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HAZARDOUS WASTE MANAGEMENT PRACTICE IN CHINA: STATUS QUO AND IMPLICATIONS

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ABSTRACT

In recent years, concern over the increasing quality of industrial hazardous wastes and their improper management practices has manifested itself in the implementation of a series of measures in China. As a result, there has been an evident change in hazardous waste management. However, on account of a lack of an integrated action plan, these measures have not yet achieved their full potential. The objective of this article is to examine the problems in the current hazardous waste management system in an effort to put them into perspective.

INTRODUCTION

Hazardous waste management has become an increasingly serious problem in the world. As a rapidly developing country, China also confronts this problem. Every year large quantities of hazardous wastes are generated from its growing industries. However, there are not adequate treatment and disposal facilities for these wastes. Worse still is the lack of an integrated plan for management of the increasing waste quantities. The development of industry has been seriously hindered as a result.

In the last decades, much attention has begun to be paid to the control of hazardous waste, and significant strides have been made in establishing corresponding management legislation, developing treatment and disposal technologies, and turning the research results into industrial practice. As a result, the

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most serious situations have been alleviated, but not greatly improved. There are still many problems to be solved in the management of hazardous waste.

PRESENT STATE OF INDUSTRIAL WASTE IN CHINA

Generation

China is a country generating a large amount of industrial waste each year. With the development of industry, the annual quantity is growing rapidly. It reached 0.62 billion tons in 1993 (Figure 1), of which about 5 to 10 percent were hazardous wastes. It is estimated that the total amount of industrial waste a year will be over 1.0 billion tons up to the year of 2000 [1].

These wastes come from almost all the industries. Figure 2 illustrates the proportions of six main industries in waste generation in 1993. It is shown that mining, electricity and heat supply, and ferrous metal industry are the major contributors of industrial wastes.

Treatment, Disposal, and Emission

The generated industrial waste has four "outlets": disposal, storage, comprehensive utilization, and emission. As is shown in Figure 3, only 53.3 percent of industrial waste generated in 1993 was removed from the environment, while the other 46.7 percent (0.3 billion tons) was still kept in it. Because of the late start of solid waste pollution control, the low level of treatment and disposal technology, and lack of funds and experience, most of this part was simply piled up without any control of leakage, dispersion, or run-off, which caused potential pollution to water and air. Up to 1993, the total accumulated amount of industrial waste has

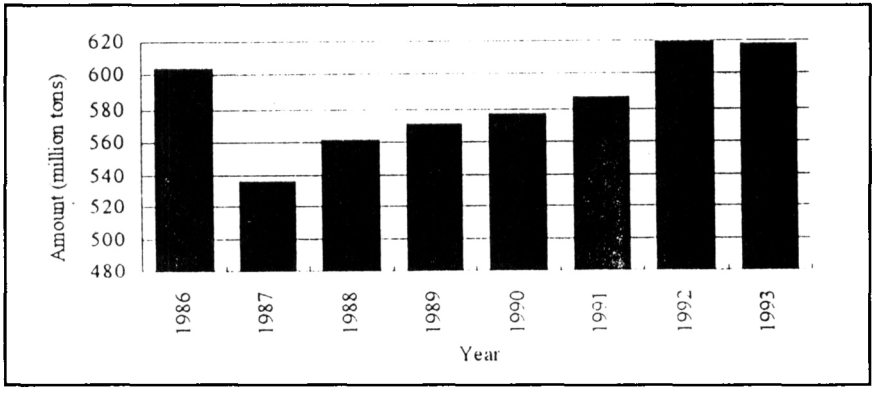

Figure 1. Total amount of industrial waste in China [1-5].

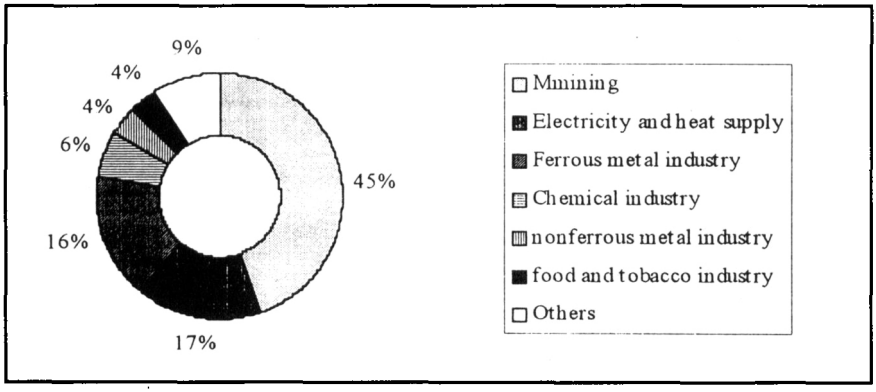

Figure 2. Generated amounts of industrial wastes by industries (in FY 1993) [5].

