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Introduction

Content

Technical Guidelines on Energy Saving and Carbon Reduction in Flat Glass Production

1 Overview

1.1 Scope

This document specifies the technical requirements, accounting, testing, implementation and management for energy conservation and carbon reduction in flat glass production.

This document applies to new, reconstructed and expansion projects as well as energy-saving and carbon-reduction retrofits and operation management of existing production lines of flat glass manufacturers producing float glass, rolled glass and other flat glass products. It covers the entire process including raw material preparation, melting, forming, annealing cold-end processing, waste heat utilization and pollutant treatment.

1.2 Purpose

Based on full life cycle accounting and the application of advanced energy-saving and carbon reduction technologies, this document defines energy efficiency benchmarks and carbon emission control thresholds for all links of flat glass production, and establishes a scientific and unified system of technical specifications. It guides enterprises to adopt advanced technologies such as low-carbon raw material and fuel substitution, intelligent transformation and clean energy application, boosts the improvement of industrial energy efficiency and the reduction of carbon emission intensity, and achieves green and sustainable development.

2 Normative References

The following referenced documents are indispensable:

ISO 14040 Environmental management — Life cycle assessment — Principles and framework

ISO 14044 Environmental management — Life cycle assessment — Requirements and guidelines

ISO 14064-3 Greenhouse gases — Specification with guidance for the validation and verification of greenhouse gas assertions

ISO 14067 Greenhouse gases — Carbon footprint of products — Quantification and reporting requirements and guidelines

ISO 14403 Glass melting furnaces — General rules for calculating energy consumption

ISO 50001 Energy management systems — Requirements with guidance for use

GB/T 2589 General Principles for Calculation of Comprehensive Energy Consumption

GB 21340 The Norm of Energy Consumption per Unit Product for Glass and Cast Stone

GB/T 32151.7-2023 Requirements for Carbon Emission Accounting and Reporting — Part 7: Flat Glass Manufacturers

GB/T 39803-2021 Technical Requirements for Energy Consumption Evaluation of Flat Glass Manufacturing

GB/T 39809 Measurement Method of Energy Consumption for Flat Glass Melting Furnaces

3 Terms and definitions

3.1

Flat Glass

Glass products manufactured via float, rolled and other processes, featuring flat surfaces and uniform thickness, which are applied in construction, transportation, electronics and other sectors, including float glass, rolled glass, etc.

3.2

Energy-saving and Carbon-reduction Retrofit

Retrofitting activities that adopt advanced and applicable technologies and equipment, optimize production processes, substitute raw materials and fuels, improve energy utilization efficiency, and reduce energy consumption and greenhouse gas emissions.

3.3

Benchmark Energy Efficiency Level

An advanced energy utilization level achievable by flat glass manufacturers under current technical and economic conditions, serving as a demonstration benchmark for energy conservation and carbon reduction across the industry.

3.4

Low-carbon Raw Materials and Fuels

Energy sources and raw materials that replace traditional fossil fuels and can cut carbon emission intensity, including natural gas, hydrogen, recycled glass (cullet), etc.

3.5

Carbon Capture, Utilization and Storage (CCS)

A technical process of capturing carbon dioxide from flue gas of flat glass production furnaces, followed by purification, utilization or storage of the captured carbon dioxide.

3.6

Life Cycle Assessment

Compilation and evaluation of environmental impacts over a product life cycle。

（SOURCE:ISO 14044:2022，3.2）

3.7

Carbon Emission per Unit Product

Average direct and indirect greenhouse gas emissions (measured in carbon dioxide equivalent) generated by an enterprise for producing one standard unit of flat glass (calculated by weight case; 1 weight case = 50 kg) within a specific period (normally one year). Recalculation shall be conducted if major changes occur to production processes, raw material and fuel mix, etc.

3.8

Carbon Dioxide Equivalent (CO2e)

Metric for comparing GHG emissions based on global warming potential.

（SOURCE:ISO 14067:2018，3.1）

4 Technical Requirements

4.1 Energy Efficiency Benchmarks

4.1.1

For flat glass production lines with a daily melting capacity greater than 800 tons, the benchmark energy consumption per unit product shall not exceed 8 kg of standard coal per weight case, and the reference energy consumption level shall not exceed 12 kg of standard coal per weight case.

