Research on the Treatment Technology of Refractory Organic Compounds in Coal Chemical Wastewater

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Abstract: With the proposal of the "Two Mountains Theory", energy conservation and emission reduction have become the core goal of the transformation of the coal chemical industry. How to treat the difficult to degrade organic matter in coal chemical wastewater has become the primary problem that coal enterprises need to solve. Coal enterprises should clarify the characteristics of coal chemical wastewater, adopt traditional treatment technologies, and use biochemical, physicochemical, and adsorption methods to remove difficult to degrade substances from wastewater; Actively introducing oxidation technology, using ultrasonic oxidation technology, electrocatalytic oxidation technology, etc. to treat difficult to degrade organic compounds in coal chemical wastewater; Reasonably utilizing biological treatment technology to reduce environmental damage during wastewater treatment; Using membrane treatment technology to accelerate the treatment of difficult to degrade organic compounds in coal chemical wastewater, enabling it to meet discharge standards and further promoting water resource recycling.

Keywords: Coal chemical wastewater; Difficult to degrade organic matter; Source of wastewater; Processing technology

Introduction:

Coal chemical wastewater refers to the wastewater generated during the conversion process of coal, including coal gasification, coal liquefaction, and coal coking. Due to the complexity of the coal conversion process, a large amount of wastewater with high pollutant concentration and complex water quality is generated, which poses significant challenges to the treatment of coal chemical wastewater. The production process of coal chemical industry involves various chemical reactions, and the pollutants produced are also quite complex, many of which are difficult to degrade organic compounds. This requires coal enterprises to choose corresponding treatment methods for different types of pollutants. This article analyzes the characteristics of coal chemical wastewater and proposes the use of traditional treatment techniques, oxidation treatment techniques, biological treatment techniques, and membrane treatment techniques to treat coal chemical wastewater. Harmless treatment of difficult to degrade substances in the wastewater is carried out to meet the national discharge standards, further improve the quality of coal chemical wastewater treatment, minimize the impact of coal chemical wastewater on the atmosphere, water sources, soil, etc., and further promote the sustainable development of the coal industry.

I. Sources and characteristics of coal chemical wastewater

Coal chemical wastewater mainly comes from the large amount of industrial wastewater generated during the conversion of coal into various chemical products. The wastewater contains a large amount of toxic and harmful substances such as phenols and ammonia nitrogen, as well as recalcitrant organic compounds such as indoles, biphenyls, and pyridines, which can cause serious damage to the atmosphere, groundwater, soil, and environment. Therefore, coal enterprises must strictly follow the national coal chemical wastewater treatment standards to treat wastewater, eliminate harmful substances that are difficult to degrade in wastewater, and discharge coal chemical wastewater only after meeting the discharge standards.

1. Coking wastewater

In order to obtain coke, gas, and other by-products, coal enterprises will heat the raw coal at high temperatures to accelerate the high-temperature cracking of coal blocks. During the high-temperature heating process, a large amount of wastewater will be generated, and the harmful components of the wastewater are relatively complex. Due to differences in the composition of raw coal and coking processes, there are also differences in the composition of coal chemical wastewater generated by coal enterprises during high-temperature cracking. Overall, coking wastewater contains high levels of harmful substances such as phenols and ammonia nitrogen, as well as some difficult to degrade polycyclic aromatic compounds such as pyridine and indole. These components have strong biological toxicity and are difficult to degrade, making treatment difficult.

