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Development Trends of Energy Saving Technologies in Chinese Steel Industry

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Development Trends of Energy Saving Technologies in Chinese Steel Industry

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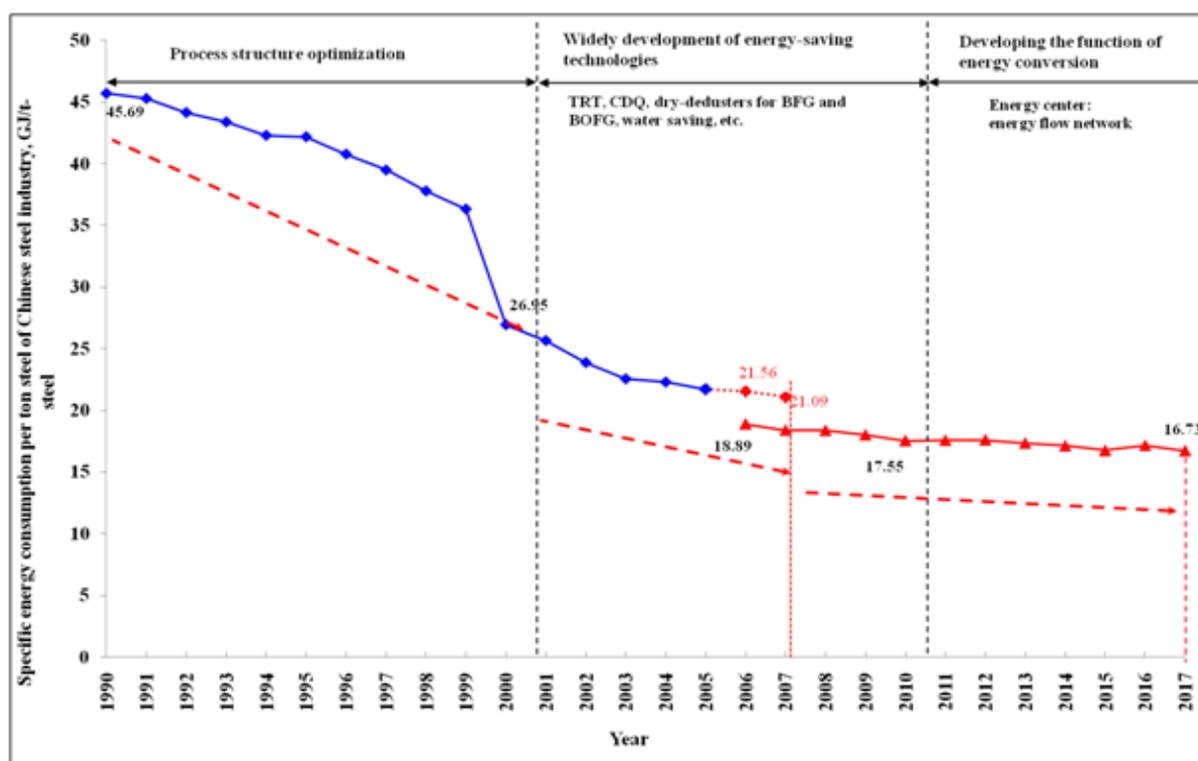
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Abstract. Since the 21st century, the energy consumption per ton steel of Chinese key steel plants was reduced from 26.95GJ/t-s in 2000 to 16.73GJ/t-s in 2017 by technical progress, such as coke dry quenching (CDQ), dry de-dusting of blast furnace gas (BFG) and converter gas (BOFG). In the future, developing interface technologies and building an industrial ecological chain connecting related industrial sectors and the society would be the development trends of energy saving technologies in Chinese steel industry.

1. Status of Energy Saving in Chinese Steel Industry

The energy consumption of the Chinese steel industry shares about 11%~13% of total energy consumption in China at present [1, 2]. The Chinese steel industry has made great achievements in energy saving in the past 30 years. Process structure optimization by six key & common-shared technologies - continuous casting (CC), pulverized coal injection (PCI), blast furnace (BF) campaign elongation, continuous rolling, energy conservation and BOF slag splashing technology - has played an important role since 1990s [3,4]. The energy consumption per ton steel decreased year by year, especially in Chinese key steel plants. Their energy consumption significantly decreased from 26.95GJ/t-s in 2000 to 16.73GJ/t-s in 2017 (Figure 1)[2,5].





(Note: Data after 2000 are from members of CISA. Electricity conversion factor was 11.8 MJ/kWh from 1990 to 2005, and 3.6 MJ/kWh from 2006 to 2017)

Figure 1. Energy consumption of the Chinese steel industry from 1990 to 2017

2. Achievement and Measures for Primary Energy Saving Technologies

2.1. Coke Dry Quenching (CDQ)

The coke capacity of the CDQ in China was about 138 Mt/a in 2015. The CDQ penetration was increased from 12% in 2000 to 90% in 2015 (Figure 2). Especially since 2010, 57 sets of new CDQ equipment have been constructed in China. 30% of them were built with high pressure and high temperature boilers. The average specific electricity generation from the CDQ was about 125kWh/t-coke and the total electricity generated from the CDQ was about 16.3 billion kWh/a in 2015. In the future, attention will be paid to the CDQ with high pressure boiler for improving the energy saving effects and enhancing the quality and quantity of recovered steam from the CDQ.

