation of

- The PRC's Tentative Regulations on the Environmental Management of Toxic Chemicals;
- The PRC's Tentative Procedures on the Environmental Management of Toxic Chemicals Import;
- The Criteria for the Test of Toxic Chemicals;
- The Procedures for the Risk Assessment of Toxic Chemicals.

The NEPA is also the national agency in charge of the London Guidelines on Information Exchange of International Trade of Chemicals.

Although the government has devoted much efforts to the hazardous waste management in China, the severity of pollution by solid wastes and particularly by hazardous wastes has not yet been commonly recognized by the society-at-large. Even the agencies for environmental protection have not yet paid a full attention to this problem. The environmental legislation for the prevention and control of pollution and the management of solid wastes is still near to a blank. The standards for the pollution control of solid wastes are not amplified. The agencies in charge of the environmental management of solid wastes are weak and at a lower level of management. It is in a great demand to devote major efforts to developing the economic and technical policies for the prevention and control of solid waste pollution and to promoting the research and development of the pollution control of hazardous wastes, including the minimization, resourcefulization and non-harmfulization of hazardous wastes. The industry of environmental protection for the disposal and utilization of solid wastes has not yet been established. It is also necessary to strengthen the international cooperation in the field of the prevention and control of pollution by solid wastes, including technology, experience and fund.

## 3 Recommendations on the strategy for hazardous waste management in China

As mentioned above, there remain many problems in the management of hazardous wastes in China, relating either to legislation, experience and technology availability or to financial resource. There is an urgent need for a full set of effective management strategy directed toward the problems present and based on the national conditions in China.

An effective management strategy of hazardous wastes should follow the principle of cradle-to-grave which has been proven the most effective to manage wastes in many countries. This principle may have two senses. One sense is that no waste can be generated from a production process or a human activity, or discharged out of a system comprising the said process or activity. This is so-called zero discharge. This sense can be realized by using no-waste technology or fully enclosed cycle process. The other sense is that wastes must be managed at every stage from their generation, collection, transportation, storage, to final treatment or disposal to minimize their damage to the environment and human health. The limited legislation, available technology, experience in management, qualified manpower and financial resources determine that it is impossible to realize the principle of cradle-to-grave in an all-round way in China, at least in the near future. Therefore, the management strategy of hazardous wastes in China should be a stepwise one comprising a short-term goal and a long-term goal. The short-term goal is to control the development of hazardous waste pollution by encouraging the use of available technology for pollution control of hazardous wastes, and by developing and formulating gradually a full set of laws, regulations and standards special for the management of hazardous wastes.

The long-term goal is to follow in all round the principle of cradle-to-grave. For the purpose, major efforts should be devoted at the present stage to the development of appropriate technology, administrative structures, institutions and legal and economic instruments for the management of hazardous wastes. The advanced technology, experiences, and equipments should introduced from other countries in connection to the innovation of production process in China.

Legislation is the most effective means for the management of hazardous wastes. A realistic set of laws and regulations for the environmental management of hazardous wastes should be developed on the basis of the national conditions in China by taking reference to the related foreign legislative systems and viewing the experiences and lessons from legislative practices in other countries. For this purpose, the wide surveys and scientific research should carried out so that the legislation can have a scientific basis. It should be to determine the China-specific definitions and classifications of hazardous wastes; obligations of waste generator; the concrete requirements of collection, transfer, transportation, storage, treatment and disposal of wastes; record and report systems; analysis and monitoring systems; procedures for dealing with accidents; compensation and penalty systems and others. These issues should be studied individually so that the law or regulations formed by them can play an active role in controlling pollution and protecting the environment and human health, and can be feasible. In addition, the administrative structure systems should be perfect and efficient to fully play their enforcement functions in order to

ensure the implementation of such law and regulations. However, it is still not enough to have these only. It should be necessary also to improve the quality of managers working in all positions of hazardous waste management. They should be given constantly specialized training to allow them to have the necessary expertise for their respective jobs in the management.

Technical support system is another important aspect of hazardous waste management. The government should subsidize special fund to organize the scientific research institutions and industrial sectors in order to develop various appropriate technologies, such as comprehensive utilization technology, non-harmfulization technology, minimization technology, non-waste or less-waste processes, incineration process and others. In regard to the development of technology, the government should formulate the corresponding technical and economic policies to encourage every technical and economic activity which may help protect the ecosystem and the environment.

In view of the deficiency in experience, technology and financial resource for the management of hazardous wastes in China as a developing country, it is essential to promote the international cooperation in this context. There are vast vistas of international cooperation in regard to the legislation, management experience or technical development in China. The government ought on its own initiative to absorb the foreign advantageous experiences, to introduce the advanced technologies, to strive for the financial support, or to attract the foreign investment. On the other hand, developed countries should have their responsibility for providing China with technical and economic assistance in order to make their contribution to the solution of global issue. We hope to undertake some cooperative research projects relating to the issue of hazardous waste management in China in collaboration with the foreign research institutions or international organizations of interest in this issue. It is also hoped that the foreign cooperations come to China to look for their opportunity in investment.

## References

Jin Jianming. Huanjing Ke Xue Dongtai; 1988(3):1

Shi Qing. Disposal and utilization of solid wastes. Beijing: Oceanographic Press, 1986:256

The China's Environment Yearbook 1990. Beijing: Chinese Environmental Science Press, 1990

(Received October 21, 1992)