Advanced Oxidation Technology for Refractory Organic Compounds in Wastewater

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Abstract. As a relatively important task in the current industrialization development, wastewater treatment has become increasingly demanding in the context of China’s current rapid industrialization. In order to improve the quality of industrial wastewater treatment, it is necessary to clarify the relevant treatment technologies according to the requirements of the treatment process. Meanwhile, scientific treatment methods should also be combined with the requirements in the wastewater treatment technology, especially for the treatment of refractory organic compounds in wastewater. In other words the quality of wastewater treatment can be improved only by scientific treatment of refractory substances in wastewater. Therefore, this paper analyzes the advanced oxidation technology for degrading refractory organic compounds in wastewater, with the aim to clarify the treatment of refractory organics in wastewater and then improve wastewater treatment quality.

1. Introduction
Advanced oxidation technology, which is commonly used in wastewater treatment, can be adjusted according to the requirements of technical practice in its application. Meanwhile it can also conduct a scientific analysis of the treatment of refractory organic compounds in wastewater and realize the scientific planning for the implementation of wastewater treatment. This paper aims to clarify the application mode of the advanced oxidation technology based on the research on its application in degrading refractory organics in wastewater. Combining the requirements in the implementation of related technologies, it also analyzes the methods of treating the refractory substances in wastewater with the advanced oxidation technology. By improving the application measures of related technologies, this paper attempts to ensure the application of related technologies can improve wastewater treatment quality.

2. Related Concepts

2.1. Wastewater Treatment
Wastewater treatment is intended to reduce the environmental pollution caused by industrialization. In the industrial production process, special treatment for wastewater formed during production ensures that the wastewater can be recycled. Meanwhile, in order to better demonstrate the level of industrial development, many factories have established wastewater treatment plants to reduce pollution brought
by wastewater. Proper wastewater treatment can lay a solid foundation for improving the quality of the factory production. Besides, scientific treatment methods can precisely analyze the wastewater resulting from industrial production, thereby improving the wastewater treatment capacity during the treatment process [1].

2.2. Degradation of Organic Compounds
Degradation of organic compounds refers to a technique for treating pollutants adopted by modern industrialization to better plan industrial development. According to different techniques used in the chemical analysis, degradation of organic compounds can also be called the attenuation of organic pollutants. Based on chemical means, this technique degrades original pollutants and finally generates new products by use of chemical technology [2]. In general, degradation of organic compounds is commonly used in wastewater treatment. Since there are numerous factors that cause wastewater and each factor has a different correlation with another, degradation of organic compounds is necessary for wastewater treatment. Moreover, degradation of organic compounds can improve wastewater treatment capacity and contribute to wastewater recycling.

2.3. Advanced Oxidation Technology
Advanced oxidation technology refers to a chemical method for treating and degrading wastewater based on chemical means. According to its different application forms, advanced oxidation technology can be divided into different oxidation modes [3]. The application of each oxidation mode can improve the capacity and efficiency of wastewater treatment through scientific analysis of the wastewater treatment. Since the advanced oxidation technology can integrate related techniques during wastewater treatment, it can refine the technical application system according to requirements of the techniques involved, thus laying a solid foundation for the scientific development of technology application. Theoretically, the advanced oxidation technology for degrading wastewater is based on organic decomposition and mineralized decomposition, through which this technology can make adjustment to the method of wastewater treatment.

3. Application of Advanced Oxidation Technology in the Treatment of Refractory Organic Compounds in Wastewater
The advanced oxidation technology for treating organic compounds in wastewater mainly involves chemical oxidation technology, electrochemical oxidation technology, wet air oxidation technology, supercritical water oxidation technology, and photocatalytic oxidation technology. The specific technical application process is shown in Figure 1 below:
3.1. Chemical Oxidation Technique
Chemical oxidation is another technology for degrading refractory organic compounds in wastewater. Catalysts are essential for adjusting the treatment method during the whole process of wastewater treatment and scientific catalysisis conducive to degrading refractory organic compounds inside the wastewater. In addition, the chemical oxidation technology destroys internal molecular structure of the refractory organic compounds through oxidative decomposition, thus ensuring effective degradation. In many cases, the application of chemical oxidation technology is highly valued in the treatment of industrial wastewater. In summary, the chemical oxidation technology makes scientific planning for the degradation of refractory organic compounds by combining chemical oxidation and catalysts, thereby improving the comprehensive capacity of advanced oxidation technology [4].

3.2. Electrochemical Oxidation Technology
The emergence of electrochemical oxidation marked another improvement made in the treatment technology for degrading refractory organic compounds inside wastewater. Since the electrochemical oxidation technology involves different control mode in its application, it changes the oxidation method during the entire process of wastewater treatment. Meanwhile, the overall technological application form alters due to the change in the application form of the electrochemical oxidation technology involved in wastewater treatment. Direct electrochemical oxidation and indirect electrochemical oxidation are the two commonly adopted electrochemical oxidation techniques, whose specific technical application are redescribed as follows.
3.2.1. Direct Electrochemical Oxidation. Based on direct electrochemical oxidation, this technology first deactivates the surface molecules of refractory organic compounds in wastewater by adjusting the composition form of these surface molecules wastewater treatment. Then it degrades these refractory organic molecules with the chemical oxidation technology, thereby laying a solid foundation for improving wastewater treatment capacity and making scientific treatment plan, and fully demonstrating the characteristics of wastewater treatment technology [5]. The direct electrochemical oxidation equation is as follows:

$$M + H_2O_2 - e^- = M(OH) + H^+$$

3.2.2. Indirect Electrochemical Oxidation. Indirect electrochemical oxidation is adopted when ion replacement in the whole wastewater treatment needs to be changed due to the different ion composition of the refractory organic compounds. In order to improve the quality of wastewater treatment, it is necessary to analyze the indirect electrochemical oxidation technology for wastewater treatment according to the requirements in its application. This technology realizes potential conversion in the wastewater treatment work through ion substitution, thereby ensuring effective wastewater treatment [6].

