Analysis on Energy Conservation and Emission Reduction for Non-ferrous Metals Industry

Chunyan Cheng and Wenjia Yu

Abstract The non-ferrous metals industry is a major energy consumer and carbon emission player in China. By systematically analyzing the result of energy conservation and emission reduction in non-ferrous metals industry of China, and by looking into the development trend of the industry, this paper proposes that we enhance the energy conservation and emission reduction in the future through expanding the import of raw material, enhancing the recycling level of resources, promoting the advanced technology and so on.

Keywords Energy conservation • Emission reduction • Energy consumption • Carbon emission • Sulfur dioxide

The non-ferrous metals industry of China began to boom when the new century has come, and the industry scale jumped to the first in the world in 2010 [1]. The annual output of ten kinds of non-ferrous metals was 31.21 million tons in 2010, and the apparent consumption was 34.3 million tons, increased by 13.7 and 15.5% respectively during Eleventh Five-Year Plan; enterprises of scale and above accomplished 3,300 billion yuan sales revenue, and 219.3 billion yuan profit, increased by 29.8 and 28.1% respectively during Eleventh Five-Year Plan. With the expansion of non-ferrous metals industry, the energy consumption and waste emission also increased. In 2010, coal consumption in the whole industry reached 90.98 million tons of standard coal, the emission of carbon dioxide reached 470 million tons and emission

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of sulfur dioxide reached 0.92 million tons, accounting for 2.8, 5.2 and 4.2% of the domestic overall amount respectively, which indicates that the issues of high energy consumption and pollution have become the bottleneck restraining the development of non-ferrous metals industry.

In recent years, the government successively launched a number of policies and measures to strengthen the energy conservation and emission reduction in non-ferrous metals industry. Then what is the effect of these measures in the past 10 years? What are the existing problems? How will the non-ferrous metals industry develop in the next 10 years? How much is the potential of energy conservation and emission reduction? What are the key points? The research and answers to those questions are significant for the sustainable development of Chinese non-ferrous metals industry.[1]

1 Gradual Increasing of the Industry Energy Efficiency, Continuous Decreasing of the Production Energy Consumption

1.1 Gradual Decreases of Consumption Intensity, Gradual Increases of Energy Efficiency

In recent years, the boom of Chinese non-ferrous metals industry relied largely on the extensive pattern of development of increasing investment in fixed assets and expanding the industry scale. Although by promoting advanced technology and clean production, the energy consumption of unit product show decline trend, the energy consumption and waste emission rise inevitably due to the excessively growing of production [1]. In 2010, the coal consumption of the whole industry reached 90.98 million tons of standard coal, increased by 1.4 times as that in 2001, wherein the energy consumption in copper, aluminum, and lead-zinc sectors account for 6, 66 and 11% (Fig. 1); the average annual growing speed of energy consumption in 2000–2010

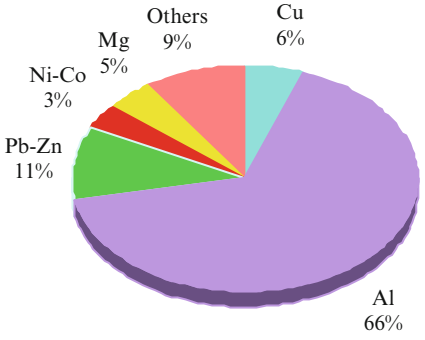

Fig. 1 Energy consumption proportion of major products in 2010 (Data Source: China Nonferrous Metals Industry Association)

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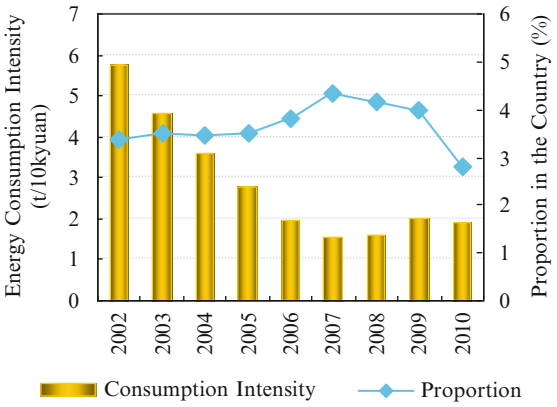


