

Outlook in Sourcing Refractories

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Abstract

The conditions for sourcing refractory used for the iron and steel making process have recently undergone significant changes as its supply and demand balance is now determined by various new factors which were not found previously. In this paper, some of these new factors are discussed such as environmental regulations on the production of refractory in China and restrictions on the usage of refractory in Japan which contains chemical materials classified as specific chemicals substances and designated as poisonous or deleterious substances.

1. Introduction

Japan imports most of its raw materials for refractories for use in the steel industry although it does produce a fraction of them. Therefore, the supply of and demand for such raw materials produced overseas—those produced in China, in particular—affect the conditions for sourcing refractories considerably. **Figure 1** shows the main countries that produce refractory raw materials. **Figure 2** shows the production ratios of countries that produce magnesite, bauxite, and graphite. As shown in the graphs, China procures large portions of all the raw materials, and thereby China's production of raw materials affects the supply of and demand for refractories considerably.

2. Price Changes of Refractory Raw Materials and Factors of Such Changes

The procurement costs of refractories started fluctuating more widely in 2008 compared to the past. The main factor of such variation is the violent fluctuations of raw material prices due to changes in the supply of and demand for raw materials. **Figure 3** shows the price trends of magnesia, alumina, and graphite in China. The variation factors are described below.

Around the Beijing Olympics in 2008, the supply became tight since the operation of the factories of raw material manufacturers was stopped and transportation was restricted as measures against air pollution. As a result, the prices of magnesia, alumina, and graphite increased significantly for those days.

At the beginning of 2010, the Chinese government instructed flake graphite manufacturers to modify their equipment to reduce energy consumption and emissions. That increased the production costs and at the same time the output decreased. In addition, in the latter half of 2010, the demand for graphite for lithium-ion battery

materials increased, which led to a tight supply-demand balance. As a result, the supply availability for refractories was also limited and thereby the price rose. After that, in the Spring Festival in 2011, the supply and demand started to balance out and the price also started decreasing.

In 2017, the Chinese government tightened the environmental regulations as countermeasures against air pollution (PM2.5) and for other purposes. The revised regulations were applied to mining at mines and operations at factories and caused the closure and disassembly of factories, which reduced the production capacity significantly. Factories were required to modify their equipment to satisfy the revised regulations. These factors in turn increased the manufacturing costs of refractory raw materials.

Regarding magnesia in particular, the Chinese government completely prohibited mining at mines under one's own name. In Liaoning, the supply of dynamite was stopped to eliminate illegal mining. In addition, the government determined standards for measures to reduce dust and noise in machining and manufacturing. Companies that could not satisfy the standards were closed or their equipment was disassembled. In addition, the production in winter (season in which heating was required) was controlled to improve the air quality. The supply decreased due to these factors, and the price skyrocketed.

The environmental regulations for alumina were also tightened as was the case with magnesia. The stoppage of illegal mining and operation stop at small-scale mines reduced the output of bauxite and band shale (raw materials). Even factories that continued operations had to modify their equipment to satisfy the regulations, which increased the manufacturing costs, leading to a higher price.

Raw material manufacturers modified their equipment to satisfy the environmental regulations and as a result, the supply became

