

Article 9 Table 5

The Best Available Techniques Which Shall Be Applied in Processing Techniques for Steel Industry

Energy users in the steel industry shall comply with the contents of the Best Available Techniques below.

I. Sintering Process

Item	Description
1. Waste heat recovery from the sintering process	It mainly refers to the waste heat recovery from sinter cooler.
2. Combustion efficiency optimization of ignition furnace in sintering machine	Combustion efficiency of the ignition furnace can be improved to reduce energy consumption. Available techniques include but are not limited to: use of hot air from the cooling machine as the combustion air of the ignition furnace; ignition furnace equipped with an automatic control system for adjusting furnace pressure, temperature and air-fuel ratio according to the surface of the mixture on the sintering pallet, the flame of the furnace nozzle, and the process changes.

II. Coking Process

Item	Description
1. Recovery of coke oven gas	Recovered coke oven gas can be used as fuel for the production process, converted to electricity and heat, and optimized or high valued.
2. Use of low humidity coals	Available techniques include but are not limited to: moisture control of coals within 12% through the use of indoor bins, feed control, preheating and drying, so as to increase coke production, reduce coking energy consumption in coke ovens, improve coke quality and stabilize coke oven operation.
3. Dry coke quenching	With dry coke quenching, the hot coke is mainly placed in the quenching furnace, and the heat is transferred to the boiler area through cold circulating air. The heated boiler water is converted into steam for power generation or sold to users.

III. Blast Furnace Process

Item	Description
1. Recovery of blast furnace gas	Recovered blast furnace gas can be used as fuel for the production process or converted to electricity and heat.
2. Power generation of blast furnace top gas pressure recovery turbine	<p>(1) Blast furnace Top gas pressure Recovery Turbine (TRT) is a power generation system that can convert the physical energy of high-pressure blast furnace top gas into electricity by using an expansion turbine. Even if the pressure difference is small, a certain amount of gas makes energy recovery economically feasible.</p> <p>(2) It is critical for the blast furnace top gas pressure recovery turbine to ensure that the expansion turbine can operate stably and efficiently with the blast furnace gas containing dust without damaging the operation of the blast furnace.</p> <p>(3) Dry type TRT generate more electricity than wet type TRT.</p>
3. Direct injection of reducing agent	Available techniques include but are not limited to: injection of pulverized coal, fuel oil or natural gas to replace part of the coke used for chemical reduction of blast furnace, reducing the production of coke and saving energy.
4. Waste heat recovery from hot blast stove	In the ironmaking process, the hot blast stove can be used to preheat the cold air blown into the blast furnace to raise the temperature of air blasting as required for the operation of the blast furnace. The hot blast stove uses a mixture of blast furnace gas and coke oven gas as fuel, and there is a risk of energy waste if its exhaust gas with a temperature of 250°C~350°C after combustion is discharged directly through the chimney.
5. Blast furnace gas recovery from blast furnace top gas for charging and pressurizing	<p>(1) The blast furnace gas, produced during the blast furnace production and purified by the gas purification system, can be used as fuel for combustion in its hot blast stove as well as pressurized gas before the charging bin.</p> <p>(2) The blast furnace gas after charging is exhausted to the atmosphere through a pressure relief valve via a silencer in the conventional process. It is recommended to add cyclones on the charging and</p>

	<p>pressurizing relief pipelines as well as to add an ejector to the recovery pipeline in the blast furnace gas recovery system.</p> <p>(3) The cyclone can be used to remove the powder and particles in the blast furnace gas by the change of the flow rate, achieving the quality of the recovered gas up to less than $5\text{mg}/\text{Nm}^3$. In addition, the collected powder and particles are sent back to the charging bin for resource recovery during pressurizing charging bin.</p> <p>(4) The ejector can be used to inject the high-pressure blast furnace gas through the nozzle to recover it to the common pipeline of blast furnace gas.</p>
6. Use of motor blower	<p>The motor blower is driven by a motor (replacing the steam turbine blower) with associated auxiliary system characterized by simplicity, flexible operation, and less cooling water, which is built in an energy-saving and environment-friendly technique.</p>

IV. Converter Steelmaking and Continuous Casting Process

Item	Description
1. Recovery of converter gas	<p>Recovered converter gas can be used as fuel for the production process, converted to electricity and heat, and further optimized or high valued; for example, carbon monoxide (CO) is purified to provide chemical raw materials required by the petrochemical industry (coproduction between steel and petrochemical plants).</p>
2. Automation control of converter and refining operation	<p>(1) Today, the world's major steel mills are committed to introducing automation control of converter operation, which includes static control and dynamic control; wherein the dynamic control is carried out mainly by substance analysis and furnace gas analysis.</p> <p>(2) At present, production control of advanced steel mills in the world is mainly carried out by substance analysis, furnace gas analysis or both.</p> <p>(3) The molten steel in the converter is delivered to be treated in the refining system with automation control, such as vacuum degassing, ladle refining, alloy wire or powder addition and stirring</p>

	stations. (4) Using automatic temperature measurement and sampling equipment is necessary to accurately obtain the temperature and composition required for downstream continuous casting.
3. Optimization of stirring of converter blowing	Converter steelmaking is a top-bottom blown system that can remove impurities such as carbon, silicon, phosphorus, etc. in molten iron by top blown oxygen and the bottom stirred inert gas (nitrogen or argon) to convert molten iron into molten steel, and then adding steel scrap and alloys to balance heat and adjust the composition of molten steel.

