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Pollution status and environmental sound management (ESM) trends on typical general industrial solid waste

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Abstract

General industrial solid waste is an important part of solid waste, but it has not get people's attention for a long time. There is no specific regulation or relevant technology standards for the safety protection of general industrial solid wastes in China. A lot of general industrial solid wastes were generated in China every year, which will pollute the soil, ground water, air and human's health seriously if not properly treated. Based on waste yield and hazards, some typical industrial wastes such as tailings, gangue, acidic waste rock, fly ash, smelting waste slag and phosphogypsum were selected to discuss the pollution status, regulation problems and environmental sound management trend. The result indicates that, the current national standard system has many problems in the management scope and requirement. It is urgent to revise the provision of "national standard for pollution control on the storage and disposal site of general industrial solid waste", such as site selection, admission, design, construction, operation, closure and other technical requirements, in order to improve the environmental sound management (ESM) trend on typical general industrial solid waste. Besides, increasing technological upgrading, developing new materials and improving the comprehensive utilization were also proposed.

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Keywords: general industrial solid waste; hazards; management ; standard; trend

1. Introduction

General industrial solid waste is an important part of industrial solid waste, including fly ash, slag, smelting waste slag, tailings, gangue, sludge, etc. [1] Those wastes are common in China and the generation is very huge. China has established a large number of storage and disposal sites by refer the foreign experience. Most of the general industrial solid wastes were usually stored openly. Although the related financial and technical input has been increased in recent years, the huge gape still exists in the comprehensive utilization of the general industrial solid waste between the

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developed countries and China. In the year of 2012, that the output of general industrial solid waste reached 3.29 billion tons, including 2.03 billion tons of comprehensive utilized amount, 708 million tons of treated amount, and 598 million tons of stored amount according to the data of "China Environment Statistical

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Yearbook 2012". Treated amount refers to the amount of industrial solid waste burnt or eventually placed comply with the requirements of pollution control regulation and no longer be utilized again. Stored amount refers to the amount of industrial solid waste that stored temporarily or stored in the special storage facility or other centralized stockpiling place. [2]

Table 1.1 generation and treatment status of national general industrial solid waste（unit：10 kilo-tons）

Year	Generation	Emission	Utilization	Storage	Disposal
2001	87794	2891.9	46848	29876	14262
2002	93509	2633.3	49669	29657	16376
2003	99258	1940.7	55613	27244	17376
2004	119035	1760.9	67393	25669	26360
2005	133287	1654.4	76497	27539	30920
2006	150457	1282	92035	22131	42594
2007	174553	1196.9	109661	23965	41004
2008	188770	781.93	122663	21687	47902
2009	202513	710	137355	20710	47060
2010	239357	498	160795	23752	56751
2011	322722	433	195214	60424	70465
2012	329044	144	202461	59786	70744

These long-term stockpiling of waste will not only take up a lot of our resources, meanwhile, it can release large amounts of toxic and hazardous substances to the surrounding such as heavy metals, acidic and alkaline water, pungent gas, dust, etc. The toxic substance release process is relatively slow with a lag, which cause the potential and persistent threats to the environment. It is estimated that a lot of general industrial solid wastes have caused hazard to human health and surrounding environment which were exposed to the environment without effective treatment.

This article analyzed the latest amount statistics, relevant state policies and regulations, management and operation status of storage and disposal site on several typical general industrial solid wastes. The key problems in environmental management were discussed, and the future environmental sound management (ESM) trend was also proposed.

2. Pollution situation and management status of typical general industrial solid wastes

Typical general industrial solid wastes with a large quantity and relatively cause serious environmental pollution problems in China including tailings, fly ash, phosphogypsum, gangue, acidic waste rock, smelting waste slag and carbide slag, etc. Smelting waste slag consists of blast furnace slag, steel slag, ferroalloy slag and non-ferrous metal slag [3].At present, the domestic production of industrial solid waste is still high and the responsibility management system is not clear, which lead to the great damage of ecological environment, and human health. The general situation of typical general industrial solid waste was summarized as follows:

