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A Glance at the World

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This column comprises notes and info not subjected to peer-review focusing on waste management issues in different corners of the world. Its aim is to open a window onto the solid waste management situation in any given country, major city or significant geographic area that may be of interest to the scientific and technical community.

Toward comprehensive utilization of large-scale industrial solid waste in China

In China, large-scale industrial solid waste (LSISW) signifies industrial solid waste produced in various industrial fields in volumes of over 10 million tons. This kind of waste has a great effect on the environment and safety. In China, LSISW mainly includes tailings, coal gangue, fly ash, slag, red mud, industrial by-product gypsum, and calcium carbide slag. LSISW management warrants particular attention since China has generated more and more solid waste during recent years. According to the Ministry of Industry and Information Technology (MIIT), China generated 11.8 billion tons of LSISW during the period of the eleventh five-year plan (2005–2010), while stockpiles increased by a net 8.2 billion tons to 19.0 billion tons. By the end of 2010, the total amount of LSISW in the country reached 2.76 billion tons a year, and of this 40.0% was comprehensively utilized. With the fast pace of urbanization and industrialization, more industrial solid waste is being produced, and the enormous production of such waste makes greater demands for comprehensive utilization. According to the MIIT, China will generate 15.0 billion tons of LSISW during the period of the twelfth five-year plan (2011–2015), while stockpiles will increase by a net 8.0–27.0 billion tons. This stockpile of 27 billion tons will require an additional 400,000 μ of land (1 μ = 666.67 square meters). By the end of 2015, the total amount of LSISW will reach 3.22 billion tons a year. The increase in the quantity of stored waste will produce environmental pollution and provoke potential safety problems. To promote comprehensive utilization of LSISW, the MIIT released the 12th Five-Year Plan for the industrial solid waste sector on December 17, 2011, targeting reuse treatment of LSISW in China. (Carbide slag was not included in this plan because its utilization has already reached almost 100%.)

The development goals of that plan are as follows. (1) By 2015, the utilization rate of LSISW will increase to 50% and China will utilize 1.6 billion tons of industrial solid waste a year. The value of the annual output will attain 500 billion RMB, and more than 2.5 million jobs will be created in this sector. During the period of the twelfth five-year plan, the total amount of LSISW for comprehensive utilization will reach 7.0 billion tons. This utilization of LSISW will result in a decrease of 350,000 μ of storage land. (2) The following will be required for the comprehensive utilization of LSISW in China: developing a series of innovations with self-owned intellectual property; promoting a series of advanced technologies; cultivating strong innovative capacity, competitiveness, and influential enterprises; building a number of pilot industrial bases that are characterized by comprehensive utilization of LSISW. A circular economy industrial chain will have to be established, whereby comprehensive utilization of LSISW is a key element. A management system will have to be set up regarding comprehensive utilization of LSISW by pharmacists in China.

To achieve this aim, organization and implementation of 10 major projects regarding LSISW have been proposed for the period of the twelfth five-year plan. (1) Extracting valuable metal from tailings engineering will be conducted (with a budget of 10 billion RMB). This will be carried out in such areas as the following: setting up projects for separating magnetic tailings and separating iron from hematite tailings; extracting iron, vanadium, and titanium from vanadium titanomagnetite tailings; and recycling multiple elements from manganese ore tailings. (2) To upgrade tailings filling technology, low-cost tailings filling projects need to be established (with a budget of 20 billion RMB), particularly cemented full tailings filling, and tailings filling with sand and water in the tailings for mined-out regions, and filling tailings with a dry emission pile for areas of subsidence. (3) It is necessary to produce high-value-added building materials using tailings as raw materials (with a budget of 10 billion RMB), such as producing aerated concrete and high-strength structural materials. (4) After detoxification processing, the tailings should be applied to safe agricultural production and ecological rehabilitation and improvement (with a budget of 1.0 billion RMB); examples here are producing slow-release fertilizers, soil regulators, and new kinds of materials that can help restore polluted environments. (5) It is necessary to produce high-value-added building materials using fly ash as raw material (with a budget of 18 billion RMB); examples here are extracting aluminum oxide from high alumina fly ash, preparing silicon aluminum alloy using high alumina fly ash as raw material, and extracting drift beads and toner from fly ash using deep processing. (6) A series of projects has to be set up for the treatment and comprehensive utilization of steel slag (with a budget of 12 billion RMB); examples here are steel slag pretreatment, steel slag powder and compound powder using steel slag as raw material, and producing gelling material used for filling mined-out regions. (7) Nonferrous metal smelting residue comprehensive utilization has to implemented (with a budget of 17 billion RMB); examples here include extracting gold, silver, zinc, indium, antimony, and other materials from nonferrous metal smelting residue by acid leaching, extracting lead, arsenic, and cadmium from nonferrous metal smelting residues by calcination and acid leaching. (8) It is necessary to establish a series of projects dealing with com-

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prehensive utilization of cyanide residue (with a budget of 5 billion RMB); examples here are preparing sulfuric acid using cyanide residue and extracting lead, zinc, copper, and iron from this residue. (9) Projects have to be set up for the production of plaster board and super-strength gypsum using industrial by-product gypsum as raw material (with a budget of 5.0 billion RMB). (10) A project to make comprehensive utilization of red mud has to be set up (with a budget of 2.0 billion RMB); examples here are directly extracting iron from red mud and preparing building materials using red mud in Shanxi, Shandong, Henan, Guangxi, and Guizhou provinces, where an abundance of red mud is produced.