3.3. Wet Oxidation
Wet oxidation is also one of the common oxidation technologies used in wastewater treatment. In the actual application process, different requirements for catalysts lead to different application forms of wet air oxidation technology. Generally, in order to better demonstrate the application effect of the wet air oxidation technology for wastewater treatment, it is essential to appropriately adjust its application methods, that is, wet air oxidation and wet air catalysis [7].

3.3.1. Wet Air Oxidation. Wet air oxidation technology conducts control analysis on the wastewater treatment according to the requirements of its application, thus better demonstrating its technical characteristics and ensuring effective wastewater treatment. During its application, wet air oxidation further distinguishes the related application methods according to the requirements for degrading the refractory organic compounds, thus ensuring effective degradation in wastewater treatment. However, it should be noted that catalysts are not used in the application of wet air oxidation technology and thus the application effects of the entire technology are reduced [8].

3.3.2. Wet Air Catalysis. The wet air catalysis technology combines catalyst and air oxidation to degrade refractory organic compounds in wastewater, improving the effectiveness of degradation. In addition, this technology can degrade the molecular composition according to the requirements of its application, thereby providing a guarantee for the wastewater treatment work.

3.4. Supercritical Water Oxidation Technology
The supercritical water oxidation technology, which is also commonly used in wastewater treatment, realizes scientific control of wastewater degradation treatment in that it degrades the refractory organic compounds in wastewater with water oxidation. In application, this technology can ensure the comprehensive control of wastewater treatment by means of water oxidation and rapidly degrade refractory organic compounds.

3.5. Photocatalytic Oxidation
Photocatalytic oxidation is also a commonly used technology in wastewater treatment. Different requirements for the degradation of refractory organic compounds in wastewater treatment lead to different degrading methods. This technology can achieve catalytic separation of refractory organic compounds through photocatalytic oxidation, which reflects the application characteristics of current
wastewater treatment technology. In general, the application of photocatalytic oxidation technology consists of the following steps:

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\text{TiO}_2 + h\nu = \text{TiO}_2(e^- (CB) + h^+ (VB)) \\
\text{OH}^- + h^+ (VB) = \text{OH} \\
\text{O}_2 + e^- (CB) = \text{O}_2^- \\
2\text{HO}_2 = \text{H}_2\text{O}_2 + \text{O}_2 \\
\text{H}_2\text{O}_2 + \text{O}_2^- = \text{OH}^- + \text{OH} + \text{O}_2
\]

4. Case Analysis
Experimental analysis is required as the main treatment method in the degradation of refractory organic compounds inside wastewater. Combining the requirements for treating refractory organic compounds in a wastewater treatment plant, the author designed the experiment below.

4.1. Selection of Experimental Instruments
Experimental oxidation analysis was selected in the treatment of refractory organic compounds in the wastewater treatment plants. The main experimental instruments selected are as follows:

Electronic balance, visible spectrophotometer, magnetic electrode, tableting machine, electron microscope, digital camera, X-ray diffractometer.

4.2. Selection of Experimental Materials
The main materials involved in the experiment are sulfuric acid, nitric acid, sodium hydroxide, copper nitrate, absolute ethanol, sodium sulfate, ammonium nitrate, and the like, which are all provided by Beijing Chemical Works.

4.3. Experimental Device Assembly
After the selection of relevant experimental materials, the experimental instruments are assembled in combination with the requirements in the treatment of refractory organic compounds. Based on the analysis of advanced oxidation technology, an adjusted electrochemical experiment assembly device is adopted. The specific experimental assembly is shown in Figure 2:
4.4. Analysis of Experimental Results

Through the analysis of technical application in the whole experiment, it is found that the adopted experimental device lays a solid foundation for the treatment of refractory organics in the experiment based on the analysis of advanced oxidation technology. The results show that appropriate selection and application of experimental materials in the experiment above guarantees the experimental test and demonstrates the effect of whole experimental analysis and test. Besides, it is also found that in the technical treatment based on oxidation technology, relevant technologies provide a basis for the treatment of mixed solution.

Figure 2. Experimental assembly device
The results of the experiment show that in the implementation of the existing oxidation technology treatment, the treatment of the refractory organic compounds is effectively guaranteed by use of relevant techniques, and the comprehensive capacity of the treatment technology for refractory organic is improved. In addition, the treatment method of oxidation is adjusted according to the specific requirements in the course of the experiment. This is because there were differences between the relevant technologies in terms of treatment methods in the current experiment, which lead to new requirements for controlling the treatment of refractory organic compounds. Finally, the experimental results show that the advanced oxidation technology can achieve technical separation for the treatment of refractory organic compounds in wastewater, thereby meeting the technical needs of treating refractory organics to the maximum extent.

5. Conclusion
In summary, in application of the advanced oxidation technology for degrading refractory organic compounds in wastewater, it is necessary to analyze the related concepts involved according to the requirements of wastewater treatment and timely adjust the method of oxidation according to the requirements of the advanced oxidation technology so as to ensure the effect of wastewater treatment work. Based on the analysis made in this paper, the application of advanced oxidation technology in the degradation of refractory organic compounds in wastewater can be summarized as follows: chemical oxidation technology, electrochemical oxidation technology, wet air oxidation technology, supercritical water oxidation technology, and photocatalytic oxidation technology. Appropriate application of the above five oxidation technologies ensures scientific degradation of refractory organic compounds in wastewater, thereby demonstrating the characteristics of the current wastewater treatment technology and meeting the actual needs for oxidation technology in wastewater treatment.

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