V. Electric Arc Furnace and Continuous Casting Process

Item	Description
1. Optimization of electric arc furnace process	Available optimization of electric arc furnace process include but are not limited to the following technique items: (1) (Ultra) high power operation (2) Water-cooled side walls and roofs (3) Oxy-fuel burners and oxygen lancing (4) Bottom tapping system (5) Foaming slag practice (6) Ladle or secondary metallurgy (7) Automated sampling and the addition of alloying elements (8) Increased energy efficiency (9) Computer-based process control and automation
2. Optimization of molten steel stirring	Using top blowing or installing inert gas stirring at the bottom of the ladle; or installing supersonic oxygen blowing and carbon-increasing devices in the electric furnace so to uniform the molten steel temperature, thereby reducing power consumption.
3. Thermal insulation	Available techniques include but are not limited to: use of insulation materials such as carbonized rice husk, refractory brick or insulation cover to reduce the heat loss of electric arc furnace and ladle.

VI. Hot Rolling Process

Item	Description
1. Hot charging of blooms and slabs	Increase the hot charging ratio and the temperature into the reheating furnace of

	blooms and slabs to reduce the fuel consumption of the reheating furnace.
2. Direct rolling	For energy-saving, the slabs produced by continuous casting are delivered to subsequent rolling treatment without reheating or only slightly heating the edge.
3. Waste heat recovery from cooling water of skid pipe in the reheating furnace	<p>Available techniques include but are not limited to:</p> <p>(1) Evaporating cooling (cooling water in, steam out) (Evaporating cooling), wherein the steam recovery is generated by vaporizing the water with the heat carried in the cooling water of skid pipe in the reheating furnace. Recovered steam can be sent into the steam pipe network for internal use or external sale. Compared to water cooling, the biggest advantages of evaporating cooling include the reduction of the amount of cooling water and power consumption of the cooling water pump. The water consumed by evaporating cooling is converted into steam.</p> <p>(2) Waste heat recovery from cooling water of traditional water cooling (cooling water in, cooling water out).</p>
4. Heating furnace equipped with advanced combustion technique	<p>Available techniques include but are not limited to:</p> <p>(1) Regenerative combustion system, which is used to preheat the combustion air or gas up to 1,000°C by fully using the combustion exhaust gas with a heat accumulator under alternating operation modes of heat storage and heat release. Therefore, it can greatly reduce the flue gas discharge temperature and increase the effect of energy-saving, but the practical performance shall be analyzed on a case-by-case basis.</p> <p>(2) Digital combustion heating furnace, which can be used to generate optimal energy output by using the temperature PID for controlling the switch of each burner based on the difference between the set temperature and the actual temperature in each control area. But the practical performance shall be analyzed on a case-by-case basis.</p>
5. Control system for dynamic furnace pressure and atmosphere closed loop of	(1) Control of dynamic furnace pressure of the heating furnace can be achieved by

heating furnace	<p>predicting the level of air intake to compensate for the furnace pressure based on the state change of control loop of furnace pressure as the furnace door opens, which can effectively inhibit the amount of air intake as the furnace door opened.</p> <p>(2) Control of oxygen-containing atmosphere closed loop of heating furnace can be achieved by automatically controlling the air fuel ratio in the multi-furnace area based on theoretical control (Soft sensor) and the measurement feedback of oxygen content in the combustion exhaust gas. Therefore, it can improve the uncontrollability of oxygen-over (deficient) atmosphere and the control accuracy of oxygen content, thereby achieving the effect of energy-saving, but the practical performance shall be analyzed on a case-by-case basis.</p>
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VII. Cold Rolling, Coating and Cutting

Item	Description
1. Control system for annealing furnace temperature	<p>(1) The temperature control of the annealing furnace is a distributed control system (DCS) architecture, which is a common practice used in various steel mills.</p> <p>(2) Due to the growing development of automatic control technology, there are some available techniques, including fuzzy control, numerical simulation model, and expert system, which can be combined with PID control of furnace temperature.</p>
2. Waste heat recovery	<p>Heat recovery equipment can be designed in the following production lines include but are not limited to:</p> <p>(1) Continuous annealing line</p> <p>(2) Annealing furnace for Hot Dip galvanizing line</p> <p>(3) Annealing and pickling line</p> <p>(4) Electrical steel line</p>

VIII. Integration of Energy Resources

Item	Description
Integration of regional energy resources	For example, many energy by-products are produced along with processes in integrated steel mills. In addition to some self-consumption energy resources, the steam produced by cogeneration and waste heat recovery, various industrial gases (oxygen, nitrogen, argon) produced by the air separation plant, and excess energy exchangeable with adjacent factories in the same industrial park zone can be integrated into regional energy resources with the most efficient way. Interconnection of excess energy is integrated into regional energy resources to improve energy efficiency, reduce resource consumption and regional emissions of pollution and greenhouse gases, thereby effectively reducing environmental impact and improving environmental quality.