Research on enhanced absorption technology of odour pollution

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Abstract. The Odor pollution problem in the feed industry was particularly prominent, which restricts the development of the industry and threatens the “vegetable basket” livelihood project. The air pollutant emission of feed processing enterprises were investigated in Pearl River Delta and its surrounding areas, find out the peculiar odor pollutants in feed industry through analysis and monitoring. With the characteristics of many kinds of odor pollutants and low threshold in feed industry, high efficient adsorbent was developed to explore the influence of adsorbent concentration, residence time, temperature and space velocity on the purification efficiency of odor gas, so as to achieve more efficient coordination of odor VOCs pollutants. In this study, a highly effective SCOP adsorbent was developed, and the removal rate of the main odor pollutants was more than 90%. It provides technical support for air pollution control and government environmental management of feed industry.

1. The significance and necessity of the project

China was the world’s largest feed producer and has ranked first in feed output for seven consecutive years since 2012. In 2018, total production reached 228 million tons, accounting for nearly 25 percent of global production. The rapid development of feed industry has brought about a series of air pollution problems, which have seriously restricted the development of the industry, especially the problem of malodorous gas disturbing the people was particularly prominent, and residents’ complaints have led to the production of feed enterprises or frequent relocation.

Feed was one of the most important grass-roots industries for people’s livelihood, and its development has a profound impact on the vegetable basket of urban and rural residents in China. However, the current lack of air pollution control and management technology in China’s feed industry was seriously inconsistent with the trend of rapid development of the industry, which exposes the following pressing problems:
1) Feed processing would emit a variety of air pollutants, mainly VOCs and odor gas. Its production and emission nodes, emission characteristics, emission factors and other basic information is not clear, it is difficult to support the pollution control of the industry.

2) Feed industry management technology reserves were insufficient. The existing masking method, dilution and diffusion method, adsorption method, combustion method, biological method, ultraviolet photolysis purification, photocatalytic oxidation and other technology treatment effects were not well, could not meet the requirements of industry management.

3) The feed industry lacks a standard policy. The air pollutant emission standard of feed industry has not been promulgated, and the regulations, standards and policy measures for odor pollution control were not perfect, leading to the lack of control in the industry.

This project was intended to carry out research on the emission characteristics of odor pollutants and pollution control technology in feed industry, promote the solution of hot issues of odor pollution faced by national and local governments, and provide scientific basis and technical support for air pollution control in feed industry, which has outstanding significance and urgency.

2. Emission characteristics of waste gas from feed industry
Expanding technology in feed industry was the main link to produce pollutants, which would produce a certain amount of odor and harmful gases. The concentration of odor pollutants in this industry was generally low, the composition was complex, the threshold was low, the monitoring was difficult, the treatment was difficult, the treatment requirements were high, making the treatment of odor pollutants in feed industry more difficult. Emissions, the olfactory threshold was low, easy to cause the stench gas pollution events, according to the analysis of expanded feed in the process of production will produce ammonia, sulfide, mercaptan, sulfur ether, amine, organic acids, such as the stench gas in addition to the hydrogen sulfide and ammonia, foul-smelling substances was organic matter more, these organisms has the characteristics of low boiling point, volatile strong, easy to cause the stench gas pollution, the stench gas easy to local residents affect physical health and ecological environment, lead to complaints are increasing. Therefore, the treatment of waste gas from feed industry has become a very important environmental protection problem. The main volatile organic compounds are shown in Table 1.

| Main components of volatile organic compounds in the feed production industry |
|-----------------------------|-----------------------------|-----------------------------|
| benzene                     | n-hexane                   |
| acetone                     | Isopropanol               |
| cyclohexane                 | methyl mercaptan          |
| ethylene propylene glycol   | ethyl acetate             |
| acetonitrile                | Isopropanol               |
| ethylbenzene                | ethyl alcohol             |
| hydrothion                  | methyl ether              |
| trimethylamine              | ammonia                    |

3. Study on waste gas from feed industry

3.1. Comparison of various governance methods
At present, feed production enterprises generally use traditional odor gas control technology, but the treatment effect needs to be further improved. Traditional odor gas control technology was divided into physical and chemical control technology. Physical deodorization method was usually used as the pre-treatment of deodorization treatment process, mainly including sealing method, masking method, dilution and diffusion method, setting greening isolation belt method, etc. [1]. Chemical deodorization mainly includes chemical oxidation method, wet washing method, liquid absorption method, biological method, membrane separation method, low-temperature plasma method, UV photolysis method, etc. [2-4].
In recent years, low temperature plasma technology and photo catalysis technology have developed rapidly, which have certain effect on the control of odor gas. However, due to the immature technology, it is difficult to meet the requirements of industrial treatment. In terms of VOCs treatment, absorption method is a relatively mature and effective control technology, which has a good potential application prospect in the treatment of odor pollutants in the feed industry. Therefore, it is of great significance to develop a new efficient absorption and control technology suitable for the treatment of odor pollutants in the feed industry.

To sum up, in terms of VOCs treatment, absorption method was a relatively mature and effective control technology, which has a good potential application prospect in the treatment of odor pollutants in the feed industry. Therefore, it was of great significance to develop a new efficient absorption control technology suitable for the treatment of odor pollutants in the feed industry.