Fig. 2 Variations of intensity and proportion in the country of energy consumption during 2002–2010 (Data Source: China Statistical Yearbook, Yearbook of Nonferrous Metals Industry of China)

reached 10%, while the consumption proportion in all the country declined from 3.4 to 2.8%. Though the total amount of energy consumption of non-ferrous metals industry shows up-trend, the energy consumption intensity decreases gradually, from 5.74 to 1.88 t of standard coal/10,000 yuan during 2002–2010, with the decreasing amplitude of 67 and 13% annually on average (Fig. 2). The drop of consumption intensity indicates that the energy utilization efficiency of non-ferrous metals industry keeps rising, and unit energy consumption can generate more industrial added value. The industrial added value in non-ferrous metals industry grew by over eight times during 2002–2010.

1.2 The Energy Consumption of Unit Product Keeps Dropping

From 2000 to 2010, the comprehensive energy consumptions in smelting copper, aluminum oxide, lead and zinc are 360, 632, 454 and 947 kg/t respectively, the decreasing amplitude reached 72, 48, 37 and 59% respectively; direct current consumption of primary aluminum went down from 14,214 to 13,084 kWh/t, or by 8% (Fig. 3). Generally speaking, the non-ferrous metals industry has achieved preliminary effect in energy conservation since the new century, through heightening the technology and equipment level, adjusting the industry structure and other measures.

2 Gradual Increasing of Carbon Emission, Gradual Decreasing of Emission Intensity

In 2010, the nonferrous metals industry of China consumed electric power of 326.3 billion kWh, coal of 73.13 million tons, natural gas of 2.38 billion cubic meters, coke of 5.539 million tons. According to the IPPC CO_2 emission factor of electricity, coal, petroleum, natural gas and so on, the total emission amount of CO_2 caused by energy consumption is about 470 million tons in the nonferrous metals industry in 2010,

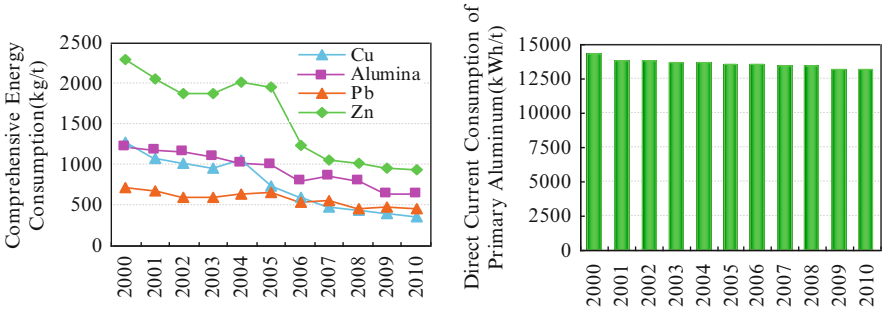
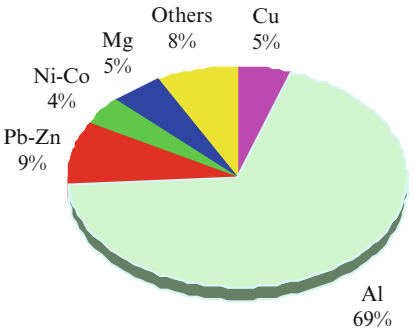


Fig. 3 Comprehensive energy consumption of the major products in nonferrous metals industry in 2000–2010 (Data Source: Yearbook of Nonferrous Metals Industry of China)

Fig. 4 Ratio of carbon emission in mining, dressing and smelting of major products (Data Source: Yearbook of Nonferrous Metals Industry of China, IPCC)



wherein the CO_2 emission of electricity and coal reached 94.9%. In 2010, the CO_2 emission of non-ferrous metals industry is mainly from the mining, dressing and smelting of aluminum, copper, lead-zinc and magnesium, accounting for 85% of the total CO_2 emission of non-ferrous metals industry, wherein, the CO_2 emission from the mining, dressing and smelting of aluminum, copper, lead-zinc accounts for 69, 5 and 9% respectively (Fig. 4). The CO_2 emission from the dressing and smelting of aluminum accounts for nearly two-thirds of the total industry, so it's the key field of energy conservation and emission reduction in non-ferrous metals industry.