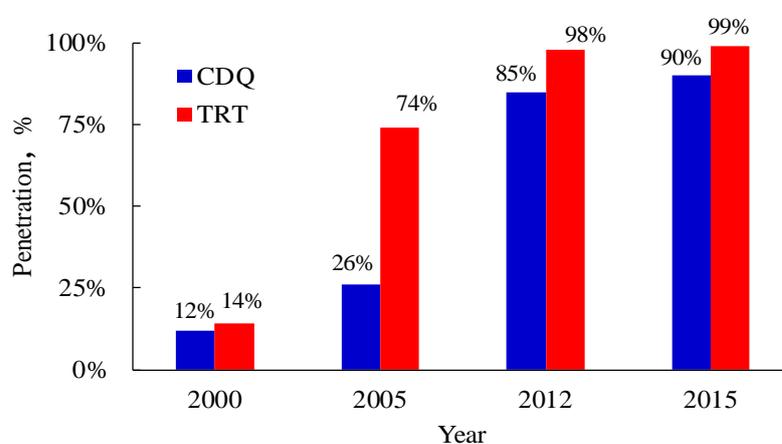


Figure 2. Penetration of the CDQ and TRT in the Chinese steel industry from 2000 to 2015

2.2. Top-pressure Recovery Turbine (TRT)

By the end of 2015, all the blast furnaces over 2000 m³ and 99% of the ones over 1000 m³ in China were equipped with TRT (Figure 2). Now the electric power capacity of TRT varies from 6 MW to 37 MW for the blast furnaces from 1000 m³ to 5576 m³. In 2015, the electricity generation from the TRT was about 1.8 billion kWh/a. However, there is considerable gaps of the effectiveness and efficiency of TRTs among different steel plants. So the integration of TRT operation and BF production should be further improved.

2.3. Dry Type De-dusting System for BFG and BOFG

Up to now, the dry de-dusting technology of BFG has been applied to both small and large blast furnaces. The furnaces has been operated stably for several years since they were furnished with the dry type de-dust system. This system shows many advantages over the wet one, such as higher de-dusting efficiency, easier processing of dust, less resistance loss, less electricity consumption, higher BOFG recovery efficiency, and smaller floor space[2,6]. The dry de-dusting for BFG and BOFG are considered as the key technologies to be further developed in steel industry

3. Technologies Developed in the Future

3.1. Interface Technologies

“One Ladle Technology” is being used in Shougang Jingtang steel plant (Figure 3), with all-time capped operation, to reduce the number of online cycling iron ladles, and eliminate re-ladling station.[7,8] This implementation reduces the plant area by 1150m², investment by 41.58 million RMB, 108 labors, soot emission by about 4.7 thousand t/a, power consumption by about 3.87 million tce/a, and the loss of molten iron temperature by 7.7 to 12.9 thousand tce/a.[9]