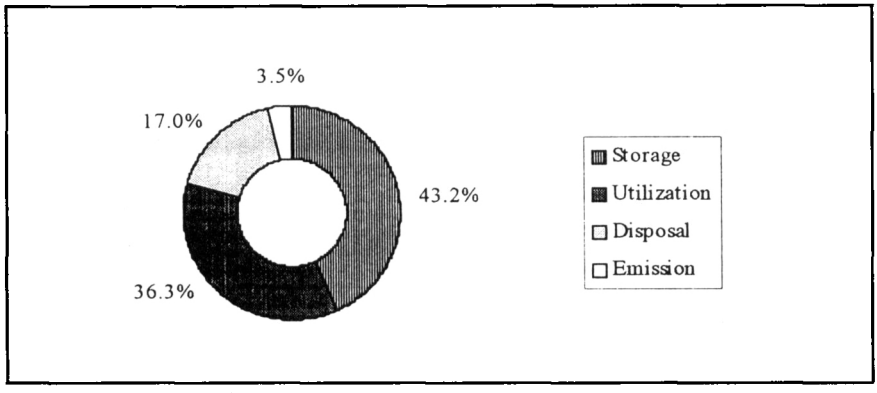

Figure 3. Outlets of industrial waste (in FY 1993) [5].

reached 6.0 billion tons, which occupied an area of 52 km^2, including arable land of 41 km^2 [2]. Although the amount of emission was greatly reduced in the past few years (Figure 4), 7.4 million tons of industrial waste still were discharged into the water body, which seriously polluted the water and led to the reduction of lake areas.

This situation contaminates ground and surface water and endangers the human health and the environment. As a result, pollution accidents frequently happen, more than 100 accidents every year, at great loss to the national economy [1]. For example, the chromium residual storage site in Jinzhou City has caused ground

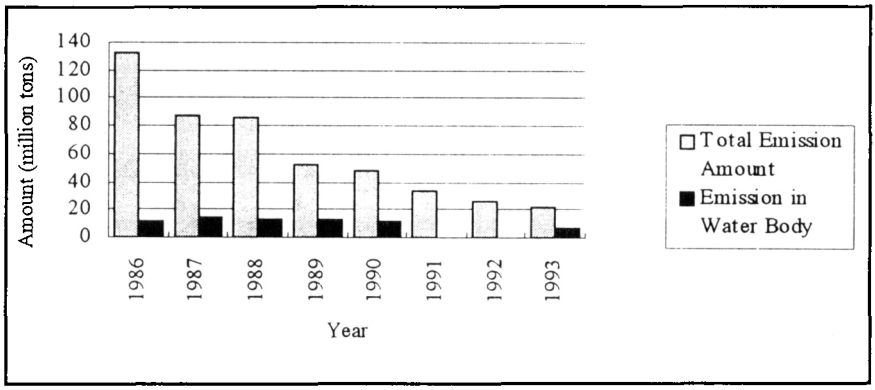

Figure 4. Industrial waste emission [1-5].

water pollution in an area of about 12.5 km long by 1 km wide, and made more than 1,800 surrounding wells undrinkable in the 1980s.

Comprehensive Utilization

Owing to strengthened macro-management and a series of incentives for comprehensive utilization (i.e., re-use and recycling), conspicuous progress has been made in this respect (Table 1). Since 1980, the total amount of comprehensively utilized industrial waste is steadily increasing, and the utilization ratio has exceeded 35 percent since 1991. Comprehensive utilization of industrial waste not only alleviated the crisis of pollution, but also produced great economic benefits.

However, the utilization ratio is still quite low compared with that in the developed countries. And the current technologies adapted to this field are still limited to the production of building materials, road construction materials, and agricultural use with some kinds of industrial waste such as slag, powdered coal ash, coal gangue, and tailings [1]. It is very urgent to develop high technologies for industrial waste utilization.