3.2. Research progress of absorption method

Chemical absorption method adopts low volatile or non-volatile liquid as absorbent, and according to the solubility difference of each VOCs component in the absorbent (physical absorption) or chemical reaction characteristic difference (chemical absorption), pollutants in the exhaust gas can be absorbed and purified through absorption equipment such as packed tower and rotating packed bed. Absorbent was the core of absorption technology, which was divided into organic solvent absorbent, surfactant absorbent, microemulsion absorbent and ionic liquid absorbent. An ideal absorbent should have the following characteristics [5]: 1) low volatility or no volatility; 2) High absorption capacity (large absorption amount and fast absorption speed); 3) Low toxicity; 4) Low biodegradability or non-biodegradability; 5) Low cost, low corrosion of equipment. In industrial applications, because VOCs exhaust gas often has complex components and large fluctuation in content, the composite absorbent formed by organic solvents, surfactants, ionic liquids and other substances was mostly used. The components in the composite absorbent cooperate and promote each other to jointly improve the absorption purification effect and impact resistance of the absorbent [6]. Therefore, for the treatment of VOCs, it was particularly important to develop an ideal absorbent.

3.3. Waste gas collection and treatment facilities and processes

Governance facilities and processes. The combined treatment technology of "double tower enhanced absorption" was adopted. The air volume of treatment is 1500 m³/h to 5000 m³/h, and the odor concentration range was 5000 to 20000 (dimensionless). The odor concentration before and after purification was determined by three-point comparative odour bag method (GBT 14675-1993). First of all, the exhaust gas enters the spray tower, and the paint mist and particulate matter in the exhaust gas are absorbed by the principle of gas-liquid reverse contact, so as to achieve the pretreatment effect of filtering particulate matter, smoke and dust and cooling. It then leads to a packed tower containing adsorbents for further treatment of contaminants and final flue gas discharge. The specific process is shown in Fig1.
4. Purification effect of new adsorbent
The new absorbent developed in this project, together with water and SDBS absorbent, was placed in a packed tower to simulate the flue gas emission during normal production in a feed factory. The air flow into the packed tower was 2000 m$^3$/h, and the odor concentration was 4000 to 5000. Then the concentration of the waste gas treated with three kinds of adsorbents was measured. The test results were shown in Table 2.

Table 2. The odor exhaust gas outlet concentration was sampled with different absorbents

|       | SCOP | Water | SDBS |
|-------|------|-------|------|
| 0.5   | 417  | 724   | 550  |
| 1.0   | 417  | 724   | 724  |
| 1.5   | 417  | 977   | 724  |
| 2.0   | 417  | 977   | 977  |
| 2.5   | 417  | 1337  | 977  |
| 3.0   | 417  | 1337  | 977  |
| 3.5   | 417  | 1337  | 977  |
| 4.0   | 417  | 1965  | 977  |

As shown in Table 2, different absorbents have different removal rules for malodorous waste gas. Water and SDBS reduce their purification efficiency with the extension of time, indicating that the absorption capacity of the two absorbents was limited. When SCOP was sampled, the outlet concentration of odor exhaust gas was always kept at a low level within the experimental time range. The results showed that the adsorption capacity of SCOP as adsorbent was much higher than that of water and SDBS as adsorbent.

It was determined that SCOP was the optimal absorbent, and then SCOP was used as the absorbent alone to control the absorption effect of the odor concentration between 5000 and 20000 under the same air inflow rate of 2000 m$^3$/h. Test whether SCOP can maintain good absorption effect in different odor concentration. The test results were shown in Table 3.

Table 3. Removal effect of SCOP absorbent on odor waste gas with different concentrations

|       | 5000 | 10000 | 20000 |
|-------|------|-------|-------|
| 0.5   | 417  | 550   | 550   |
| 1.5   | 417  | 550   | 724   |
| 2.5   | 417  | 550   | 977   |
| 3.5   | 417  | 724   | 977   |

As shown in Table 3, SCOP absorbent also has good purification efficiency for odor waste gas with different concentrations. The removal rate decreases slightly with the increase of odor concentration, but the exit concentration was always within 1000, which has a good application prospect.

5. Conclusion
At present, China's feed industry air pollution control and management technology was lack, feed processing would emit a variety of air pollutants mainly VOCs, odor pollutants, the existing technology was difficult to solve the odor complaint problem. Chemical absorption method was a mature VOCs treatment technology, its core was absorbent, but the feed industry air odor VOCs pollutants emission has its industry characteristics, the existing absorption process was difficult to meet the feed industry air odor VOCs treatment requirements. Therefore, it was necessary to research and develop novel effective uses like SCOP as an absorption, optimization and improvement of the absorption process to meet the treatment requirements of odorous VOCs pollutants in the feed industry.

Acknowledgments
The research was funded by the National Key Research and Development Plan of China (2019YFC0214300), Special Funds for Research from the Environmental Charity Project of South
China Institute of Environmental Sciences (PM-zx703-202003-103), the Guangdong Science and Technology Plan Project (2017A030223005), the Guangzhou Science and Technology Plan Project (20180410147), and the National Air Pollution Prevention Joint Research Project Funded China Center (DQGG0204).

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