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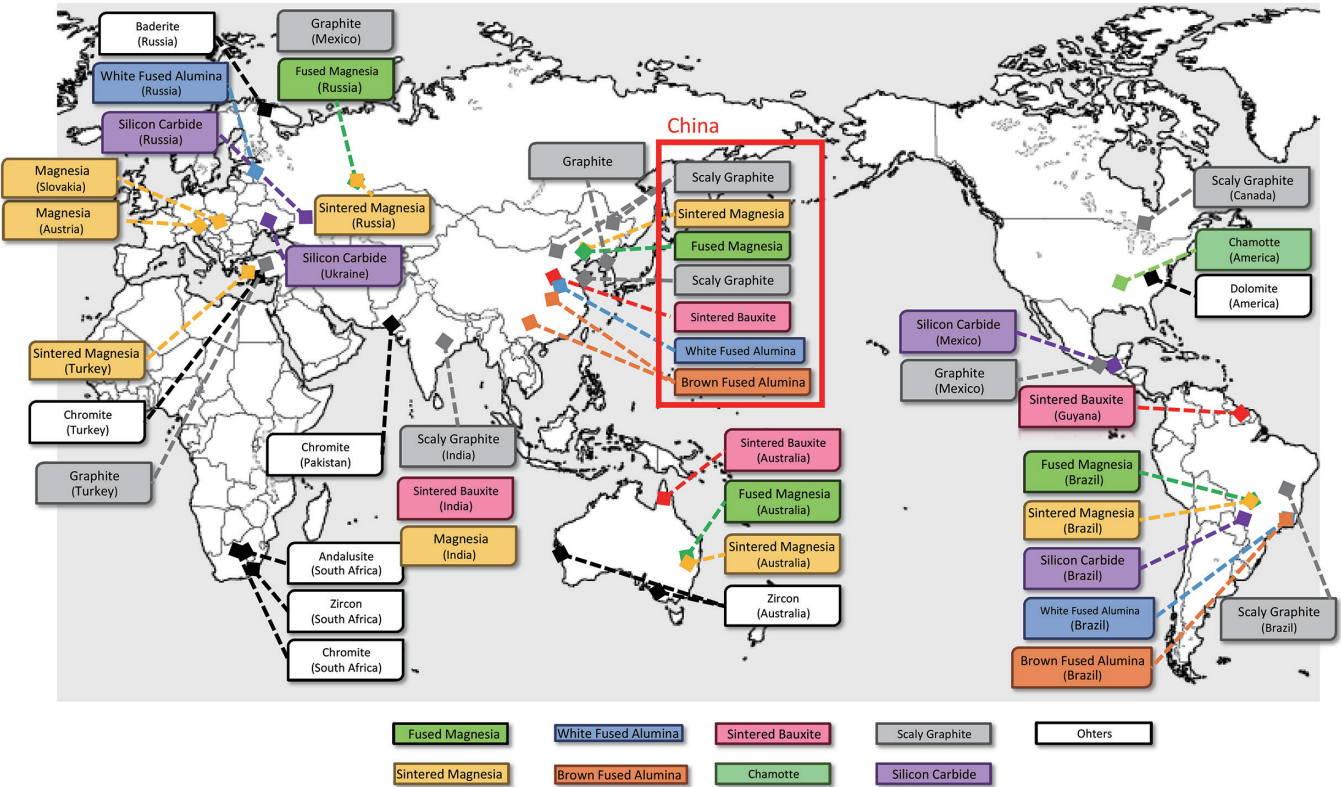


