Application of Energy Efficiency Optimization Technology in Steel Industry

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Abstract: It's systematically analyzed that energy efficiency optimization technology has been applied in the field of steel industry. The fundamental principal of energy optimization technology is reasonably matching the quality and price of energy as well as energy-dominated systematic energy efficiency management system. Specific measures of energy optimization have been put forward, which include taking high efficiency utilized technology such as energy saving from the original, the production process and recycling of waste heat and waste energy etc., integrating and configuring energy in an optimized way of high efficiency and excellent quality, fully realizing the function of different energy in order to optimize the utilization sequence of energy, and improving the energy medium system by themselves. Finally it is clearly pointed out that the steel industry should pay more consideration about the great deal of energy system which they have used now and an ideal energy evaluation methodology and standard should be built as soon as possible if they want to take full usage of the real role and function of energy in all aspects.

Key words: energy efficiency optimization; energy quality; energy value; steel industry

As energy price rising continuously caused by increasing shortage of global energy resources, it has become an important strategy to optimize energy efficiency of process and equipment and utilize the energy effectively as much as possible for the sustainable development of steel industry (including waste heat and energy produced during manufacturing process), which can not only reduce the cost of production, but also play an important role in the society in the field of energy conservation and emission reduction.

Energy efficiency monitoring and optimization technology (energy efficiency optimization), on the basis of monitoring and analyzing energy consumption and energy efficiency throughout whole process, refers to evaluating energy efficiency among various processes, process interfaces, main units and equipment scientifically. Then systematic resolutions are put forward for energy efficiency optimization for the purpose of energy efficiency improvement, energy saving and sustainable development for the whole process of steel industry.

Steel industry consumes great percentage of energy in China[1], which accounts for 3.61% of GDP, while energy consumption accounts for 14.4% of total industry energy consumption. Steel industry contributes a lot to the development of national economy, but energy consumption is far more than its contribution rate to GDP. It is urgent to develop advanced energy-saving technology, which is to optimize relevant process and coherence between related processes, study to assess unit or equipment energy utilization level, reduce process and system energy consumption effectively, recover and utilize waste heat and waste energy produced in the steel industry as much as possible, and thereby to improve the efficiency of energy utilization during production process eventually, by monitoring and evaluating energy utilization efficiency of each process, process interface, main unit or equipment in the whole process of steel industry directly or indirectly.

1 Basic Principles of Energy Efficiency Optimization

Energy is vector, which is directional and is a process of only entropy increase and disintegration[2]. It is the foundation of energy saving by recovering and utilizing energy efficiently and preventing energy from devaluating. During metallurgical process there are time, space, energy quality and energy quantity. Users need to consider economic adaptive efficiency and coupling benefits. The quantity of waste heat and

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energy is enormous in metallurgical process as well as energy quality difference. Optimization of system energy quality structure is the basis to improve the system efficiency.

Regarding to the long term development requirements of energy conservation and emission reduction of the steel industry in China[3], it's the guidance of improving the energy efficiency of process and equipment continuously. There are three themes for optimizing energy efficiency, which are process energy saving, technology energy saving, management energy saving, to achieve the target of "high quality with high use, quantity and quality matching, equivalent substitution, integrated optimization, cascade utilization". Thus the market competitiveness of steel enterprises can be improved.

1.1 Energy quality and energy value matching rationally

Currently most of enterprises allocate energy usage wrongly, recover high quality energy with a low efficiency and prefer to use high quality energy. It causes that high quality energy is under usage and low quality energy is available nowhere. The energy is wasted largely and does not play its value fully. The main issues are as follows:

(1) The fuel gas[4] runs with three mixed network mode of BFG, COG and LDG, which causes high quality energy with low use, network control instability and high operation cost.

(2) Pay attention to new water consumption of per ton steel, but ignore the total water consumption. Excessively pursue low consumption of new water, leading to the rise of total water consumption. New water consumption decreases, but the cost increases. Pay no attention to the value of different water quality itself.

(3) Steam, which has characteristics of decreasing quickly[5], low energy efficiency and big process losses, is main transfer medium of process. Steam quality (pressure, temperature) determines the ability of working. Due to production need, enterprises use high pressure and high temperature steam in an improper way by decompressing and cooling down. For example, one enterprise produces, recovers, consumes amount to 500 t of steam annually, which equals to 550 kt of standard coal. Daily average consumption is 410–520 t/h and pressure is 0.5 MPa, the steam is decompressed from 1.4 MPa in the steam pipe network which causes energy loss more than 12.8%.

(4) Continuous energy flow is supplied to discrete energy users, but energy quality and energy level don't match it, which result in low energy efficiency, such as vacuum jet, heating, fire-fighting, etc. Nowadays RH process in steelmaking generally is vacuumed by using steam jet, so the continuous energy flows to the discontinuous users, causing a lot of profits loss. The mechanical vacuumizing technology should be applied, using electric drive instead of steam consumption. Thus, energy system operates flexibly and the consumption is low. These measures can completely replace steam vacuumizing and achieve same effect, with power consumption per ton steel only 2–3 kWh[6]. The power generated by using the steam for vacuumizing can generate up to 15 kWh per ton steel. By contrast, energy saving is large.

(5) Power system operates inefficiently and pays too much attention to the safety while ignoring efficiency. The situations are as follows: low power factor, low load ratio, low power grid voltage, unreasonable allocation of reactive compensation, high loss, etc.

Therefore, it can be seen that steel enterprises need to focus on quality matching and optimize energy value and try to avoid allocating energy according to the main process requirements, which causes waste of energy and value loss. It is necessary to analyze and evaluate the rationality of enterprise's energy using in both aspects of quantity and quality, tap energy saving potential and develop new technology of energy saving. When researching of energy using, researchers should not only pay attention to loss of energy "quantity", but also pay attention to the devaluation of energy "quality"[7].

1.2 Energy efficiency management of energy-oriented system

At present, energy management of steel industry is basically in the safety and insurance mode of production-oriented, leading to inefficient energy management, high energy consumption and great loss of benefits[8]. The main issues are as follows:

(1) The value of energy medium is seriously separated from price and the internal mechanism is isolated from market. For example, the price of Baosteel's steam is 192 RMB/t and coke oven gas 2.2 RMB/m^3; while the price of many other enterprises is