HAZARDOUS WASTE MANAGEMENT IN CHINA

At the beginning of the 1990s, the principle of industrial pollution prevention was established, which emphasized the basic strategic change from end-of-pipe control to integrated management, and proposes the implementation of clean production. Great studies have been made since. On the basis of this principle, a series of measures have been taken to take control of hazardous waste from generation, collection, storage, utilization, treatment, to final disposal, which

Table 1. Comprehensive Utilization of Industrial Waste

Time	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993
Total amount (Mtons)	95.3	121.1	147.3	137.1	147.1	161.3	169.4	222.9	255.5	248.3
Utilization rate (%)	22.0	26.2	24.4	25.6	26.2	28.2	29.3	37.9	37.0	36.3

Source: [1-6]

include waste declaration and registration, waste exchanges, manifest tracking systems, regional centralized waste disposal centers, and information systems.

Waste Declaration and Registration

In order to develop regional and statewide hazardous waste management plans, it is important to establish corresponding hazardous waste inventories as the first step. From 1991, the Chinese EPA has started a trial project in solid waste declaration and registration in seventeen cities including Beijing, Tianjin, and Shanghai. Enterprises numbering 10,688 have taken part in the project and the registered hazardous waste accounted for over 95 percent of the total generated hazardous waste in most of the seven cities [7].

During the trial, the waste sources and waste distribution in these cities were learned clearly, allowing a great step forward for the exchange, recycling, treatment, and disposal of solid waste, and laying a good basis for the integrated management of solid waste.

However, some existing problems are disturbing:

1. As is known, total quantities will depend on the ultimate regulatory definition of hazardous waste. Surveys to date have been conducted without a clear definition, and thus results may overstate or understate waste generation, depending on whether the regulatory definition will be broadened or narrowed. No definition of hazardous waste has been passed as regulatory so far in China. The adopted definition now is the "Hazardous waste category to be controlled" based on the Basel Convention or the named hazardous wastes lists of some developed countries [8].
2. The accuracy of data obtained is closely related to the cooperation of generators. As there is no complete and effective waste management system being operated in China now, it is difficult and cost-consuming to supervise every generator. As a result, the data obtained often underestimate waste generation levels because generators are reluctant to highlight waste problems. This problem is aggravated by the fact that generators often do not have a good understanding of their own wastes. Sometimes, assessments from experts or published data is more reliable than the other approaches such as mailed questionnaires, though the former in theory suffers greatly from the weaknesses of scant interaction between reviewers

and generators, inconsistencies in the database, and problems in the selection of "credible" experts [9].

3. Databases should be improved. Though there are seventeen cities which have registered and declared their wastes, and established a corresponding database, most of these databases have been designed to function only as recorders. No extrapolation or comparison has been conducted across industries, regions, or statewide. It is unknown whether extrapolation based on number of employees [9, 10] or waste-generation rate in each industrial category is more applicable to China. This leads to the ignorance of even an order-of-magnitude estimate of hazardous waste quantity in China.

It is evident that great attention has to be paid to these problems in order that the databases themselves have more meaning and money not be wasted in meaningless efforts.

Waste Exchange

According to more than twenty years of experience abroad, a waste exchange system has many advantages: reducing waste disposal costs, saving raw materials, recovering resources, and preventing environmental pollution. So the Chinese EPA and local Environmental Protection Boards (EPBs) have actively conducted one. At present, some special organizations for waste exchange have been developed and have achieved good economic and environmental benefits in Shenyang and Shanghai City. For example, Shanghai Yangpu District Research Institute of Environmental Protection established a waste acid and alkali exchange center in 1989. So far, 20,000 tons of waste acid and alkali have been exchanged and comprehensively utilized [7].