Fig. 1 Distribution of production of leading refractories raw materials

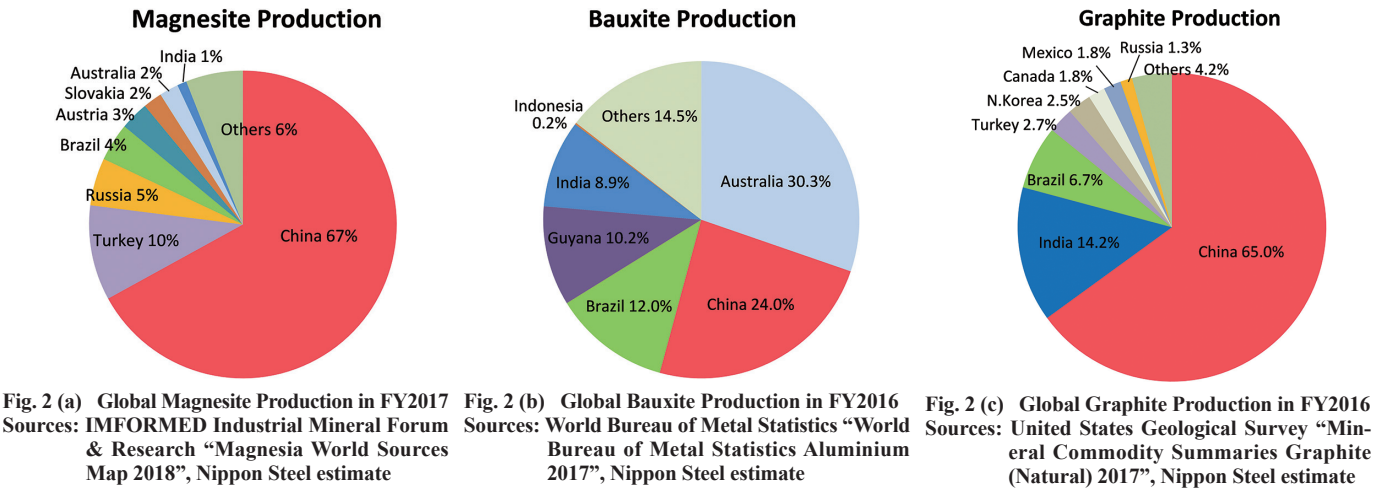


Fig. 2 (a) Global Magnesite Production in FY2017
Sources: INFORMED Industrial Mineral Forum & Research “Magnesia World Sources Map 2018”, Nippon Steel estimate

Fig. 2 (b) Global Bauxite Production in FY2016
Sources: World Bureau of Metal Statistics “World Bureau of Metal Statistics Aluminium 2017”, Nippon Steel estimate

Fig. 2 (c) Global Graphite Production in FY2016
Sources: United States Geological Survey “Mineral Commodity Summaries Graphite (Natural) 2017”, Nippon Steel estimate

stable and the prices slowly started to decrease. Since the summer of 2019, the supply has been excessive due partly to temporary deceleration of the world economy, and the price has rapidly decreased. However, the supply and demand conditions and the degree of price decrease vary between grades (the degree of supply and demand moderation and the degree of price decrease are high for low-grade products). The price decrease of rather high-grade refractory raw materials remains small.

All these large price fluctuations for the major refractory raw materials were caused by the decrease in the supply due to the environmental regulations. Although the situation has temporarily returned to normal, environmental problems in China have not been resolved and thereby the situation needs to be continuously and

carefully monitored in the future.

3. Users’ Actions for the Regulations

The previous chapter described the influence of the Chinese environmental regulations on the supply side. This chapter introduces cases in Japan where users had to take measures to satisfy Japanese regulations.

3.1 RCF regulations (regulations on specific chemical substances)

Refractory ceramic fiber (RCF) was added to Class 2 substances designated in the Ordinance on Prevention of Hazards due to Specified Chemical Substances (hereinafter referred to as the “Ordinance”) under the Japanese Industrial Safety and Health Act (enforced on November 1, 2015).

