

## Study on purification of acetone gas by UV/Fenton

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**Abstract.** VOCs was one of main air pollutants. Fenton reaction was concerned because of its oxidation, high speed and high efficiency. In this paper, the Fenton reagent combined with UV was used to purify acetone gas, and the effect factors was studied. The results showed that the removal efficiency of acetone gas was highest, up to 90.2%, when pH value was about 3, oxidation reduction potential was 480mV. The removal rate of acetone gas increased nearly 5% when UV was added on Fenton reagent.

### Introduction

Volatile organic compounds (VOCs) were the common air pollutants emitted by the petroleum and chemical industry which affect public health and welfare owing to their toxicity potential, carcinogenicity and stability<sup>[1,2]</sup>. Recently emission control of VOCs has become a major concern in air pollution prevention. Treating effluent gas including VOCs to harmless level is an arduous process<sup>[3,4]</sup>. Therefore, the treatment and recovery of VOCs were paid more attentions in the world.

The control technologies of VOCs are usually divided into oxidation method, biological method<sup>[5]</sup>, absorption method, adsorption method and Plasma method<sup>[6]</sup> and so on. Because VOCs have the characteristics of wide sources and complex components, so in the practical application, single technology is usually difficult to achieve VOCs effective purification, so the combined technology has become the current developing direction. Chemical oxidation is concerned because of its oxidation, high speed and high efficiency<sup>[7]</sup>. The Fenton reagent is firstly applied in waste-water treatment, which is one of the advanced oxidation processes, is recognized as a powerful photo-catalytic degradation technology<sup>[8,9]</sup>. Now days, the photo-Fenton reaction has been extensively studied. It may offer a promising technology even in the effluent gas treatment for VOCs owing to its greater efficiency<sup>[10-12]</sup>. In this paper, acetone gas was selected as objective VOCs pollutant, Fenton reagent was used to oxidate acetone; the combination method of the absorption with chemical oxidation was studied.

### Experimental

#### Materials and Reagents

Acetone( $\text{CH}_3\text{COCH}_3$ ), the Fenton reagent ( $\text{Fe}^{2+}$  and  $\text{H}_2\text{O}_2$ ) ; Hydrochloric acid (HCl), Sodium hydroxide (NaOH). All reagent grades are AR, they were purchased Shijiazhuang Reagent Factory.

#### Experimental process

The experimental system includes two parts of gas distribution system and absorption system, the absorption system comprises an absorption tower and a liquid recirculation system, the experimental setup is showed in Fig.1.

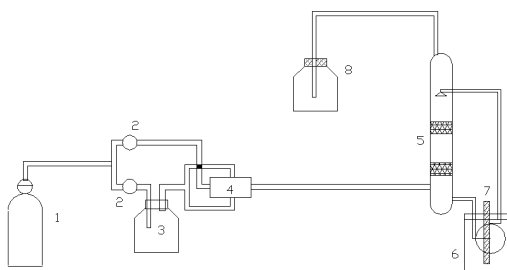


Fig.1. Experimental setup

air tank; 2. flow-meter ; 3. acetone; 4. three way pipe; 5. oxidizing agent bottle;  
6. reaction tower;7.the uv lamp; 8. exhaust gas treatment device.

## Methods

### Determination of the pH value

As chemical absorption liquid, the Fenton reagent was adjusted by hydrochloric acid solution and sodium hydroxide solution. After the system was stable, pH value of the circulation absorption liquid was measured by pH meter with pH composite electrode.

### Determination of the redox potential

The redox potential of the Fenton reagent was measured by pH meter with 501 ORP composite electrode.

### Determination of acetone gas concentration

Acetone gas concentration was determined by Gas chromatograph (GC-14C, Shimadzu Corporation) with a 50m capillary column and a flame ionization detector. The analysis conditions were 90°C of column temperature, 150°C of inlet temperature and 200°C of detector temperature. The peak time of acetone was about 1.77min.

Removal efficiency of acetone gas was calculated as follows:

$$\eta(\%) = \frac{C_1 - C_2}{C_1} \times 100\% = \frac{S_1 - S_2}{S_1} \times 100\%$$

Where C1 and C2 are the inlet concentration and export concentration, mg/m<sup>3</sup>, S1 and S2 are the import and export of peak area.

### Determination of gas phase products

Gas phase products in the exhaust gas was analysed by gas chromatography mass spectrometry (GC-MS, QP2010, Shimadzu Corporation).

## Results and discussion

### Effect of pH on acetone removal rate

When the acetone air flow was 50 L/min and the Fenton reagent flow was 250 ml/min, acetone gas was absorbed and chemically oxidated by Fenton reagent under different pH as shown in Fig.2.