4.1.2

For production lines with a daily melting capacity ranging from 500 tons to 800 tons inclusive, the benchmark energy consumption per unit product shall not exceed 9.5 kg of standard coal per weight case, and the reference energy consumption level shall not exceed 13.5 kg of standard coal per weight case.

4.2 Raw Material Preparation Technologies

4.2.1

Granulation, briquetting and preheating technologies for batch materials shall be promoted. The preheating temperature of batch materials shall be no lower than 150°C, and the gas generation rate shall be controlled below 8%.

4.2.2

Optimize batch formulations and develop low-melting-temperature formulas to reduce carbonate content. The oxide composition of glass shall comply with low-carbon design requirements.

4.2.3

The blending ratio of recycled glass (cullet) shall be no less than 30%, among which high-quality cullet shall account for no less than 60%, so as to guarantee stable chemical composition of raw materials.

4.2.4

Automated batching systems shall be adopted with a batching precision error of $\leqslant \pm 0.3\%$ to reduce raw material waste and energy efficiency loss.

4.3 Melting and Forming Technologies

4.3.1

Full thermal insulation technology for glass melting furnaces shall be promoted; the surface temperature of the furnace body shall not exceed 80°C. Infrared high-radiation energy-saving coatings shall be applied to raise the heat reflectivity to over 85%.

4.3.2

Oxy-fuel combustion or pure oxygen combustion processes shall be prioritized, with oxygen concentration controlled above 90% and thermal efficiency improved to over 65% to cut greenhouse gas emissions.

4.3.3

External batch preheating and high-power fuel-electric hybrid melting technologies shall be promoted. The melting temperature can be reduced by 50–80°C, and the melting cycle shortened by more than 10%.

4.3.4

Glass defoaming agents shall be applied to eliminate foam layers thicker than 30 mm inside the melting furnace, avoiding heat insulation and fuel waste.

4.3.5

Optimized sealed thermal insulation design shall be adopted for tin baths and annealing furnaces to cut heat loss by over 20%. Intelligent temperature control systems shall be equipped to keep temperature fluctuation within ±2°C.

4.4 Clean Energy Substitution

4.4.1

Qualified enterprises are encouraged to carry out pilot projects of hydrogen combustion technology.

4.4.2

Waste heat and pressure recovery technologies shall be promoted, and distributed power generation systems shall be constructed. The waste heat utilization rate of production lines shall be no less than 80%, and the self-power supply ratio ≥15%.

4.4.3

Enterprises are encouraged to build renewable energy power generation facilities such as photovoltaic and wind power on factory premises to prioritize meeting production power demand.

4.5 Intelligent and Digital Technologies

4.5.1

Intelligent control systems shall be equipped for the three major thermal systems: melting furnace, tin bath and annealing furnace, to realize real-time monitoring and automatic adjustment of temperature, pressure and combustion status.

4.5.2

Digital simulation for melting & forming and cold-end optimized control technologies shall be applied. The coverage rate of online defect detection shall reach 100%, and the utilization rate of intelligent equipment such as automatic cutting and stacking shall be ≥90%.

4.5.3

A digital energy management platform shall be established to realize real-time collection, analysis and early warning of energy efficiency and carbon emission data, with a data transmission accuracy rate ≥ 99%.

4.6 Pollutant and Carbon Emission Control

4.6.1

The emission concentration of particulate matter shall be≤10mg/m³, sulfur dioxide≤30mg/m³, and nitrogen oxides≤100mg/m³, meeting ultra-low emission standards.

4.6.2

Production lines with a daily melting capacity above 800 tons shall be equipped with CCS (Carbon Capture and Storage) devices. The carbon dioxide capture efficiency shall be≥85%, and CO_2 purity ≥99.5%.

4.6.3

Carbon dioxide recovery and utilization technologies shall be promoted for the production of food-grade carbon dioxide, chemical raw materials or mineral carbonation, with a comprehensive utilization rate ≥70%.

5 Accounting and Testing

5.1 Carbon Emission Accounting

5.1.1

The accounting boundary covers the full life cycle including raw material mining and transportation, production processes (raw material preparation, melting, forming, annealing, etc.), energy consumption and waste treatment.

