Current Situation and Future Development Direction of Water Utilization in Chinese Steel Industry

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Abstract. Considering the serious shortage of water in China, there are two main problems of water utilization in steel plants. One is to save fresh water consumption, and the other is to reduce the waste water discharge. In 2012, the fresh water consumption and the waste water discharge of Chinese key steel plants accounted for 1.2% and 2.4% of the industry sectors. The discharge standard of water pollutants for steel plants in China is more and more rigorous. Since the new century, the specific fresh water consumption per ton steel of Chinese key steel plants was reduced from 25.24t in 2000 to 3.25t in 2015 by technical progress, such as coke dry quenching (CDQ), dry de-dusting of blast furnace gas (BFG) and converter gas (BOFG), etc. Technologies for saving fresh water and reducing waste water discharge will be developed in the future. Seawater desalination technique will be developed in the eco-industrial port zones of steel plants to reduce the ground water extraction. Civil sewage will be processed and used in the suburban steel plants. These two demonstration projects have been built in Shougang Jingtang steel plant and Tangshan steel plant respectively.

Introduction

In an integrated steel plant, water is used for direct and indirect cooling, gas cleaning, scale breaking, and washing operations. China is short of water seriously. Since water resources are not rich in China, water saving in steel industry has been on the important agenda of energy saving and emission reduction since the new century. More attentions have been paid to water recycle and treatment technologies.

Status of water utilization in Chinese steel industry

The Chinese steel industry has made great achievements in water saving. The fresh water consumption per ton steel decreased year by year, especially in Chinese key steel plants. Their fresh water consumption significantly decreased from 25.24t/t in 2000 to 3.25 t/t in 2015 (Figure 1) [1-3], with a reduction of about 87%.

Figure 1. Fresh water consumption in Chinese key steel plants from 2000 to 2015.
The main problems of water utilization in the steel plants are to save the fresh water consumption and to reduce the waste water discharge. In 2012, the fresh water consumption and the waste water discharge of Chinese key steel plants accounted for 1.2% and 2.4% of the industry sectors (Figure 2).

![Figure 2. Ratio of fresh water consumption and waste water discharge of Chinese key steel plants in 2012.](image)

The Technical Progress of Water Utilization

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 3). Especially since 2010, 57 sets of new CDQ equipment have been under construction in China and 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 total, about 57 million tons of water was saved in 2015 due to CDQ.

![Figure 3. Penetration of the CDQ and TRT in the Chinese steel industry from 2000 to 2015.](image)

Dry de-dusting Systems for BFG and BOFG

Up to now, the dry de-dusting technology of BFG has been applied to both small and large blast furnaces. It has been operated stably over several years. Up to 2010, there were more than 90 BOFs equipped with dry de-dusting systems for BOFG in China. The dry de-dusting system shows many advantages over the wet type, such as higher de-dusting efficiency, easier processing of dust, less resistance loss, and less electricity consumption[4]. The dry de-dusting for BFG and BOFG has been considered as the key technologies to be further promoted in steel industry (Table 1).
Table 1. Dry type de-dusting technology for BFG and BOFG.

<table>
<thead>
<tr>
<th>Dry de-dusting technology</th>
<th>For BF</th>
<th>For BOF</th>
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</thead>
<tbody>
<tr>
<td>Water saving</td>
<td>Almost 100%</td>
<td>80% of wet type de-dusting</td>
</tr>
<tr>
<td>Energy saving</td>
<td>Increase 25-30% of power generating capacity by TRT</td>
<td>Increase BOFG recovery volume by 21m³</td>
</tr>
<tr>
<td>Reduce power consumption</td>
<td>Almost 100%</td>
<td>1/2 of wet-type de-dusting</td>
</tr>
<tr>
<td>Dust emission</td>
<td>&lt; 5 mg/m³</td>
<td>&lt; 10 mg/m³</td>
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**Technologies Developed in the Future**

In the future, there are two kinds of steel plant in circular economy society, i.e. suburban steel plants and steel plants in eco-industrial port zones. In suburban steel plants, scrap, waste plastic, garbage, civil sewage and other urban wastes would be recycled conveniently and effectively. The development of large integrated steel plants at harbors will gradually turn some harbor cities with other basic conditions into eco-industrial zones. Eco-industrial chain based on a new-generation steel plant would be built in the eco-industrial port zones.

**Suburban Steel Plants**

In terms of water quantity, quality and economy, it is feasible to introduce urban sewage into iron and steel plants, which can not only alleviate the water consumption pressure of iron and steel plants, but also greatly release the pressure of domestic water supply in urban areas. The treatment of industrial waste water and civil sewage has developed well in Chinese steel industry, and related projects have been implemented in many steel plants in recent years (Table 2)[1].

Table 2. Capacity of civil sewage water utilization and treatment of several steel plants.

<table>
<thead>
<tr>
<th>Plant</th>
<th>Treatment capability, kt/d</th>
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<tbody>
<tr>
<td>Tangshan steel</td>
<td>36</td>
</tr>
<tr>
<td>Tisco</td>
<td>24</td>
</tr>
<tr>
<td>Jinan steel</td>
<td>7</td>
</tr>
<tr>
<td>Ningbo steel</td>
<td>39</td>
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Tangshan steel plant has made up a good example to reduce the fresh water consumption. Two water treatment systems were set up in Tangshan steel plant in 2009 (Figure 4). One was for treatment of civil sewage and industrial waste water, and the total treatment capacity was up to 6000 t/h by adopting advanced patented technologies. The other one was deep-treatment for producing high-quality soft water and desalted water with the supply rate of 1000 t/h and 300 t/h, respectively.

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**Figure 4. Recycling of water and treatment of waste water in Tangshan steel plant.**
The fresh water consumption was reduced from 10.4 t/t-s in 2000 to 3.2 t/t-s in 2013. The water recycle rate was increased to 98.1% in 2013 (Figure 5). Especially, fresh water supplied from deep wells and rivers are no longer used in the south area of Tangshan steel plant [5].

![Figure 5. Fresh water consumption per ton steel and water recycle rate in Tangshan steel plant.](image)

Steel Plants in Eco-Industrial Port Zones

The four sets of 12.5 kt/d seawater desalination equipment were built and distilled water was produced in Shougang Jingtang steel plant. The low quality waste heat was effectively used to carry out thermal desalination and reduce industrial water consumption, which greatly reduced the operation cost of seawater desalination (Figure 6) [6].

![Figure 6. Flowchart of seawater comprehensive utilization in Shougang Jingtang steel plant.](image)

The step utilization of energy was realized. The heat utilization rate could reach 82.2%, saving 18 million tons of fresh water, which accounts for about 50% water consumption of the steel plants. The redundant heat with low temperature was used for seawater desalination. The seawater can evaporate between 40-70 °C under the vacuum condition. 24 Mt/a surface water were saved, which is about 33% water consumption of a steel plant with a yield of 9.8 Mt/a steel. Desalinated water were used instead of softened water, reducing industrial salt about 816 t/m. “Zero emissions” of the gas, vapor and waste water was realized [6,7].

Conclusions

The water saving efficiency of the Chinese steel industry is remarkable. Many techniques of water saving have been used and popularized, such as CDQ, dry de-dusting technology for BFG and BOFG, etc. In the future, technologies for saving the fresh water consumption and reducing the waste water discharge will be developed. Seawater desalination technique will be developed in the steel plants in eco-industrial port zones to reduce the surface water extraction. Civil sewage will be processed and used in the suburban steel plants.
References


