Policies, standards and managements associated with PG utilization

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Abstract. With rapid growth in the production of high concentration phosphate and compound fertilizers in China, PG production is increasing every year. However, its utilization is not increasing at the same pace. Phosphogypsum is usually stored in such a way that not only it occupies lot of land, but also leads to minimal environmental pollution. As PG is now catching attention of planners and environmentalists, its utilization and environmental friendly treatment is becoming a matter of increasing concern in social sustainable development.

1. Introduction
Phosphogypsum (PG) refers specifically to gypsum produced as an industrial by-product in the largest quantity during processing of phosphate ore into fertilizer. Normally production of one tonne (t) of phosphate fertilizer generates 4.5 to 5.5 t PG [1].

With rapid growth in the production of high concentration phosphate and compound fertilizers in China, PG production is increasing every year. However, its utilization is not increasing at the same pace. Phosphogypsum is usually stored in such a way that not only it occupies lot of land, but also leads to minimal environmental pollution. As PG is now catching attention of planners and environmentalists, its utilization and environmental friendly treatment is becoming a matter of increasing concern in social sustainable development [2].

Policies, standards and managements issues related to PG are discussed in this document, in order to help the PG utilization and management effectively.

2. Policies
Due to the certain environmental risks, PG is now being paid great attention by the Ministry of Environmental Protection of China. The Chinese Government has issued a series of measures to support the comprehensive utilization of PG. For example, ‘Measures for the administration of the collection and use of special funds for new wall materials’, ‘Notice on the publication of the comprehensive utilization of enterprise income tax preferential catalogue (2008 Edition)’, ‘Circular on the relevant issues concerning the implementation of the enterprise income tax preferential catalogue for the comprehensive utilization of resources’, ‘Circular on the comprehensive utilization of resources and other products' added-value tax policy’, ‘Circular on investment and financing policy measures to support the development of circular economy’, and other series of preferential policies have been formulated to encourage the use of PG resources [3].

During the period of the 11th Five-Year Plan (2006-2010), the China Phosphate Fertilizer Industry Association listed comprehensive utilization of PG as a priority activity. Following the principle of
'reducing, reusing and recycling', awareness about PG as a resource was increased so as to realize the goal of utilization rate of 20% by 2010 and to achieve overall rate of PG utilization synchronous with development of the phosphate fertilizer industry. During the period of the 12th Five-Year Plan (2011-2015), the relevant industrial units were issued a number of guidelines through policy decisions -- ‘Implementation plan for safe disposal and comprehensive utilization of phosphogypsum’, ‘Guidance on the comprehensive utilization of resources’, ‘Plan for comprehensive utilization of industrial solid waste’, ‘Implementation of the comprehensive utilization of solid waste’, ‘Circular of the State Council on the issues of circular economy development strategy and the recent action plan’, and others to regulate the overall utilization of industrial gypsum. These policy decisions aimed that the goal of comprehensive utilization rate of PG in the 12th Five-Year Plan reached 40%, and the overall goal of safe disposal rate reached more than 90% [3].

In 2011, the Ministry of Industry and Information Technology of China issued the policy decision ‘Access conditions of ammonium phosphate production’. It clearly puts forward that ammonium phosphate enterprises must construct the facilities of PG yard, and the utilization rate of PG must reach 15% of annual production in 3 years. The enterprises not meeting these requirements must shut down. Within 3 years, monoammonium phosphate and diammonium phosphate manufacturers were not allowed to build new plants or reconstruct the old ones. For the relocation of enterprises in accordance with the regional planning and then create a new wet process phosphoric acid plant for monoammonium phosphate and diammonium phosphate production, full utilization of PG was mandatory. These access conditions caused a strong shock in the phosphate fertilizer industry, and a huge pressure is constantly being transformed into dynamic and comprehensive plans for utilization of PG.

In 2012, the National Development and Reform Commission along with six ministries issued the "The policy outline for China's comprehensive utilization of resources technology" to promote the comprehensive utilization technologies for using PG for the production of sulfuric acid, cement, potassium sulfate, ammonium sulfate and calcium carbonate and other chemical raw materials, cement retarder, paper-faced plaster board, building plaster, wall plaster, building block and other building materials products, and to promote utilization of PG for reclamation of saline-alkali soils. Utilization of PG for the production of sulfuric acid and building materials was found to be the best utilization mode.

The process of development and utilization of PG is not easy because the investment involved is large, added value and profits are low, ability of phosphate fertilizer enterprises to accumulate PG is poor, and the capital strength is weak. Although China has implemented the incentive policies, funding and projects to support PG utilization, there still exist problems. In China’s current fiscal and tax preferential policies, the difficulty of comprehensive utilization of PG is far greater than that of other industrial by-products like gypsum.