5.1.2

The accounting methods specified in ISO 14067 shall be adopted to clarify the calculation logic for emissions from fossil fuel combustion, raw material decomposition and indirect emissions from purchased energy.

5.1.3

Enterprises shall establish carbon emission data ledgers to record raw data such as fuel consumption, raw material dosage and energy input, with a retention period of no less than 5 years.

5.2 Testing Requirements

5.2.1

Energy consumption testing shall be carried out in accordance with the methods specified in GB/T 39809. Full-process energy consumption measurement shall be conducted at least once a year, and testing institutions shall hold corresponding qualifications.

5.2.2

Continuous Emission Monitoring Systems (CEMS) shall be adopted for carbon emission testing to monitor greenhouse gas indicators including carbon dioxide and methane, with an effective data transmission rate of ≥95%.

5.2.3

Key energy-saving equipment (such as thermal insulation materials, burners, waste heat boilers, etc.) shall be inspected regularly at intervals of no more than 2 years to guarantee compliance of technical performance.

6 Implementation and Management

6.1 Renovation Implementation

6.1.1

Production capacities failing to meet the energy efficiency reference level shall formulate renovation plans specifying technical routes, renovation schedules and expected targets.

6.1.2

Renovation projects shall entrust qualified institutions to complete scheme design and construction. Post-renovation energy efficiency and carbon emission assessment by a third-party testing institution is mandatory.

6.1.3

Enterprises are encouraged to participate in benchmark demonstration projects, prioritize cutting-edge technologies such as hydrogen-fueled melting and low-carbon raw material substitution, and enjoy corresponding policy incentives.

6.2 Energy Management

6.2.1

Enterprises shall establish an energy management system complying with ISO 50001 and assign no fewer than 2 full-time energy management personnel.

6.2.2

Annual energy-saving and carbon reduction targets shall be formulated and decomposed to each production link. Internal audits and management reviews shall be conducted periodically to ensure target achievement.

6.2.3

Technical archives for energy saving and carbon reduction shall be created to record information including technology application, equipment operation and renovation effects, serving as the basis for evaluation and assessment.

Annex A (normative)

Calculation Method for Full Life Cycle Carbon Emissions of Flat Glass

A.1 Overview of the Method

The full life cycle carbon emission accounting for flat glass complies with the requirements of ISO 14040, ISO 14044 and GB/T 32151.7-2023. Combined with the production characteristics of the industry, the Life Cycle Assessment (LCA) method is adopted to systematically quantify carbon emissions in all phases including raw material acquisition, production and processing, product transportation and waste disposal, so as to guarantee the scientificity and accuracy of accounting results.

A.2 Accounting Boundary and Functional Unit

A.2.1 System Boundary

It covers the complete life cycle of flat glass, ranging from raw material mining and procurement, production and processing (raw material preparation, melting, forming, annealing), product packaging and transportation, consumption and use to waste disposal.

A.2.2 Functional Unit

"One weight case (50 kg) of flat glass" is adopted as the unified accounting unit to ensure comparability among different enterprises and production lines.

A.3 Accounting Procedures

A.3.1 Process Identification

Clarify major processes in each phase of the full life cycle, including raw material mining, batch preparation, furnace melting, tin bath forming, annealing treatment, product transportation, waste recycling, etc.

A.3.2 Data Collection

Collect activity data of each process, such as raw material consumption, energy consumption, transportation distance and waste discharge volume. Priority shall be given to enterprise measured data, supplemented by authoritative database data (e.g. IPCC Database, China Life Cycle Database (CLCD)).

A.3.3 Emission Factor Matching

Match corresponding emission factors according to the region of data source, energy type and other conditions, including emission factors for fossil fuel combustion, power grid emission factors, transportation emission factors, etc.

A.3.4 Emission Calculation

Calculate carbon emissions by phase following the formula: Carbon emissions of a certain phase = Activity data × Corresponding emission factor. Sum up the phase-based emissions to obtain the total full life cycle carbon emissions.

A.4 Data Quality Requirements

Accounting data shall be authentic, traceable and accurate, and data sources shall be clearly recorded. The accounting error rate shall not exceed 5%. If alternative data are used, the basis for substitution and uncertainty impacts shall be stated in the report.