But the operation of these centers has shown that the exchanged wastes mainly focus on waste solvents, especially waste acid and alkali. The center in Shenyang City has geared up to its full performance so far. Besides those non-technical factors, the following reasons may contribute to the situation:

1. There are no reliable or consistent information sources. Although the system of registration and declaration has been instituted in the two cities and the data obtained can provide some useful information, the details of demanded and supplied wastes are unclear and necessitate complicated matching and bargaining procedures.
2. There are no strong legislative or economic incentives to drive waste exchanges. One key prerequisite of carrying out waste exchange in developed countries is the presence of clear and strict legislative requirements that hazardous waste should be disposed, and the high cost of disposal [9]. Waste generators have resorted to waste recycling on-site or to waste exchange off-site to deal with their own wastes. In China, however,

almost half of the industrial wastes are simply piled up without appropriate control. Even if there are some regional disposal facilities, the disposal fee is not high enough to stimulate waste recycling.

3. Insufficient propaganda as well as simple lack of awareness of waste exchange is another hindrance to implementing the system. Compared with other measures, waste exchange is newer and requires more initiative from the industries involved.

With regard to these problems, the feasibility of implementing waste exchange system should be further explored.

Manifest Tracking System

In order to follow the hazardous waste from its generation to its final destination and improve environmental management, the Chinese EPA selected Shanghai City as an experimental city to implement a manifest tracking system in 1988. However, it has shown that neither the manpower nor the legislative backing is at present available to monitor and control such a sophisticated system, dealing with above one thousand waste generators, several hundred waste recyclers and users, and numerous transporters of all sizes and types. It is also unrealistic to expect the people involved in the activity quickly to become familiar with the system. Therefore, a simplified manifest system has been adopted in Shanghai during the past few years [7, 11]. Priority has been given to heavy metal-containing wastes from electroplating facilities and salt residues from heat treatment processes. Five copies of tickets, in which important information about hazardous waste is recorded, are transferred among waste generators, transporters, consignees, and authorities (Figure 5).

It is apparent that the flow of the tickets is not from generators to receptors, differing from that of developed countries. This should be attributed to the actual

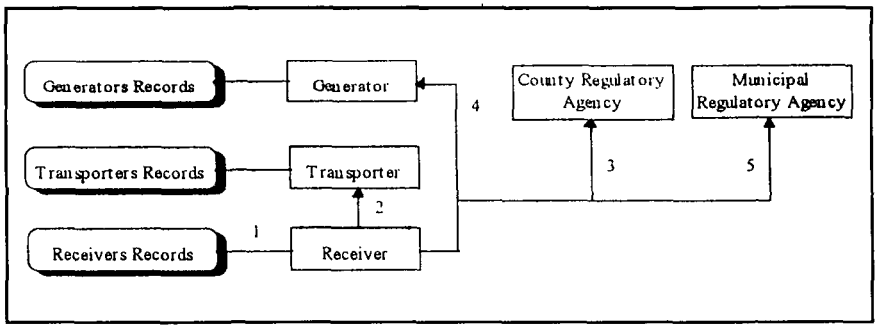

Figure 5. Simplified manifest system in Shanghai.

situation in Shanghai City, as there are no disposal facilities for hazardous waste for the time being, leading to the lack of final destinations for the tickets.

While the introduction of manifest system has been helpful, it is in great need of improvement.

Regional Centralized Waste Disposal Center

It is of great necessity to develop economic and effective technologies for hazardous waste disposal. Landfilling has received great attention as a technology suitable to China. During the past few years, the construction of regional centralized waste disposal centers, mainly landfills, has become another important measure for hazardous waste management. Several projects have been planned or implemented for this purpose. In the research projects of Eighth Five-Year Plan of National Science and Technology, Wuxi City was selected as an experimental city to construct a landfill for hazardous waste disposal. Great efforts were made in the preparation for the engineering [8]. Unfortunately, the project was aborted because of the shortage of funds. The first landfill for hazardous waste in China was built in Shenzhen City in 1994. Though the engineering provided valuable experience for the future, it could not be adopted as a demonstration site on account of its volume (23000 m^3) and the specific characteristics of wastes accepted. At present, another landfill for hazardous waste is being constructed in Shenyang City under the loan of World Bank [12], which is expected to supply a suitable example to popularize in China. A similar project also is being planned in Beijing City.

Hazardous Waste Management Information System

Another development in hazardous waste management in China is the establishment of hazardous waste management information system, as it has been learned that informed decision making not only depends upon an efficient decision mechanism, but also requires an accessible information base [13]. During recent years, various statewide and regional hazardous waste management information systems have been developed, which has greatly strengthened the management of hazardous waste [14]. For example, a waste registration center and a hazardous waste emergency response center have been developed in Wuxi City under the loan of World Bank. However, because many of these systems were developed without integrated planning, incompatibility of the different systems and repetitiveness of some contents have become two important problems to be solved.