The total CO_2 emissions of nonferrous metals industry kept rising in 2002–2010, from 1.2 to 4.7 $\times$ 10^8 t, increased by 3.1 times; whereas the emission intensity showed an inverse trend, and dropped from 17 t/10,000 yuan in 2002 to 7.3 t/10,000 yuan in 2010, or dropped by 57.4% (Fig. 5). The nonferrous metals industry has achieved remarkable results in dealing CO_2 emission.

3 Obvious Effect of Treatment of Sulfur Dioxide Pollution

At present the SO_2 emission of China ranks the first place of the world [2], and the industrial SO_2 emission accounts for 78% of the total emission of the country, including 4.2% from the nonferrous metals industry. The SO_2 emission of

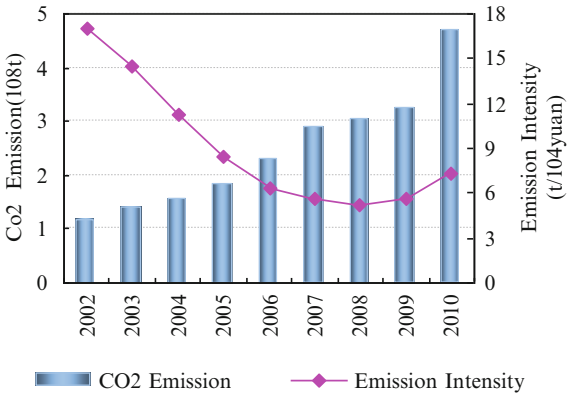


Fig. 5 Emission intensity of CO2 in 2002–2010 (Data Source: Yearbook of Nonferrous Metals Industry of China, China Statistical Yearbook)

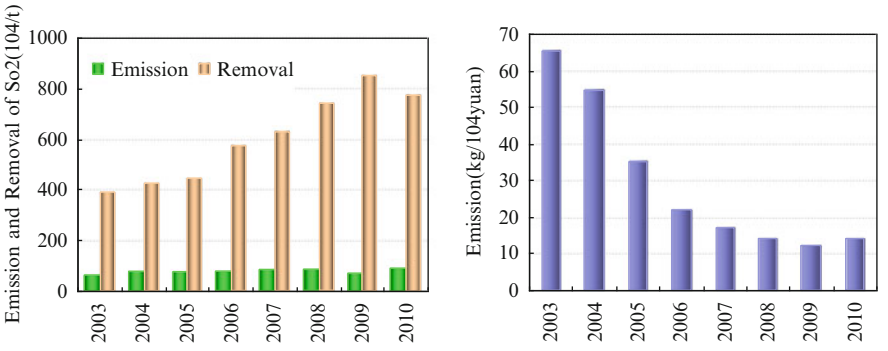


Fig. 6 The variation of SO_2 emission, removal and emission intensity during 2003–2010 (Data Source: Yearbook of Nonferrous Metals Industry of China, IPCC)

nonferrous metals industry comes mainly from combustion of sulfur-bearing fossil energy, especially the grizzle [3]. From 2003 to 2010, the SO_2 emission of the nonferrous metals industry rose from 630,000 to 920,000 t, or by 45%; the SO_2 emission share in the whole country increased from 2.9 to 4.2%; the SO_2 removal rose from 3.91 to 7.69 million tons, or nearly doubled; the emission intensity showed downtrend, during 2003–2010, SO_2 emission of unit GDP in non-ferrous metals industry declined from 65.3 to 14.2 kg, by 78.3%. The change of SO_2 removal and emission intensity indicates that SO_2 pollution treatment has gained obvious effect (Fig. 6).

4 Key Points of Energy Conservation and Emission Reduction for Chinese Non-ferrous Metals Industry

According to the prediction of Research Center for Global Mineral Resources Strategies, Chinese Academy of Geological Sciences, in 2020, the demand for copper and aluminum in China will reach 12.99 and 28 million tons respectively,

increasing by 75 and 77% of that of 2010 respectively; it is predicted that by then, domestic production of refined copper and primary aluminum will increase to 7.4 million tons and 23 million respectively, by 63 and 42% of that in 2010. In the next 10 years, the sustainable development of the nonferrous metals industry will certainly result in the continuous growing of energy demand, so the situation of energy conservation and emission reduction will be more severe. From the view of sustainable development of the industry, the key points of energy conservation and emission reduction lie in the following aspects:

Firstly, strictly restrain the blind expansion of domestic industries of high energy consumption, and enlarge the import scale of products such as primary aluminum.

