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EXPERIMENTAL STUDY ON SIMULTANEOUS DESULFURIZATION AND DENITRIFICATION OF DOPED TIO2 BASED ON PHOTOCATALYSIS

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ABSTRACT

Today, flue gas desulfurization and denitrification technology are a research hotspot in the field of environmental protection. The development of new technologies and new equipment that can be simultaneously removed on the same equipment has become a new trend in the field of flue gas purification technology, especially research and development of new types of the concurrent removal of multiple pollutants from resource-based flue gas has more potential for development. This project is mainly to study the effect of TiO_2 on the simultaneous catalytic oxidation of sulfur oxides and nitrogen oxides to achieve simultaneous desulfurization and desulphurization under visible light irradiation.

KEYWORDS

Doped TiO_2, fluidized bed, simultaneous desulfurization and denitrification.

1. INTRODUCTION

At present, the flue gas desulfurization and denitrification technology are a research hotspot in the environmental field. The more mature method of SO_2 removal in the industry is mainly limestone/gypsum method, and the removal of NO_X is mostly selective catalytic reduction (SCR method) and selective non-catalytic reduction method (SNCR). The method of selective catalytic reduction (SCR method) is currently the main development direction [1]. Many SO_2 and NO_X removal processes are simply a combination of desulfurization and denigration technologies. They have a large footprint, high investment and operating costs, and do not achieve true simultaneous removal of SO_2 and the purpose and effect of NO_X. In order to reduce the cost of flue gas purification, the development of new technologies and new equipment that can be simultaneously removed on the same equipment has become a new trend in the field of flue gas purification technology, especially research and development of new types of renewable resources Simultaneous removal technology has more potential for development.

Titanium dioxide photocatalytic material is currently the most promising photocatalyst, characterized by a large energy gap, strong oxidizing and reducing properties, no selectivity to target degradation products, mild reaction conditions, and no light irradiation. Light corrosion, good acid and alkali resistance, chemical stability, no toxicity to organisms. In the past 20 years, great progress has been made at home and abroad in the research of titanium dioxide photocatalysts for wastewater treatment and organic pollutants in the gas phase. Especially researches on degradation of atmospheric and indoor low-concentration pollutants have become research hotspots. Many research institutes and enterprises in China have carried out research work in the field of nanotechnology [2]. However, there have been few reports on using titanium dioxide catalysts for simultaneous desulfurization and denitrification of flue gas. In particular, studies on simultaneous desulfurization and denitrification of flue gas under visible light conditions have not been reported. We propose to achieve simultaneous desulphurization and denitrification of flue gas on a catalyst. Its core is based on the fact that electrons and holes in titanium dioxide will migrate to different positions on the surface of the particle under light conditions [3]. The hole itself has a strong electronic ability. It can capture the electrons in the system of sulfur dioxide and nitrogen oxides to be oxidized, and the oxidation products of the two can be absorbed by dilute ammonia to produce ammonium sulfate and ammonium nitrate fertilizer to realize the recycling of waste gas. The research of this topic is carried out under this background. It lays a theoretical foundation for the development of practical photocatalytic oxidation against China's national conditions while removing SO_2 and NOx from flue gas.

2. TECHNICAL SOLUTIONS

2.1 Selection of catalyst

TiO_2 is a polymorphic and acidic amphoteric oxide with extremely stable chemical properties, no corrosion after illumination, good acid and alkaline resistance, no toxicity to organisms, and rich sources. Nano-TiO_2 surface effect and quantum size effect make it have stronger redox and adsorption capacity and these effects are necessary for photocatalytic reaction. Nano-TiO_2 photocatalytic technology is simple, low cost, low energy consumption, mild reaction conditions, high catalytic activity, good chemical and thermal stability, no secondary pollution, no irritation, and safety Non-toxic and other features.

2.1.1 Doping type

The experimental TiO_2 dopant selected non-metal N. According to the data, Asahi et al calculated the electronic states of several anions such as C, N, F, P, and S doped with TiO_2 through the density function method and found that the electronic energy states after N and S doping meet the requirements, but Due to the large S ion radius, the formation energy of impurity levels is much greater than that of N and it is not easy to enter the interior of the crystal lattice. The 2pfi level of N can be hybridized with the 2p level of O and the bandgap of the material is narrowed. Therefore, nitrogen doping has the best response to visible light.