To promote the successful implementation of this plan, a number of polices have been planned and proposed, some of which are as follows: (1) the reinforcing of legal requirements relating to construction and implementation of legal regulation of comprehensive utilization of LSISW; (2) establishing an effective system for comprehensive utilization of LSISW and creating of a platform of information about such utilization; (3) promotion of research efforts into technical innovation and encouragement of technical progress in this area on the part of enterprises; (4) development of comprehensive utilization of LSISW bases and promotion of specialized enterprises; and (5) the formulation of policies that more effectively support comprehensive utilization of LSISW. Among these, the following deserve mention: promoting the criteria for recognizing an enterprise that comprehensively utilizes LSISW; improving the system for recognizing products that are made using LSISW; state provision of preferential taxation policies to enterprises that comprehensively utilize LSISW, particularly those that support large-scale production or conduct high-value-added comprehensive utilization; promoting resource tax reform, with resource tax rates being increased for products that utilize resources; promoting the process whereby environmental taxes will replace discharge fees; earmarking special funds for the promotion of the comprehensive utilization of LSISW; and putting some products made using comprehensive utilization of LSISW on lists of government purchases.

In general, this plan will establish a solid foundation for China's move toward comprehensive utilization of LSISW. However, a number of challenges remain. (1) The supportive policies should be clear and substantial, and more financial support needs to be provided by the government. At present, bulk solid waste is used by the facilities that produce such waste, such as steel factories, metallurgical factories, and coal mines. Most of the investment for the comprehensive utilization of LSISW is made by these facilities, and the waste product is used almost entirely by the facilities themselves. This means that it is very difficult for large-scale economic development of this industrial solid waste to be achieved. For example, there should be a large market for bricks made from fly ash; however, since clay bricks can be obtained for 0.2 RMB per brick, bricks made from fly ash, which cost 0.3 RMB per brick, are not competitive in price. Most bricks made from fly ash are used for building houses in mining areas, and the demand for these bricks is low; thus, there is limited chance for making a profit by producing these bricks. Therefore, to provide greater motivation to entrepreneurs, clearer and more substantial supportive policy should be provided by the government for firms engaged in the comprehensive utilization of LSISW. (2) Synergy mechanisms need to be implemented. They should be initiated by the government and be based on cooperation among such various areas as architecture, chemical engineering, and the local government. For example, the building industry does not have the technical difficulties of dealing with solid waste; dealing with solid waste requires cooperative mechanisms on the part of society as a whole. Solid waste has long been used as a raw material, and the consumption of such waste in this manner is very large. Recently, treating solid waste in a cement kiln has represented a new approach to such treatment. In this case, the technical problems can be solved by the operators of the cement plant, and the garbage can be managed by the government. Thus, synergy mechanisms need to be established whereby the government operates as the main coordinating body. One further example involves ardealite and desulfurized gypsum, which are solid waste products of chemical engineering. Because both ardealite and desulfurized gypsum are produced at widely dispersed sites, there are financial and logistics problems in effectively treating this kind of solid waste. However, waste treatment based on synergy mechanisms offers an effective way of dealing with the problem. First, the logistics of handling desulfurized gypsum should be classified as part of the garbage collection system. Other problems relating to its proper treatment can be solved with the cooperation and collaboration of architecture, chemical engineering, and the local government based on synergy mechanism. (3) Finally, a lack of public participation may impede comprehensive utilization of LSISW. Public awareness of comprehensive utilization of LSISW needs to be enhanced. Consumers should be encouraged to purchase products made using comprehensive utilization of LSISW.

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Life cycle analysis of municipal solid waste (MSW) land disposal options in Bangalore city

Bangalore city, one among the eight metros in India, produces about 3600 tonnes per day (tpd) of municipal solid wastes (MSW). A major constituent of this is organic waste. All the wastes are taken to the landfills situated on the outskirts of Bangalore. Currently all the landfills situated in Bangalore have reached their capacity and are receiving waste in excess of their capacities. In this article, four scenarios were applied to the Bangalore's urban municipal solid waste land disposal systems. The waste disposal methods are assessed using Life cycle analysis (LCA). LCA serves as decision making tool in selection of the most sustainable, economic and environment friendly land disposal options. In this study four land disposal options are considered, Scenario 1: Open dumps, Scenario 2: Landfill system without gas recovery, Scenario 3: Landfill system with gas recovery and Scenario 4: Bioreactor Landfill system. LCA studies the overall environmental burdens generated by products, processes or activities during their entire life cycle, which include extraction and processing of raw materials, manufacturing, production and maintenance, packaging, transportation and distribution and recycling (ISO, 1997). The methodological framework used in this study is the LCA as defined by ISO standards (International Standard Organization, ISO 14040:14043). The general categories of environmental impacts considered include resource use, human health and ecological groups. There are four phases for LCA, which include: (a) Goal definition and scoping, (b) Inventory analysis, (c) Assessment of potential environmental impacts and (d) Interpretation or improvement analysis. This study is concerned with the development of life cycle inventory (LCI) methods to describe and quantify the estimates of the environmental performance of open solid waste dumps, engineered landfills and bio reactor landfills.

Goal definition and scoping

The present LCA study is performed by carrying out an inventory of the inputs and outputs related to land disposal methods in Banga-