2.1 Tailings

Tailings are produced during mineral process that losses the value temporarily, it was usually stored in tailings pond. There are about 11,946 tailings ponds in China presently [4]. Tailings contain a lot of hazardous chemical substances, the ore granularity will become very fine and surface activity will be increased. A series of physical and chemical reaction is prone to happen during the process of stockpiling, which caused the leaching of heavy metals. Heavy metal is typically found in sulfide ore based non-ferrous metal ore， which is mainly distributed in the southern region of China with large rainfall and relatively higher temperatures. Sulfide minerals, especially pyrite will be easily oxidized and produce acidic waste water that further aggravates the leaching of heavy metals in the joint action of air, moisture and bacteria. Therefore, tailings, especially non-ferrous metal mine tailings posed a great threat on the soil and groundwater. “Regulations of environmental management for pollution prevention and cure on tailings” issued by “former State Environmental Protection Administration” stipulated that mining plants should build dedicated tailings ponds and seepage control measures should be adopted in tailings containing hazardous waste. On the one hand, “Tailings safety supervision and management regulations” issued by “State Administration of Work Safety” in 2006 and “Tailings Environmental Emergency Management Guide (Trial)” issued by “Ministry of Environmental Protection” in 2010 were only aim at tailings collapse, leaks and other environmental emergencies. On the other hand, the supervision and management of many domestic tailings ponds were not strictly in accordance with the standards, the problems of accumulation of heavy metals in the surrounding soil, and the indiscriminately discharging of waste water were serious in China.

2.2 Gangue

Gangue is a kind of solid waste that discharged in the process of coal mining and coal processing. It is harder than coal and has lower carbon content but higher mine rock content. Most of gangue was exposed in a circular cone shape in air and the number is very large, commonly known as gangue dump. In the year of 2013, the domestic gangue output was 750 million tons, with comprehensive utilization of 480 million tons. At present, the cumulative stacked amount of coal gangue in China is about 4.5 billion tons and the large-scale coal gangue dump has been reached 2600[5]. The problem of spontaneous combustion and producing acidic waste water after rainfall was universal in coal gangue, there is no doubt that it will pollute air, water and soil. Guidance on disaster preparedness and governance for gangue dump of coal mine established by “National Coal Mine Safety Supervision Bureau” in the year of 2005 made strict requirements for the design, site, stack, spontaneous combustion prevention, collapse prevention and comprehensive utilization. This regulation emphasized on prevention and treatment of spontaneous combustion and collapse, while the pollution prevention and management measures such as sulfate, organic pollutants and heavy metals was not mentioned.

2.3 Fly ash

Fly ash is a fine ash collected from the combustion boiler flue, the major solid waste discharged in coal-fired power plants; it is also one of the largest of industrial solid waste in China. China has produced 532 million tons of fly ash in 2013, increase of 2.31% compare the year of 2012[6].Using fly ash as building materials has been relatively mature, the comprehensive utilization rate was more than 70% in recent years, but the phenomenon that people randomly stacked fly ash near the ravine or arable land is common in some remote area. Fly ash contains small amounts of heavy metal element, it is easy to be blown away in the wind and pollute the air and soil. Article XI in Decree 19 of “Management Measures of comprehensive utilization for fly ash” issued by “National Development and Reform Commission” in 2013 regulated that newly built power plants should consider the utilization ability of surrounding ash to prevent environmental pollution and avoid building permanent fly ash yard (dump)， if it is actually needed, the siting, design, construction and operation management should conform to “Standard for pollution control on the storage and disposal site for general industrial solid wastes”（GB18599 - 2001）.

2.4 Phosphogypsum

Phosphogypsum is a waste discharged during the production of phosphate and phosphoric acid. The accumulated total stockpile of phosphogypsum has reached 250 million tons in the year 2012. The pH of phosphogypsum ranged from 1.5 to 4.5. After long-term immersion, the soluble P_2O_5, inorganic fluoride and sulfate can transfer to the environment through the medium of water and contaminate the soil, water and atmosphere [7]. At present, the comprehensive utilization rate of phosphogypsum is very low. The medium-sized phosphate fertilizer companies were located in remote mountainous areas, which were far away from gypsum consumer market, as a result, lots of phosphogypsum were stored in dump. However, the conventional plugging and seepage prevention method of vertical curtain grouting, clay stop leak, laying geotextile, susceptible to fluorine, phosphorus-containing process water corrosion were prone to erosion by process water containing fluorine and phosphorus. Once the leakage occurs, it would cause serious damage to the environment. Currently, there is no standard or technical specification completely aimed at phosphogypsum storage, “Operational measures of construction and management for phosphogypsum dump”issued by “China Petroleum and Chemical Industry Association” and “Safety technical regulation on phosphogypsum stack” of Guizhou Provence, which have brought important guiding significance for prevent environmental pollution in the construction of phosphogypsum dam.

2.5 Red mud

Red mud was discharged in aluminum industry that extracting alumina, it has a strong basicity. Red mud belongs to the second category of general industrial solid wastes, the large-scale industrial applications has not come true. By the end of the year 2012, China had accumulated about 250 million tons of red mud. It was estimated that, the accumulated stockpiling would reach 350 million tons by the year of 2015, red mud disposal sites would reach 80 units, covering more than 8 thousand acre.