In recent years, large amount of capitals has rushed in and lead to the rapid expansion of smelting industry, especially the blind expansion and repeated construction of primary aluminum and aluminum oxide capacity. Up to 2010, the capacity of aluminum oxide and primary aluminum had reached 43.9 and 23 million tons respectively, with idle capacity of 34 and 29% respectively. Currently, exactly according to the national standard, prebaked aluminum electrolysis tank under 100 kA and lagging recycled aluminum capacity should be removed, with the new projects in the industry of high energy consumption strictly restrained. At the same time, changes should be adopted to the situation of importing great amount of bauxite and aluminum oxide while enlarging the import of primary aluminum. Thus, the energy consumption and waste emission in the non-ferrous metals industry can be effectively controlled.

Secondly, improve the resource recycling level and promote the energy conservation and emission reduction.

Compared to primary aluminum, the secondary aluminum per ton can save energy of 3.4 t of standard coal, water 22 m^3, and reduce solid waste by 20 t. Improving the using of secondary resource can relieve pressure of supplying as well as decrease energy consumption and pollution.

Thirdly, advance the technical progress, raise the technological equipment level, improve the energy efficiency, and reduce the energy consumption of unit products.

It is revealed by China Nonferrous Metals Industry Association that, in the technology innovation of aluminum electrolysis, developed by China, Special shaped tank technology with new cathode structure for aluminum electrolysis, Diversion tank technology with new structure for aluminum electrolysis, and Optimization and control technology of intelligent polycyclic synergy in aluminum electrolysis with efficient energy conservation which can largely increase the anodic current density as well as obviously decrease the tank voltage, have gained great breakthrough. The direct current consumption of aluminum per ton is between 12,043 and 12,400 kWh, with the saved electricity over 1,000 kWh compared to 2010. China ENFI and other institutes have also achieved key breakthrough in the technology of copper smelting with oxygen bottom blowing. It's indicated by the operation that, energy consumption of copper per ton decreased to 320 kg standard coal (including anode copper), and 131 kg standard coal less than that of foreign technology. Henan Yuguang Gold and Lead Co., Ltd has developed the technology

of lead smelting in direct reduction method with high-lead-bearing liquid slag bottom blowing furnace. It has realized the continuity of lead smelting, and decreased the comprehensive energy consumption of lead bullion to below 300 kg standard coal, with energy saved over 30%. New progress has also been achieved in the technology application of zinc smelting in direct leaching method with atmospheric/pressurized enriched oxygen which effectively decreased the energy consumption of zinc smelting [4]. The popularization and application promotion of those technologies will largely reduce the energy consumption of unit product for companies in the non-ferrous metals industry, and thus reduces the pollutant emission of CO_2 and SO_2.

5 Conclusions

Based on the analysis of the energy conservation and emission reduction history in the past 10 years and the key points and solutions for the future non-ferrous metals industry, we can draw the following conclusions:

1. In the past 10 years, the industry energy efficiency improved gradually, and production energy consumption dropped constantly. The energy consumption intensity reduced by 67%, unit consumption of copper and aluminum oxide decreased by 72 and 48% respectively, and direct current consumption of primary aluminum declined by 8%.
2. The total carbon emission rose, while the emission intensity declined continuously. During 2002–2010, CO_2 emission caused by energy consumption increased by 3.1 times in the non-ferrous metals industry, while the emission intensity declined by 57%.
3. The treatment of SO_2 pollution achieved obvious effect. During 2003–2010, the SO_2 emission grew by 45%, the removal increased by 100%, and the emission intensity dropped by 78.3%.
4. Strictly Control should be exercised over the blind expansion of high energy consumption industries of aluminum, primary aluminum and so on, while enlarging the import scale of primary aluminum and increasing the utilization rate of secondary resource to promote energy conservation and emission reduction. In addition, developing domestic independent research and bringing in international technology to reduce the energy consumption of unit product, and remove the lagging technology step by step, improve the energy efficiency, decrease the pollutant emission, and thus promote the sustainable development of the non-ferrous metals industry.

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