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## Carbon-based catalytic desulfurization method for sulfur-containing waste gas

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## Foreword

This document conforms to GB/T 1.1-2020 "Standardization Work Guidelines Part

1.Structure and Drafting Rules of Standardization Documents". Drafting is scheduled. Please note that some content in this document may involve patents. The issuing organization of this document assumes no responsibility for identifying patents. This document was proposed by the China Petroleum and Chemical Industry Federation. This document is under the jurisdiction of the National Technical Committee on Standardization of Waste Chemicals Disposal (SAC/TC 294). This document was drafted by: Sichuan University, Chengdu Daqi Technology Co., Ltd., Lanbao (Xiamen) Water Treatment Technology Co., Ltd., and Zhonglian. Coalbed Methane Co., Ltd., Guangdong Tianruide New Energy Technology Co., Ltd., Hubei Yihua Chuxing Ecological Technology Co., Ltd., Xiamen Aidite Environmental Protection Technology Co., Ltd., Jinan Longshan Carbon Co., Ltd., and CNOOC Tianjin Chemical Research and Design Institute Co., Ltd. The main drafters of this document are. Liu Yongjun, Li Xin, Huang Ying, Guo Yongxi, Yan Yongjun, Yu Yunfeng, Yang Zaihua, Zhao Chuanchao, Yang Jidong, and Cen Wanglai. Li Yueli, Lü Chunrong, Yuan Feng, Song Yu, Chu Yinghao, Huang Kunming, Wu Bo, Yang Pei. Carbon-based catalytic desulfurization method for sulfur-containing waste gas

1.Scope This document describes a carbon-based catalytic desulfurization method for sulfur-containing waste gas and specifies the requirements for equipment, desulfurization effect, and environmental protection. This document applies to the desulfurization of sulfur-containing waste gas emitted during the production processes of industries such as chemical, steel, petroleum refining, non-ferrous metals, and building materials.

### 4.2 Process Flow



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4.2.1 Brief Description of the Process Flow Sulfur-containing waste gas enters a desulfurization tower filled with a carbon-based desulfurization catalyst. SO2 is adsorbed and catalytically oxidized into SO3 by the catalyst, and then reacts with the sulfur-containing gas. Water vapor in the exhaust gas is converted into sulfuric acid. When the desulfurization capacity of the catalyst reaches the designed sulfur capacity, the valve is switched to stop the gas flow to the desulfurization tower. Washing and regeneration are performed to transfer sulfuric acid from the catalyst pores to the regeneration solution, thereby restoring the catalyst's activity. The regeneration and washing process involves several steps. In the third stage, a step-by-step concentration reduction mode is used for washing. After several cycles, when the concentration of dilute sulfuric acid in the first-stage regenerated solution storage tank exceeds... At 20%, the solution should be pumped to the sulfuric acid refining unit. Simultaneously, the secondary and tertiary regenerated solutions should sequentially enter the primary and secondary regeneration tanks, respectively, with process water replenished to [amount missing]. Three-stage regenerated liquid storage tank. Dilute sulfuric acid with a mass fraction greater than 20% can be directly reused by enterprises after purification.

4.2.2 Simplified Process Flow Diagram A simplified diagram of the carbon-based catalytic desulfurization process for sulfur-containing waste gas is shown in Figure 1.

4.3 Sulfur-containing waste gas The sulfur-containing waste gas before entering the desulfurization tower must meet the following requirements.

a) The SO2 concentration should preferably not exceed 10,000 mg/m3;

b) The temperature should be controlled between 30 °C and 150 °C;

c) The particulate matter concentration should not exceed 30 mg/m3.

### 4.4 Process Control

4.4.1 The moisture content of sulfur-containing waste gas should be controlled at not less than 0.5% (mass fraction).

4.4.2 The oxygen concentration in sulfur-containing waste gas should be controlled at not less than 3% (volume fraction).

