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Analytical methods of steam and water in power plants - Determination of total organic carbon

火力发电厂水汽分析方法

总有机碳的测定

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Analytical methods of steam and water in power plants - Determination of total organic carbon

1 Scope

This standard specifies the method for the determination of total organic carbon in water steam from thermal power plants.

This standard applies to the determination of water samples with TOC and TOC_i contents in the range of 10 µg/L ~ 1000 µg/L.

2 Normative references

The following documents are essential to the application of this document. For the dated documents, only the versions with the dates indicated are applicable to this document; for the undated documents, only the latest version (including all the amendments) are applicable to this standard.

GB/T 6903 Analysis of water used in boil and cooling system - General rule

3 Terms and definitions

3.1

Total organic carbon (TOC)

Total carbon content in organic matter.

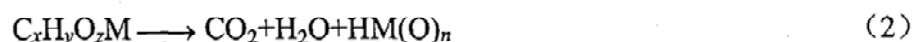
3.2

Total organic carbon ion (TOC_i)

The sum of the total carbon content in organic matter and the content of other heteroatoms that produce anions after oxidation.

4 Method summary

The organics in water will, after complete oxidation, be subject to the following reactions:



Note: M represents heteroatoms (except for carbon) in the organic matter that may produce anions after the oxidation.

When organic matter contains only carbon, hydrogen, oxygen, and no other heteroatoms [see formula (1)], the carbon dioxide produced after oxidation is directly proportional to the total organic carbon content in the water. By measuring the change in CO_2 at the inlet and outlet of the oxidizer, the carbon content (TOC) in the organic matter can be calculated, and the measured TOC content is consistent with the TOC_i content. When organic compounds contain other heteroatoms other than carbon atoms [see formula (2)], after oxidation, chloridion, sulfate, nitrate, and other anions are generated in addition to carbon dioxide (see Appendix A for details). At this time, the change in the conductivity of all atoms that may produce anions (including carbon) in the organic matter before and after oxidation is determined and converted to the sum of the carbon dioxide content (in terms of carbon) as the TOC_i content, whereas the determination of the resulting carbon dioxide content only yields the TOC content. Under such conditions, the measured TOC_i content is greater than the TOC content. The TOC_i content can more accurately reflect the corrosiveness of organic matter in water.

5 Reagents

5.1 Reagent water: It shall meet the requirements of the level 1 reagent water as specified in GB/T 6903, the total organic carbon content shall be less than 50 $\mu\text{g/L}$.

5.2 Reagent purity: It shall meet the requirements of GB/T 6903.

5.3 TOC stock solution (1000 mg/L): Accurately WEIGH 2.3770 g of superior grade pure sucrose ($C_{12}H_{22}O_{11}$) which has been dried at 100°C for 2 h. USE reagent water to dissolve it, quantitatively TRANSFER it into a 1000 mL volumetric flask, USE reagent water to dilute it to the mark. This solution shall be stored in the refrigerator, which is valid for three months.

5.4 TOC standard solution (10 mg/L): Accurately PIPETTE 1.00 mL of TOC stock solution into a 100 mL volumetric flask, USE reagent water to dilute it to the mark, the solution shall be prepared before use.

5.5 Ammonia buffer solution 1 (ammonia content approximately 1200 mg/L): PIPETTE 10 mL of superior grade pure ammonia into a 200 mL volumetric flask, USE reagent water to dilute it to the mark. This solution shall be stored in the refrigerator, which is valid for three months.

Appendix A

(Informative)

Decomposition products and potential hazards of organics in water

A.1 Heat system organic material origin and potential hazards

When organic compounds do not contain halogens, sulfur, and other heteroatoms, the decomposition products in the thermal system include formic acid, acetic acid and other low-molecular organic acids, and carbon dioxide; when organic compounds contains chlorine, sulfur and other heteroatoms, its decomposition products in the thermal system include chloride, sulfate and other anions in addition to the above anions. Studies have shown that excessive levels of organic compounds in water steam will lead to corrosion of the turbine's low-pressure cylinder blades. Since the corrosion of low-molecular-weight organic acids is far less than chloride, sulfate, and other strong-acid anions, the organic substances corrosion against equipment is closely related to the heteroatom contents such as sulfur and chlorine in organic materials. For example, if the seriously polluted cooling water leaks into the condensate, the quality of the added medicine in the system is unqualified, the feed water source is polluted seriously, the desalination system is not efficient in removing organic matter, and the leachables of the resin are large, it may introduce organic substances containing halogen, sulfur and other heteroatoms into the steam system. The case of many power plants shows that when the total organic carbon (TOC) content in the water has not exceeded the standard, the TOC_i content has exceeded the standard seriously. At this time, the steam hydrogen conductivity has exceeded the standard and the low-pressure cylinder blade of the turbine has severe corrosion. Therefore, to prevent the corrosion of the turbine low-pressure cylinder blades, it shall monitor and control the TOC_i content in the water steam.

A.2 Differences between TOC and TOC_i measurement indicators

A.2.1 Meaning of TOC measurement indicator

Total carbon content in organic matter. The measuring principle is to calculate the total carbon content in organic matter by measuring the change of carbon dioxide content before and after the complete oxidation of organic matter, and convert it to carbon content. The measurement can be performed using the membrane conductance method or the non-dispersive infrared detector. No matter how the organic composition changes, the TOC content in the water steam only expresses the total carbon content in the organic matter, and the content of heteroatoms is not reflected.

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Contact: Wayne Zheng, Sales@ChineseStandard.net

Linkin: <https://www.linkedin.com/in/waynezhengwenrui/>

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