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Development trends of environmental protection technologies for Chinese steel industry

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ABSTRACT

Chinese steel industry has made significant progress on reducing fresh water consumption and CO_2/SO_2/COD (chemical oxygen demand)/dust emissions, and improving comprehensive utilization of solid waste. Some steel companies have become topped worldwide. However, due to the large output quantity of crude steel, the whole steel industry is still a huge source of pollutants. At present, environmental protection standards are encountering challenges of lack of technical support, taxation policy and other issues. Steel industry is currently facing enormous environmental pressure. The development trends of environmental protection technologies were studied by summarizing different development stages. To realize the development targets, the industry needs to carry out its research with independent intellectual property rights, develop comprehensive management systems and establish ecological chain with other industries. This can not only raise the level of environmental protection in a broader range, but also improve the energy efficiency of iron and steel plants and increase added value of waste utilization. Finally, 23 environmental protection technologies were proposed and 4 new environmental protection practices were studied.

1. Introduction

Recently, due to serious haze weather emerging in many regions of China, it is urgently required to improve air quality and reduce industrial emissions from typical industries. A series of policies and measures have been issued by the government to guide industry transformation to realize green development especially for steel industry.

In general, the steel industry refers to coking, pelletizing, sintering, ironmaking by blast furnace and direct reduction, hot metal pretreatment, steelmaking by converters and electric arc furnaces, secondary refining, continuous casting, hot rolling, cold rolling, deep processing and relevant supporting systems, excluding ferroalloy and refractory products.

The meaning of environmental protection technologies for steel industry is the various technologies of emission management and control in every process mentioned above[1,2].

2. Current Status and Future Targets of Environmental Protection for Chinese Steel Industry

2.1. Environmental status of Chinese steel industry

At present, the Chinese steel industry has made remarkable achievements in reducing fresh water consumption and CO_2, SO_2, COD (chemical oxygen demand) and dust emissions per ton of steel, and improving comprehensive utilization of solid waste. Some steel plants have achieved the world advanced level. However, due to the increase in crude steel output (Fig. 1[3]), the total discharge of pollutants in the steel industry is still huge, and the environmental pressure on steel industry is enormous.

(1) CO_2 emissions

Compared with 2000, the direct emissions of CO_2 per ton of steel in 2012 fell by 39%; however, the crude steel output increased by 4.7 times. Thus, the total amount of CO_2 emission was increased by 2.4 times[1,4].

In "the implementation of the Bali route chart—

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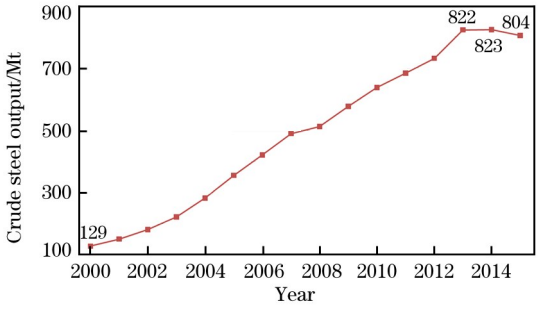

Fig. 1. Change of crude steel output in China during 2000－2015.

Chinese government on the Copenhagen climate change conference position" (May 2009), the Chinese government announced that the CO_2 emissions per unit of GDP (gross domestic product) in 2020 will be decreased by 40% to 45% compared with that in 2005[5]. In June 2015, the official document was submitted to the IPCC (Intergovernmental Panel on Climate Change) by Chinese government[6]. On March 17th, 2016, the Chinese government announced that the CO_2 emissions per unit of GDP will be decreased by 18% at the end of the "13th Five-Year Plan"[7].

During 2013－2015, China carried out CO_2 emissions trading pilots in 7 provinces (cities), and 42 provinces (cities) carried out low-carbon pilot region to explore new models of low-carbon development in line with Chinese national conditions. China planned to complete the legislation and administrative regulations to establish carbon market in 2016, and to carry out the quota allocation and start the national carbon market in 2017. Even that, for the Chinese steel plants, the pressure of CO_2 emissions reduction is still high.

(2) Fresh water consumption

The fresh water consumption per ton of steel during 2000－2015 in Chinese key steel plants are shown in Fig. 2[1,8,9].

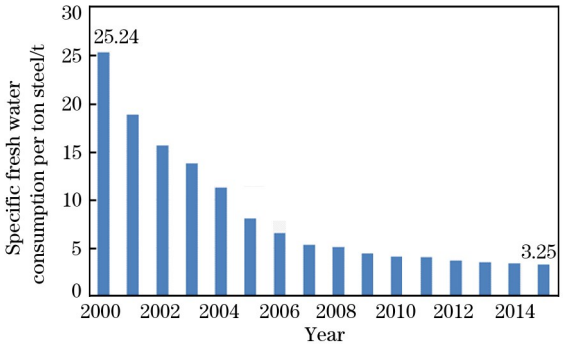

Fig. 2. Fresh water consumption in key steel plants during 2000－2015.

In this period, fresh water consumption per ton of steel in Chinese key steel plants made significant progress, which dropped from 25.24 t in 2000 to 3.25 t in 2015, with a reduction of about 87%.

(3) Pollutant emissions

The dust, SO_2, and COD emissions per ton of steel in Chinese key steel plants decreased sharply. The dust emissions per ton of steel dropped from 6773 g in 2000 to 711 g in 2015; SO_2 emissions per ton of steel dropped from 5563 to 744 g; COD emissions per ton of steel dropped from 985 to 22 g, with the decline of 89.5%, 86.6% and 97.8% respectively[1,8,9], which showed a great progress during the past 16 years.

In 2012, the generation and recycling rate of solid waste in Chinese key steel plants are shown in Table 1[10]. The comprehensive utilization ratio was 97.01% for blast furnace slag, 96.62% for steel slag, 97.37% for dust, and 96.81% for rolling mill scale. The utilization ratios of the solid wastes were quite high.

Table 1
Output and utilization of solid wastes in key steel plants in 2012

Solid waste	Output/Mt	Comprehensive utilization amount/Mt	Comprehensive utilization ratio/%	Utilization method
Blast furnace slag	164.61	160.06	97.01	Concrete aggregate, cement, etc.
Steel slag	62.28	60.65	96.62	Recovery of metallic iron, building and road materials, slag cement, concrete aggregates, etc.
Dust	38.87	37.76	97.37	Back to sintering, recovery of iron, zinc, carbon and other valuable elements, etc.
Rolling mill scale	5.69	5.50	96.81	Back to sintering, steelmaking as powder metallurgy materials, etc.

2.2. Challenges for environmental protection of Chinese steel industry

2.2.1. More stringent environmental standards

In 2012, the latest emission standards for steel industry were promulgated by the Ministry of Environmental Protection of China (Table 2).

Taken the pollutant emission standard for sintering flue gas as an example, the comparison in China and abroad are shown in Table 3. Some indexes in Chinese standards are stricter than those in foreign ones.