3. Standards

3.1. National standards
There is no international standard for PG. In China, there was no national standard for PG before 2010. Some production enterprises formulated internal control indicators for the self-regulation, but most of other enterprises did not have any quality standards for PG. In December 2007, the national standard for phosphogypsum was prepared and documented by the Decoration and Building Materials Standardization Committee. It was released in 2009 and implemented in 2010. Thus industrial units producing PG now have the regulations to follow, and by-products from the phosphate fertilizer industry can be converted into valuable materials. However, the standard is applicable only to the building materials industry.

In May 2016, the national standard ‘Treatment and disposal specification for phosphogypsum’ was implemented. The specifications provide the principle of treatment and disposal of PG, production process, raw and auxiliary materials, main equipment, production process and operational procedures,
safety and environmental protection. This standard is applicable to the treatment and disposal of the sulfuric acid from the PG. The sulfuric acid thus produced is used in the production of chemical raw materials for wet process phosphoric acid and other industries.

3.2. Local standards
The local standard -- ‘Soil amendment – phosphogypsum’ was implemented in 2004. The standard specifies the requirements, test method, inspection rules and labels, packaging, transportation and storage of PG as soil amendment. This standard is applicable to PG produced by high concentration phosphate fertilizer industry as raw material to reclaim alkaline soils. However, it does not allow PG to be used as a phosphorus fertilizer. Another local standard - - ‘Technology rules of phosphogypsum for alkaline soil improvement’ was issued by the Quality and Technology Supervision Bureau of Inner Mongolia Autonomous Region and implemented in May 2015. ‘Technical specification for safety storage of phosphogypsum DB52/T 913-2014’, edited by Wengfu (Group) Co., Ltd., was implemented in December 2014. It provides the rules for the site, design, construction, safety operation, closure, mining, safety evaluation and other safety aspects. It is suitable for the management of new, reconstructed or extension project of phosphate production units, and safe operation and management of PG storage.

3.3. Industry standards
In 2011, the standard of ‘Soil amendment – phosphogypsum HG/T 4219-2011’ was released for the chemical industry. This standard specifies the requirements of PG as soil amendment including test methods, inspection rules, packaging, labeling, transport and storage. This standard is applicable to PG produced by high concentration phosphate fertilizer units and provides by-laws for using PG as raw material to improve the alkaline and calcareous soils. Phosphogypsum to be used as soil amendment in agriculture has, therefore, a standard to follow.

The standard -- ‘Determination of phosphorus and fluorine content in phosphogypsum JCT 2073-2011’ in building materials industry was implemented in July 2012. To some extent, implementation of this standard provides rules to follow for the analysis of PG and strengthen the quality control of the product. However, there is no uniform quality analysis standard for PG. Also, there is no uniformity in the treatment of test samples of PG. Even the analytical methods for studying chemical composition of PG have not yet been unified.

The standard system of PG comprehensive utilization is still not perfect. With the continuous widening ranges of PG applications, the relevant standards developed gradually expose a lot of problems and defects, and thus cannot meet the needs of the industry. First, it is the lack of product standards for comprehensive utilization of PG. One can refer to standards for other similar products resulting in a low degree of market acceptance and difficulty for large-scale use. Second, more emphasis has been given to the technical standards, but ignored the product application standards and norms. Third, revision of standards takes long time, making it difficult to adapt to the situation and the changing environment.

4. Management
There are several problems associated with the management of PG [4-5].

(1) Managers do not treat it as a commodity. Due to lack of awareness about comprehensive utilization of PG, the by-product in the process of phosphoric acid production has been regarded as ‘waste’. Enterprises only focus on quality control of phosphoric acid, but ignore the management of PG. There is no unified standard for the construction of PG storage fields and their management. There hardly exists any in-depth study on the management of PG storage fields.

(2) The support of the enterprises for PG utilization is not enough. For any enterprise the first consideration is the economic benefits. Although PG as a resource can bring long-term benefits, in the short-term it often requires huge investment in terms of acquiring new equipment or upgrading the existing equipment. In case the government does not provide any support measures for managing PG
such as technical support or tax revenues, it is likely that enthusiasm of the enterprise will diminish leading to blocking or even termination of the project to manage PG.

(3) Lack of the safety evaluation for raw materials, processes and products. In general, PG is weakly radioactive; the intensity of radioactivity is closely related to that of phosphate rock. Although the enterprises have now solved the technology problems, the safety evaluation of PG and the final products still lacks the corresponding special standards. When enterprises deal with safety evaluation, they usually use the evaluation system for the original product. Because of the impurities and radioactivity in PG, the original evaluation system cannot accurately evaluate the raw materials, processes and products.

5. Summary
On an overall basis, the policy, standards and management of PG application in China are inadequate and needed to be improved, especially for PG applied in agriculture. There is a need to increase and improve the policy and financial support for effective utilization of PG. One way is to improve the policy mechanisms, the level of technology, and the standard system in order to increase the level of comprehensive utilization efficiency. The second is to mobilize the enthusiasm of all parties to promote the scientific application of PG. The third is to establish the national, local and industry standards for PG and related products, to ensure the use of PG as per rules and laws, and to improve the recognition in the market of the products made from PG.

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