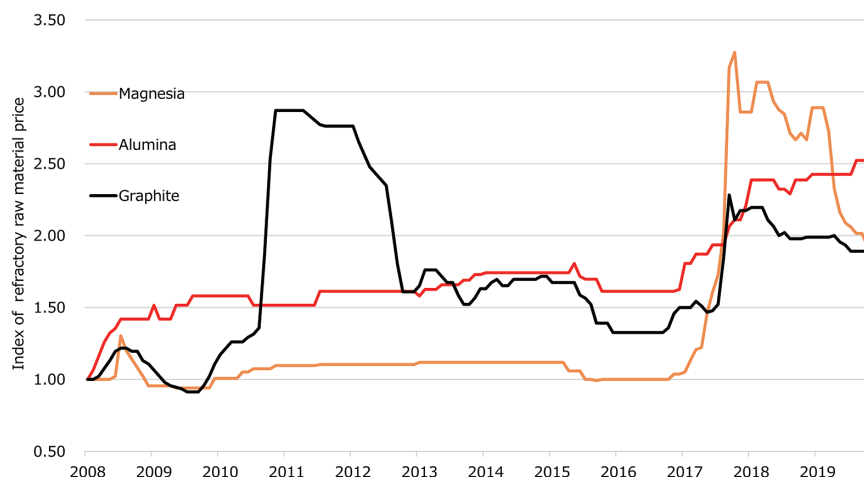


Fig. 3 Price trends of refractory raw material produced by China (modified by Nippon Steel)

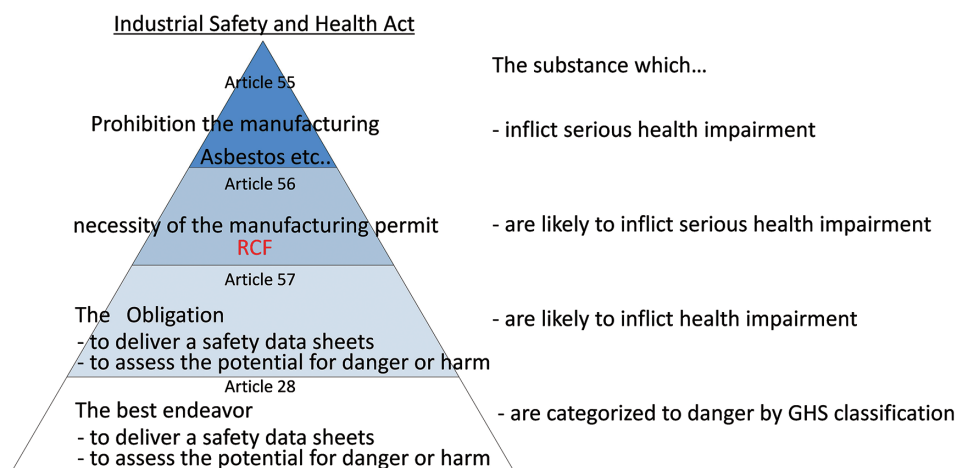


Fig. 4 System of Chemical Substances Regulations, etc. in Laws and Regulations Related to Safety and Health Act (<http://www.mhlw.go.jp/bunya/roudoukijun/anzeneisei48/dl/anzeneisei48-09-1.pdf>) (modified by Nippon Steel)

Although the production of the Group-2 substances designated in the Ordinance is not prohibited unlike asbestos, they must be properly managed during storage and use. Therefore, the revision demands that RCF be used in accordance with the handling and management instructions for the Group-2 substances specified in the Ordinance or that it be replaced with alternatives (e.g., biosoluble fiber and alumina fiber) that are not regulated.

3.1.1 Purpose of the Ordinance and target operations

The purpose of the Ordinance is to prevent workers from contracting cancers, dermatitis, neurological disorders, and other health impairments (Article 1 of the Ordinance). The target operations are manufacturing and handling of the RCF itself and pharmaceuticals and other products containing RCF. All manufacturers, processors, and users of RCF must take measures.

3.1.2 Positioning of RCF in relevant laws and regulations

Figure 4 illustrates the system of regulations on chemical substances in laws and regulations related to the Japanese Industrial Safety and Health Act.¹⁾ The regulations on chemical substances are classified into the following categories in the order of severity.

- (1) Prohibition of manufacturing (Article 55)
- (2) Necessity of permission for manufacturing (Article 56)
- (3) Management of handling and other operations in accordance

with the special regulations (Article 22)*

- (4) Self-management based on the SDS system (system to provide information on the danger and harm of chemical substances) (Article 57-2)
- (5) General measures to prevent health impairments (Article 22) and study of danger and harm (Article 28-2, nonbinding regulations)

RCF was upgraded to (3)* Management of handling and other operations in accordance with the special regulations from (4) self-management, and thereby it is more strictly regulated.