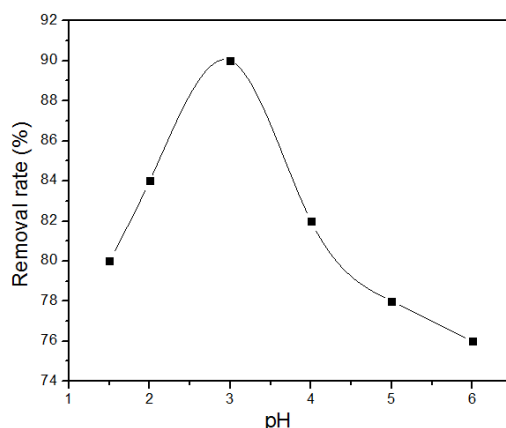


Fig.2. Relation curve of acetone removal rate with pH

The removal rate of acetone initially increased and then decreased with pH, when pH was about 3, the removal rate was the highest, about 90.1%. The reason was that when pH value was too low and  $H^+$  ion is too high, it was not easy to generate  $\bullet OH$ , so the oxidation rate of acetone was decreased, while when pH value was too high and  $OH^-$  ion is too high, it was not conducive to the reaction to the forward movement, so the removal effect of acetone was also reduced.

### Effect of oxidation-reduction potential on acetone removal rate

For a solution system, the oxidation reduction potential is a composite result of a variety of redox reaction of oxidant with reducing substances. Although it is not as the index of oxidant and reducing substance concentration, but it helps to understand the electrochemical characteristics and analyse the properties of the solution, so it is a comprehensive index. When the acetone air flow was 50 L/min and the Fenton reagent flow was 250 ml/min, acetone gas was absorbed and chemically oxidated by the Fenton reagent under different oxidation-reduction potential as shown in Fig.3.

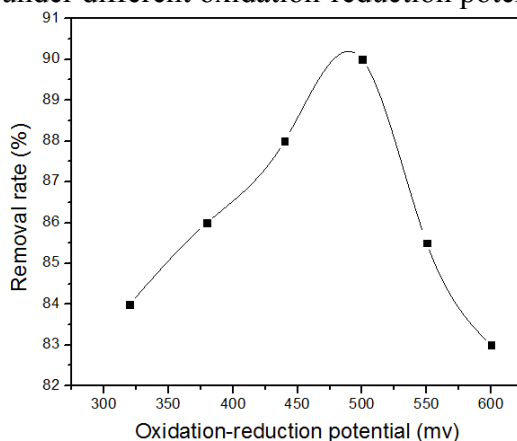


Fig.3. Relation curve of acetone removal rate with oxidation-reduction potential

From Fig.3, when the oxidation-reduction potential was about 480mV, the removal rate of acetone gas was the highest, the removal efficiency can reach above 90.2%. Obviously, the potential was too high or too low was not conducive to acetone removal.

### Effect of UV/Fenton on acetone removal rate

When the acetone air flow was 50 L/min and the Fenton reagent flow was 250 ml/min, acetone gas was absorbed and chemically oxidated by Fenton reagent and UV/Fenton reagent as shown in Fig.4.

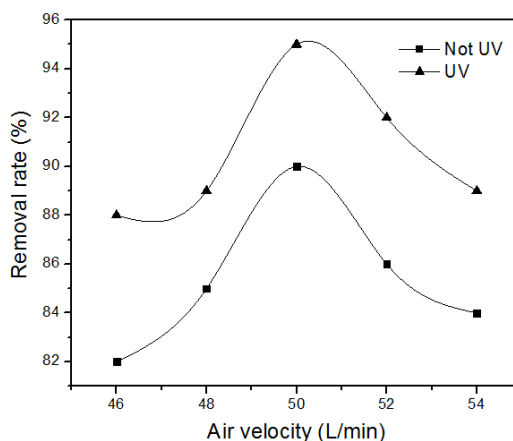


Fig.4. Relation curve of acetone removal rate with UV

The removal rate of acetone initially increased and then decreased with UV, when gas flow was about 50 L/min, the removal rate was the highest, about 95%. Compared with the Fenton reagent, the removal rate of acetone gas increase nearly 5% by UV/Fenton, the reason for this is that the solution generate The strong oxidizing  $\cdot\text{OH}$ , so the UV obviously improve the oxidation of acetone gas.

### Determination of gas phase products

The components of the exhaust gas was analysed by GC-MS. Except for trace amount of acetone and acetic acid, no other substances were found in the exhaust gas. Acetone attributed to the uncompleted purification, while acetic acid was the middle product from degraded acetone. The specific reaction was not clear, further study need to be done.

### Conclusions

This study showed that the Fenton reagent could effectively purify acetone gas. In the Influence factors, pH value and the oxidation-reduction potential had important effects on the removal of acetone gas. When pH of the Fenton reagent was about 3 and the oxidation-reduction potential was maintained at 480mV, the removal efficiency of acetone gas could reached above 90.2%. The removal rate of acetone gas increased nearly 5% when UV was added on Fenton reagent, obviously UV improved the oxidation of acetone gas.

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