Since bauxite deposits are formed in limestone areas, the anti-seepage treatment is not only difficult but also has high risk [8]. At present, red mud management still refers to “Tailings pollution prevention and control regulations”. “Code for design of dry red mud stack ”GB 50986-2014 issued by “Ministry of Housing and Urban-Rural Development” regulated that dry red mud stack must use impervious barrier and the barrier should consist of support layer, geomembrane, protective layer, the site preparation and foundation treatment were also fully detailed, it has great significance to standardized management of red mud.

2.6 Acidic waste rock

Acidic waste rock is the country rock, dunn bass and stripped waste rock that discharged after ore mining with more sulfide ore. In the year of 2013, China had accumulated about 43.8 billion tons waste rock, among them, the metal ore mining produced 4.947 billion tons of waste rock (mostly were acidic waste rock), but the comprehensive utilized volume was only 468 million tons[5]. At present, more than 160 kinds of mineral species have been discovered in China, the mining activity generates 1.25 tons of waste rock every one tons of ore mined on average. With the stripped ratio of most deep open pit increased every yearly, the emissions of acidic waste rock are increasing year by year. These waste rocks not only occupied the land, but also has the hidden danger of causing debris flow [9]. Unfortunately, there has no management practices or standards related to waste rock stack for reference. Acidic waste rock will produce acidic waste water after rain leaching, what’s more, large number of sulfide minerals can release heavy metals and various salts compounds after weathering and oxidative decomposition. There is no doubt that, without effective management, the contaminant would enter into the surrounding environment and causing serious pollution.

2.7 Smelting waste

Smelting waste mainly consists of blast furnace slag, steel slag, ferroalloy slag and non-ferrous metals slag, it has posed a serious threat to the ecological environment because of its toxicity, corrosivity, long-term pollution and imperceptibility. At present, the management of the residue field is still in its infancy and lack of the necessary

pollution control system. The lead, copper, zinc content in soil near the non-ferrous metal smelter usually exceeded several times or even a few times. This toxic substance can easily get into the groundwater through soil [10], so we must establish strict industry standards to strengthen the environmentally sound management on the stockpiling process of smelting slag.

3. Management trends

3.1 Accelerating the revision of national standards and promoting the rationalization and standardization of management

China started lately on the general industrial solid waste management, standard system development lags behind, and the related management practices for storage and disposal sites usually used "Standard for Pollution Control on the Landfill Site of MSW" as a reference. So, the malpractice of broad management and unknown object are often exist in it. In the future, we should revise the existing "Standard for pollution control on the storage and disposal site for general industrial solid wastes"（*GB18599-2001*）, and formulate specific pollution control technology requirements according to the generation characteristics and disposal characteristics of waste generated in different industrial processes. The specifications and technical requirements for general industrial solid wastes of second category mentioned in this standard must be formulated in accordance with the different effect on the environment. More detailed and stringent requirements should be set up to the aspects of impervious system, functional requirements and quality assurance for different tailings dam and stack. At last, make the safe operation and management technology system on the storage and disposal site for general industrial solid wastes initially formed. At the same time, different industry environmental protection standards should be appropriately formulated.

3.2 Strictly bound the management process through improvement of laws and regulations

In China, policies and regulations on general industrial solid waste are still not perfect, and there is not a uniform classification standard for general industrial solid waste; Statistics between different departments was not the same, and it's difficult to reach an agreement between different departments in the pollution control and management; The phenomenon of ambiguity of responsibilities or weak enforcement often exist in the local government. Therefore, we must improve the relevant legal system and develop local management regulations of industrial solid waste by local conditions in accordance with national laws and regulations. At last, make the standardization and regulation of the whole process of industrial solid waste from generation to disposal come true [11]. Besides, coercive measures should be taken to the effective management of solid waste and the generation, the final emission of pollutants should also be strictly controlled.

3.3 Increasing technological upgrading and developing new materials

Another prominent management problem of stack yard or dam is the high construction cost at present. Taking residue field as example, the waste residue was discharged with no value. To manage them well, the HDPE geomembrane and construction costs used in seepage treatment process will be about 60 yuan per square meter. Take the running time of a medium-sized slag field as 10 years, and then the total investment of standardized construction in accordance with the specification will be at least 500 million to 600 million yuan [12]. Therefore, on the basis of strengthening scientific research, applying the best management techniques and low-priced quality new material to the management of storage and disposal sites is of great significance.

3.4 Achieving the ESM pollution control and improving the comprehensive utilization

The management of general industrial solid waste should involve the entire process that from generation to final disposal. The reduction of solid waste on the source, resource utilization among the generation process and ESM after treatment can be finally realized through technical upgrading, process renovation and government support. What's more, it will become a long-term task to further improving the comprehensive utilization and reversing the increasing

trend of stockpiling year by year. This is the only way to effectively reduce the pressure on management, improve the management level and quality, reduce the incidence of pollutants leakage and dam-break of tailings dam or storage yard. Meanwhile, it has great value to promote the quality improvement work of soil and water environment in China.

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