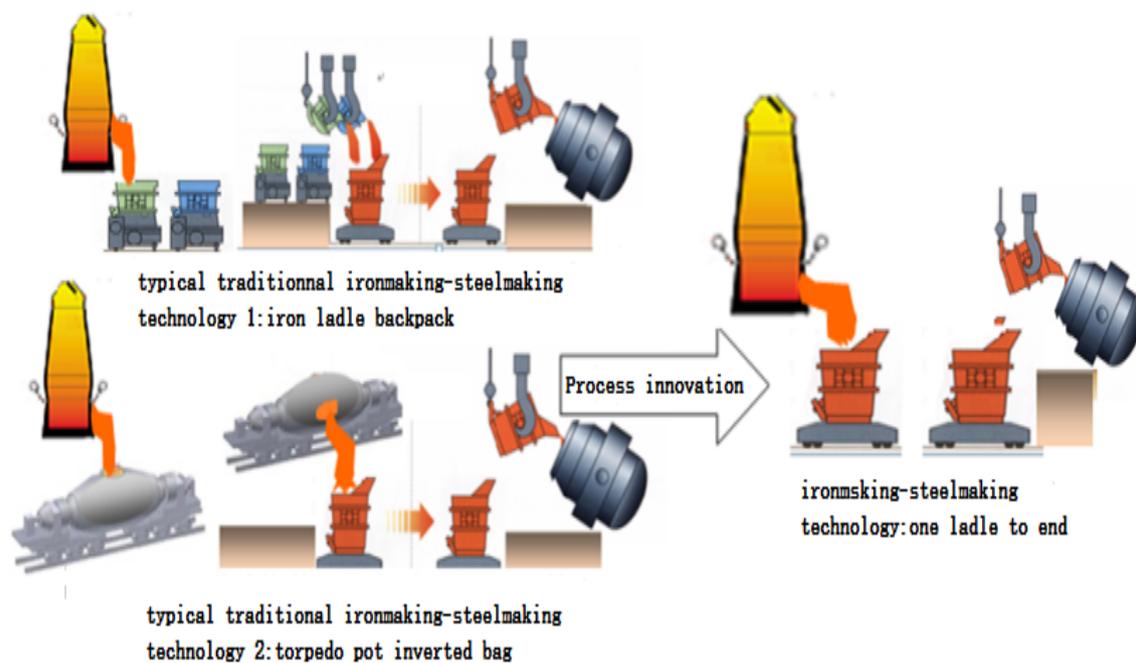


Figure 3. “One Ladle Technology” in Shougang Jingtang steel plant

3.2. Building the Industrial Ecological Chain

Considering the history of energy saving in the Chinese steel industry, the potential for improving energy efficiency is very limited given only relying on the steel plants. As a process manufacturing

industry, steel industry has the characteristics of being large scale, resource-intensive and energy-intensive. To build an ecological link between different industries and the society and achieve synergistic energy utilization would be an effective way to improve the energy efficiency of the whole society. For instance, the steel industry could build industry ecological links with related industry sectors, such as power sector, petrochemical sector, chemical sector, building materials sector, nonferrous metal sector and other industry sectors to make full use of energy. A new generation steel plant with characteristics of "three functions" and dynamic-orderly operation has been put into operation in Shougang Jingtang Steel at Caofeidian of Hebei Province, which has become a typical model for the demonstration of circular economy [10,11].

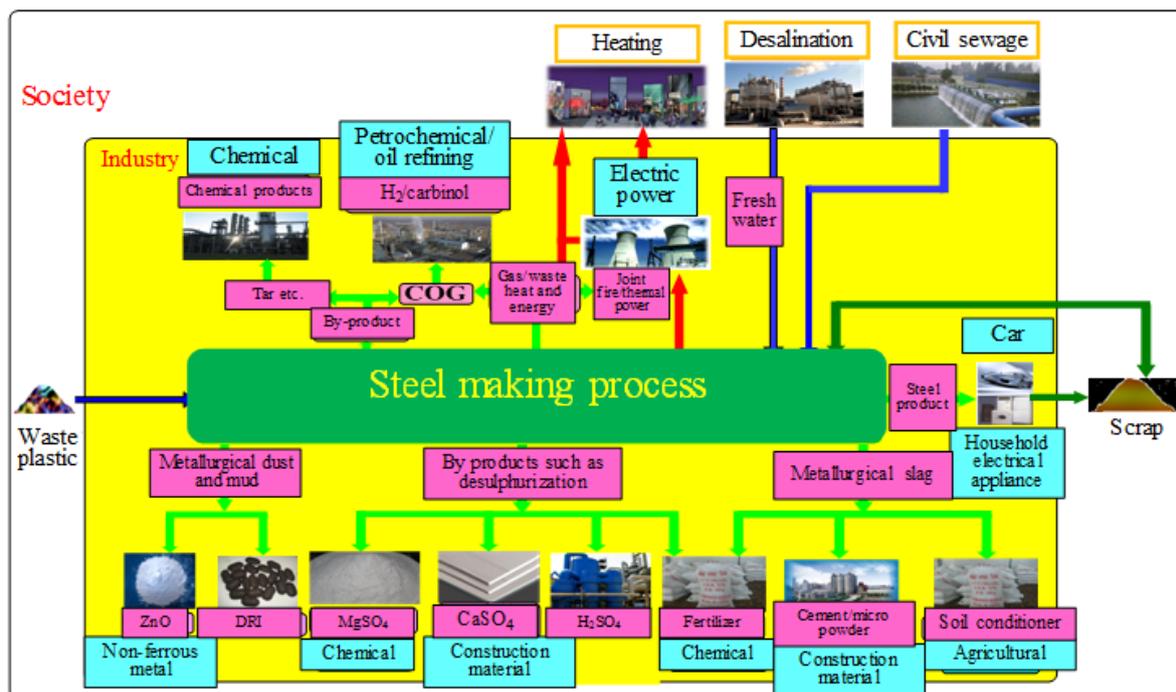


Figure 4. Eco-industrial chain based on steel making process

4. Future Developing Trends

The energy saving efficiency of the Chinese steel industry is remarkable. Many techniques of energy saving have been used and popularized, such as CDQ, TRT, dry de-dusting technology for BFG and BOFG. In the future, technologies for saving energy consumption will be further developed. Interface technologies and industrial ecological chain connecting related industrial sectors and the society would be the development trends of energy saving technologies in Chinese steel industry.

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