2.1.2 Load type

The experimental load was initially set to clay. Since the physical state of the object of photocatalytic oxidation studied in this subject is gaseous, it is required that the selected carrier should have very good adsorption performance, and the fixation process needs to be simple and easy to mold. After comparative tests and other screening, on the basis of previous studies, clays with large specific surface area and good adsorption performance were selected as the catalyst carrier. After the reaction, the catalyst can be desorption and regeneration by using the method of washing with negative heat-absorbing air to increase the utilization of the catalyst.

2.2 Photocatalytic reactor

In addition, we plan to design a bed-type supported photocatalytic reactor for the current state of exhaust gas desulfurization and denitrification at a high cost. A TiO_2-supported photocatalytic reactor is a catalyst in which a catalyst is attached to a carrier, and there is no post-treatment problem of TiO_2, and it can be continuously processed [4]. The fluidized bed type is suitable for granular carriers. After TiO_2 loading, it can still be tumbling and migrate with the mobile phase. However, the carrier particles are much larger than TiO_2 nanoparticles and can be easily separated from the reactants. The filter is sealed in a photocatalytic reactor to achieve continuous treatment. The reactor has a cylindrical shape, and the light source is placed in the center of the container. Since there must be enough light irradiation catalyst in the photoreactor to activate it, a catalytic effect is produced. The photocatalytic reactor must correspond to the form of the light field emitted by a light source of a given geometry: a point or virtual light source is characterized by an emissivity Le:

$$Le = d^2Pe/d\Omega dAs$$

Pe-radiation energy, w; Ω-solid angle, sr; dAs-surface area unit, m [2] The line source is characterized by a radiant flux Me [106]:

$$Me = dPe/dAs$$

The relationship between the light source and the light intensity: k=aI/1+bI a, b is the constant I is the light intensity.

From this we can draw a more suitable light source. The height of the photocatalytic reactor is determined by the length of the fluorescent tube. Due to the heating, a quartz glass tube with a thickness of 2 mm is sheathed on the outside of the tube. Since the surface of the quartz glass tube reflects approximately 4% of incident UV light, approximately 8 wavelengths are caused. % of the refractive loss, therefore, the maximum transmittance of the quartz glass tube is 92%.

In addition, in order to make the gas flow rate uniform in the fluidized bed, we also plan to design a thin plate with a certain number of holes so that the flow velocity is uniform when the gas passes through the thin plate [5]. Then a lot of experiments to determine the appropriate catalyst particle size, flow rate size. For heating we plan to use a wraparound type, and the optimal reaction temperature will be determined experimentally.

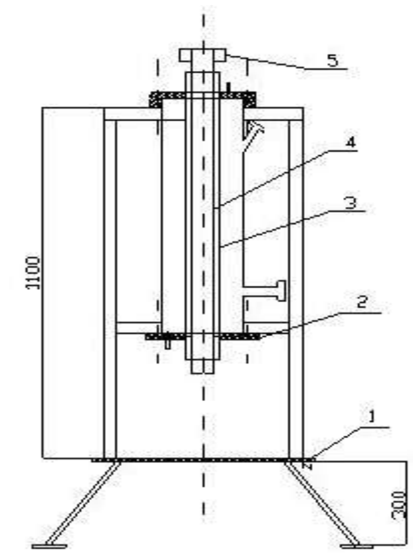

Figure 1: 1- Bracket 2 - Sealing Flange 3 - Quartz Glass Tube 4 - UV Lamp 5 – Ballast

3. INNOVATIVE

The absorption of visible light by the non-metallic element doping of nano-titanium dioxide improves the simultaneous desulfurization and denitrification under the action of visible light. The design of the fluidized bed in the reactor greatly increases the contact area between the reactor and the catalyst, thereby improving the reaction efficiency.

4. EXPERIMENTAL DIFFICULTIES

1) Determination of the effect of visible light intensity on photocatalytic reactions.

2) The doped TiO2 catalyst is attached to the carrier to prepare particles.

3) Fluidized in the reactor.

5. CONCLUSION

Improve the efficiency of purifying exhaust gas, which is more conducive to environmental protection. Allows desulfurization and denitrification to be performed at the same time, reducing the steps for purifying exhaust. Reduce equipment and operating costs, reduce the generation of secondary pollution, not only to remove the fixed source NOx. The oxidized exhaust gas can be made into chemical fertilizers to realize the recycling of waste gas.

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