4.4.3 When the SO2 mass concentration in sulfur-containing waste gas is higher than 10,000 mg/Nm3, multi-stage desulfurization should be adopted.

4.4.4 The performance of carbon-based desulfurization catalysts (such as ignition point, ash content, sulfur capacity, strength, and lifespan) should meet the process requirements, and the requirements and determination methods shall be specified. The method is described in Appendix A.

4.4.5 When the temperature of sulfur-containing waste gas exceeds 150 °C, it should be cooled down first.



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4.4.6 The pressure drop of a single-stage desulfurization system should not exceed 3,000 Pa.

4.4.7 The gas velocity inside the desulfurization tower should not exceed

0.4 m/s.

4.4.8 The mass fraction of dilute sulfuric acid in the primary regenerated solution storage tank should be 15%~20%, and the mass fraction of dilute sulfuric acid in the secondary regenerated solution storage tank should be 5%~ The mass fraction of dilute sulfuric acid in the storage tank for the third-stage regenerated solution should be less than 5%.

4.4.9 The spray density of the regenerated liquid should not be less than 20 m3/(m2·h).

4.4.10 The duration of a single regeneration (washing and settling) of the desulfurization tower should not be less than 6 hours.

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### 5.1 General Requirements

5.1.1 The layout scheme of the complete set of equipment shall comply with the provisions of GB 50016 and GB 50160.

5.1.2 The seismic resistance of the complete set of equipment shall comply with the provisions of GB 50009 and GB 50191.

5.1.3 The structural design of buildings shall comply with the provisions of GB/T 50010 and GB 50017.

### 5.2 Desulfurization Unit

5.2.1 The exhaust gas inside the desulfurization tower should preferably flow from bottom to top.

5.2.2 Manholes should be provided in the desulfurization tower, and sampling ports should be provided in the flue gas ducts leading to and from the desulfurization tower.

5.2.3 Desulfurization towers should preferably be made of reinforced concrete or steel and should be resistant to dilute sulfuric acid corrosion.

### 5.3 Regeneration Unit

5.3.1 The regenerated liquid storage tank should be located below the desulfurization tower and should be resistant to dilute sulfuric acid corrosion.

5.3.2 The regeneration device should adopt a cascade washing and regeneration method, and the number of stages should preferably be no less than 3 stages.

### 5.4 Sulfuric Acid Refining Unit



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5.4.1 The pressure of the sulfuric acid refining membrane filter should not be less than

0.3 MPa, and the filtration accuracy should not be less than 0.1 μm.

5.4.2 The flux of the refining membrane should be consistent with the flow rate of the sulfuric acid refining pump.

## 6 Desulfurization effect

6.1 Desulfurization efficiency The desulfurization efficiency should not be lower than 95%, and the calculation method is given in Appendix A. The emission of sulfur dioxide in the exhaust gas after catalytic desulfurization should comply with relevant industry standards. Environmental requirements for the industry.

6.2 Requirements for dilute sulfuric acid Dilute sulfuric acid should meet the enterprise's reuse requirements, and its concentration should not be lower than 20%.

## 7 Environmental Protection

7.1 Exhaust Gas The effectiveness of carbon-based catalytic desulfurization devices for sulfur-containing waste gas should be monitored and evaluated regularly, and the sulfur dioxide emissions should meet the relevant standards. Requirements of relevant industry emission standards.

7.2 Wastewater Wastewater generated in the sulfuric acid refining unit should enter the wastewater treatment system and be discharged in compliance with standards after treatment.

7.3 Solid waste After carbon-based desulfurization catalysts reach the end of their service life, they should be removed from the desulfurization tower and identified, and must comply with the following regulations.

a) If identified as hazardous waste, it should be subjected to advanced harmless treatment according to its own conditions, or handed over to a qualified professional hazardous waste disposal company. The relevant management agency will handle the matter.

b) After identification, it is determined to be general solid waste and shall be disposed of in accordance with environmental protection requirements.

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