Therefore, it is of great urgency to make an integrated plan to develop a hazardous waste management information system so as to coordinate the existing systems, avoid repetitive work in the future, and make full use of the achievements of present information systems.

IMPLICATIONS

In summary, the established measures in place in developed countries for hazardous waste management have been introduced in China, but not as effectively as expected. In spite of the non-technical factors involved in practice, one issue cannot be neglected: lack of statewide and regional action plans for hazardous waste management.

An action plan will address the main objectives of management: integrating short-term and long-term plans for hazardous waste control (including identifying the quantity and characteristics of hazardous waste in the region of interest, determining the priority list of hazardous wastes, and selecting an appropriate technology hierarchy to deal with them in the long run), and identifying the necessary steps to take (including determining which measures are appropriate to be taken in the region and period of interest, and how to give full play to them). These measures, including waste declaration and registration, waste exchanges, manifest tracking systems, regional centralized waste disposal centers, and information systems, consistent with the main objective and the integrated plan, are not independent of each other, but interact with each other. This complicated but systematic interrelation forms a dynamic waste management system. Therefore, it is important to ensure that proper attention is paid to the requirements of implementing certain measures and to take into account the interrelations among them. Conflicting with this principle, almost all the measures mentioned above have been separately introduced and operated in isolation in China for the time being. Even if there is some interplay between them, it is usually too weak to coordinate so as to obtain the full performance of each one involved. As is shown in Figure 6, the cities marked all have involved in the implementation of one or more measures, but there has been no complete system in operation for hazardous waste management. This will inevitably lead to ineffectiveness or even abortion of some measures. Encouragingly, some regional hazardous waste management plans are getting underway in Beijing City and Shanghai City. These are expected to provide a foundation for wise decisions.

CONCLUSIONS

1. Industrial waste management has become an urgent problem of concern in China.
2. A series of management measures have been introduced from developed countries, but the practice has not been as effective as expected.
3. Lack of statewide and regional action plans for hazardous waste management is a large barrier in establishing effective hazardous waste management systems.

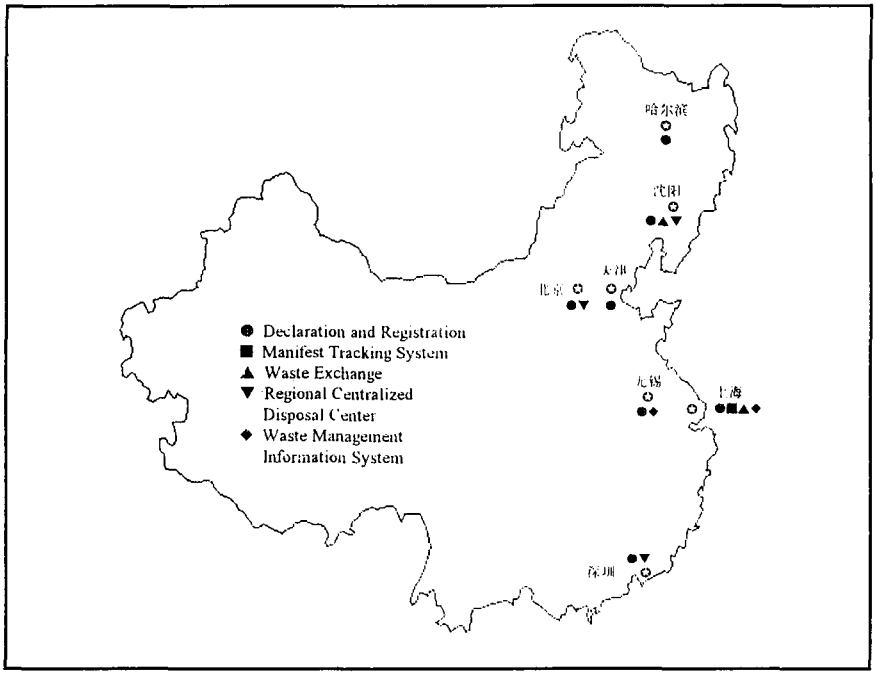

Figure 6. Hazardous waste management in several major cities of China.

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