3.1.3 Details of the Ordinance and measures taken in the steel industry
The Ordinance instructs that the following measures should be taken.

- (1) Selection of workers dedicated to applicable operations
- (2) Installation of local exhaust systems
- (3) Prohibition of unauthorized entry
- (4) Measurement of the work environment and storage of the results for 30 years
- (5) Creation of operation records, storage of the records for 30 years, posting of a notice of harm, and reporting of the records
- (6) Provision of special medical examinations (once every six months) and storage of the results for 30 years

Example operations using RCF in the steel industry are the cutting and processing of RCF (iron making and steel making processes), constructing linings for equipment with RCF, and demolition (rolling, heat treating, and annealing furnaces). The industry replaced RCF with alternatives (biosoluble fiber and alumina fiber) in consideration of the service environments.

3.2 Regulations on poisonous or deleterious substances

Some materials used in the refractory sector have become regulation targets as poisonous or deleterious substances. Specific examples that have been regulated or planned to be regulated as poisonous or deleterious substances are as follows: Quick setting agents (sodium aluminate, the regulations enforced on July 1, 2018) that are external additives to refractories for repair; castables for steel ladles (sodium fluoride, may be enforced in FY2020), and resin filling materials for the underside of furnace bottom plates (2-Furanylmethanol and 2-Furaldehyde. 2-Furanylmethanol was discussed as a poisonous substance and 2-Furaldehyde was discussed as a poisonous or toxic substance in a meeting of the Pharmaceutical Affairs and Food Sanitation Council in 2018).

3.2.1 Details of the regulations on poisonous or deleterious substances and measures for them

The revised regulations were applied to substances that are likely to cause health hazards due to their acute toxicity from the viewpoint of health and sanitation (Article 1). The following actions must be taken for the applicable substances.

- (1) Measures required to prevent applicable substances from being stolen and lost and from leaking (Article 11)
- (2) Display of “Non-medical poisonous substance” or “Non-medical deleterious substance” on containers and packages, and at storages (Article 12)
- (3) Conformance to the technical standards when discarding, transporting, and storing the applicable substances (Article 15-2 and Article 16)
- (4) Notification to the authority and emergency measures when leakage or other accident occurs (Article 16-2)
- (5) Notification to the authority when an applicable substance is stolen or lost (Article 16-2)

In cases where refractories are involved, when the work at a site involving a regulated substance is completed, the substance no longer remains. Therefore, the applicable poisonous or deleterious substances must be managed when they are purchased, stored, and

used. Also these regulations are applied to the management of manufacturers’ premises. Therefore, some manufacturers have been replacing products containing the regulated substances with those that do not contain such.

3.3 Actions to satisfy the laws and regulations

Since the laws and regulations introduced in this paper aim at protecting the health and safety of workers, the number of target substances may be increased in the future considering the objectives of the laws. Therefore, it is important for refractory users to deepen the understanding of the points and objectives of the laws and management of target substances so that, when the regulations seem to be revised, they can take actions quickly without delay.

4. Future Trend

Although, due to the temporary deceleration of the world economy—China and India, in particular—the supply and demand are in a lull, they may remain firm for the long term. Therefore, to purchase materials stably, it is necessary to closely monitor the trends in the supply of and demand for good-quality refractory raw materials, price changes, and factors of such changes. In addition, more attention needs to be paid to the relevant Japanese laws and regulations.

5. Conclusions

Regarding the conditions for purchasing refractories, in addition to the conventional factors of variations in the supply and demand balance, uncertain factors originated in environmental measures and measures to protect the safety and health of workers, as shown in the cases introduced in this paper, cannot be overlooked. In the purchase of refractories in the future, information needs to be collected from wider sources and it is important for refractory users to work to improve the use technologies so that they can flexibly cope with unstable supply that may suddenly eventuate.

Reference

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