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Test methods for slagging indexes in coal combustion

煤的燃烧结渣指数测定方法

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Test methods for slagging indexes in coal combustion

1 Scope

This document specifies the determination method, test device, test instrument and method, data processing and calculation method for slagging indexes in coal combustion.

This document is applicable to the determination for slagging indexes of power coal products such as power station boilers and industrial boilers. Applicable coal types are lignite, bituminous coal and anthracite (excluding coal with a total content of Na_2O and K_2O greater than 3% in coal ash).

This document uses Method A as the arbitration method.

NOTE: This document also gives the determination method C for slagging indexes of coal - Clustering slagging index method F, see Annex A.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

GB/T 219, *Determination of fusibility of coal ash*

GB/T 474, *Method for preparation of coal sample*

GB/T 1574, *Analysis of coal ash*

GB/T 3715-2007, *Terms relating to properties and analysis of coal*

GB/T 19494.2, *Mechanical sampling of coal Part 2: Method for sample preparation*

GB/T 39833, *Test method for coal combustion characteristics - One-dimensional furnaces method*

DL/T 567.5, *Test Methods of Fuel in Thermal Power Plants - Part 5: Fineness of Pulverized Coal*

DL/T 1106-2009, *Test methods for pulverized coal combustion slagging*

comprehensive slagging

4 Determination method A (Method Sc for probe slagging index)

4.1 Method summary

The one-dimensional furnace carries pulverized coal with a certain amount of air flow during the test. After entering the hearth, it will catch fire and burn when the furnace wall emits heat, so that it burns out. One-dimensional furnace can realize the suspension combustion test of pulverized coal and air under dynamic conditions. The burning pulverized coal flow moves downwards along the height of the hearth. Use silicon carbide rods as slagging probes to sample when pulverized coal is burned in one-dimensional furnace. Then use a blade to cut the slag sample on the surface of the silicon carbide rod to determine the slag type. Calculate corresponding slag type assignment to obtain the probe slagging index.

4.2 Test devices

The schematic diagram of the one-dimensional furnace test device is shown in Figure 1. The one-dimensional furnace test bench is mainly composed of powder feeding system, heating and temperature control system, combustion furnace body system, air smoke system and sampling analysis system. The one-dimensional furnace body adopts a vertically arranged electric heating building block structure. It is mainly composed of ignition section, stable combustion section and burnout section. Connect the powder feeder to the ignition section. The end of the burnout section is connected to the flue gas cooler, followed by dust collector and induced draft fan. Ash trough is at the bottom of the furnace body, used to collect the ash residue from the combustion of pulverized coal airflow. The outside of the furnace is covered with refractory and thermal insulation materials to ensure that the temperature of the outer wall of the furnace is $\leq 60^{\circ}\text{C}$. The residence time of pulverized coal particles in the furnace is controlled at 2s~10s. It can meet the burning-out requirements of pulverized coal particles in the furnace. The air leakage rate of the whole one-dimensional furnace test device (that is, the percentage of the leaked air mass in the flue gas mass at the inlet of the device) is controlled within 5%.

The pulverized coal burner is installed on the top of the hearth. The primary air carries pulverized coal into the top of the hearth. The secondary air is arranged around the primary air and fed from the top of the hearth. The flow of primary air and secondary air can be measured and controlled by flow meter. Use hot air to send powder. The air preheater can adjust the temperature of the hot air

$$R_{90}' = 0.5nV_{daf} \dots\dots\dots (3)$$

Where,

n - Pulverized coal uniformity coefficient (take n=1);

V_{daf} - Dry ash-free volatile matter of pulverized coal, %.

4.4.1.3 Requirements for deviation of pulverized coal fineness

The deviation of pulverized coal fineness is calculated according to formula (4):

$$\Delta R_{90} = |R_{90} - R_{90}'| \dots\dots\dots (4)$$

R₉₀ allowable deviation increases with the increase of V_{daf}: When V_{daf} is less than 15%, ΔR₉₀=1~2; when V_{daf}=15%~25%, ΔR₉₀=2~3; when V_{daf} is greater than 25%, ΔR₉₀=3~4.

4.4.2 Test preparation

According to the specified conditions of test conditions in GB/T 39833, preheat each section of the furnace body to the set temperature. Start the induced draft fan and the blower one after another. Adjust hot air temperature and excess air coefficient. Start the power feeder to adjust the amount of pulverized coal. After the furnace temperature and flue gas composition of the pulverized coal combustion in the one-dimensional furnace are stabilized, according to the ignition position of the test coal, insert six silicon carbide slagging rods (probes) into the selected measuring hole along the flame stroke. Make each slagging rod at the initial stage of ignition, the highest flame temperature, the median temperature and the furnace outlet.

4.4.3 Probe sampling

Maintain the stable operating conditions of the pulverized coal combustion of the one-dimensional furnace. Wait for a sufficient amount of ash and slag layer to deposit on the slagging probe. The continuous slagging time of the probe sampling is determined by the ash content of the coal. Generally, it is 20min~30min.

4.4.4 Observation of slag type

After the test, pull out the slagging probe carefully. Keep it as it is. After cooling, use a blade to scrape the slag sample on the surface of the silicon carbide rod. Observe and record its slag type characteristics.

4.5 Data processing and calculation methods

θ - Characteristic temperature value corresponding to slag type, in Celsius ($^{\circ}\text{C}$).

5 Determination method B (comprehensive slagging index method R)

5.1 Method summary

According to the percentage of each component of coal ash (expressed as oxide), calculate the individual slagging index of coal: mass ratio of SiO_2 to Al_2O_3 ($\text{SiO}_2/\text{Al}_2\text{O}_3$), mass ratio of SiO_2 in coal ash (G) and base/acid ratio (B/A). Comprehend the softening temperature (ST) and mass ratio of SiO_2 to Al_2O_3 , mass ratio of SiO_2 in coal ash and base/acid ratio. Conduct weighted calculation of comprehensive slagging index of coal (R) to judge its slagging characteristics. The determination of softening temperature (ST) and precision is carried out according to GB/T 219. The components of coal ash (expressed as oxides): the content determination of SiO_2 , Al_2O_3 , Fe_2O_3 , CaO , MgO , Na_2O , K_2O and TiO_2 and precision are implemented in accordance with GB/T 1574.

5.2 Data processing and calculation methods

Comprehend the softening temperature and mass ratio of SiO_2 to Al_2O_3 , mass ratio of SiO_2 in coal ash and base/acid ratio. According to empirical coefficient weighted average method of formula (6), calculate the comprehensive slagging index (R):

$$R = 1.237 \times B/A + 0.282 \times \text{SiO}_2/\text{Al}_2\text{O}_3 - 0.0023 \times \text{ST} - 0.0189 \times G + 5.415 \quad \dots\dots (6)$$

Where,

R - Comprehensive slagging index;

B/A - Base/acid ratio of coal ash;

$\text{SiO}_2/\text{Al}_2\text{O}_3$ - Mass ratio of SiO_2 to Al_2O_3 of coal ash;

ST - Softening temperature of coal ash, in Celsius ($^{\circ}\text{C}$);

G - Mass ratio of SiO_2 in coal ash.

NOTE: Method R is based on the weighted average method of empirical coefficients obtained from the statistics of a large number of coal samples of China's 300MW~600MW units.

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