2. Gasification wastewater

Gasification waste water refers to gasification waste water such as gas washing waste water produced by the chemical reaction of combustible materials into gas fuel when the middling coal fuel of the boiler takes air as the gasification medium. During the coal gasification reaction process, it undergoes processes such as gas washing, condensation, and purification. During the reaction, industrial wastewater containing aromatic and heterocyclic compounds is generated. The wastewater contains a large amount of carbon dioxide, which is soluble in water. If it is not treated or the wastewater does not meet the standards, it will be discharged in violation of regulations, causing serious water resource pollution. Gasification wastewater has a high concentration of ammonia nitrogen, contains highly toxic cyanide, as well as difficult to degrade polycyclic aromatic hydrocarbons and benzene derivatives, making it highly suitable for wastewater treatment

technology. The gasification wastewater contains a lot of toxic and harmful substances, and the requirements for wastewater treatment technology are relatively high. Coal enterprises can integrate different treatment technologies to further treat the difficult to degrade organic matter and highly toxic substances in gasification wastewater, minimizing the harm of coal chemical wastewater to the environment and human health.

3. Liquefied wastewater

Liquefied wastewater refers to the wastewater generated during coal production processes such as hydrocracking and hydrogenation refining. The wastewater contains a large amount of harmful substances such as methane and phenols, with high COD values and difficulty in wastewater treatment. It also produces low concentration oily wastewater, which requires the removal of coal oil from the water before discharge. Liquefied wastewater treatment processes are complex and costly. At the same time, liquefied wastewater also has dual properties of organic and inorganic pollution, requiring coal enterprises to scientifically apply multiple treatment methods in the treatment process to remove harmful substances from liquefied wastewater.

II. The importance of coal chemical wastewater in the context of the new era

1. Beneficial for protecting water resources

Coal chemical wastewater contains a large amount of harmful substances. If not professionally treated or discharged in violation of discharge standards, it will cause damage to groundwater, rivers and other water resources, as well as damage the living environment of aquatic organisms, disrupt ecological balance, and bring irreparable losses. By harmless treatment of coal chemical wastewater, harmful and toxic substances can be removed, and water resource recycling can be accelerated. This can not only help coal enterprises reduce costs, but also reduce the damage of coal chemical wastewater to water resources, better protect groundwater and river resources, and lay a good foundation for accelerating the green development of the coal industry.

2. Beneficial for reducing environmental pollution

In the context of energy conservation and emission reduction, coal enterprises should bravely shoulder social responsibilities, increase investment in coal chemical wastewater treatment, introduce advanced coal chemical wastewater treatment equipment, strictly treat coal chemical wastewater in accordance with national industrial wastewater discharge standards, remove difficult to degrade organic compounds in wastewater, and discharge them into the environment after meeting discharge standards, reducing pollutant emissions and environmental pollution, and practicing the concept of green development. At the same time, it is difficult to explain how organic matter treatment is beneficial for reducing harmful substances in coal chemical wastewater, facilitating the recycling of treated coal chemical wastewater, reducing its impact on the ecological environment, such as reducing pollution to soil, groundwater, and atmosphere, and maintaining ecological balance.

3. Beneficial for accelerating the transformation and development of coal enterprises

With the proposal of the “carbon peak” and “carbon neutrality” strategies, reducing carbon emissions has become a bottleneck problem in the transformation of the coal industry, and reducing carbon dioxide and pollutant emissions has become a difficult problem that coal enterprises need to solve. The treatment of coal chemical wastewater is an important foundation for the transformation and development of coal enterprises and the reduction of carbon emissions. We should actively introduce new technologies and processes for the treatment of difficult to degrade organic matter in coal chemical wastewater, choose treatment methods based on the harmful and harmful substance content of coal chemical wastewater, further improve the purification level of coal chemical wastewater, and promote the sustainable development of enterprises themselves.

III. Treatment technology for refractory organic compounds in coal chemical wastewater

1. Using traditional treatment techniques to remove difficult to degrade organic matter

The main types of pollutants present in coal chemical wastewater include CODcr, BOD5, and ammonia nitrogen. There are many difficult to degrade organic compounds, which pose significant challenges to the treatment of coal chemical wastewater. Traditional treatment techniques refer to the use of flocculation and adsorption methods to accelerate the precipitation of organic pollutants and improve the COD removal rate. Firstly, technicians can use adsorption methods to separate difficult to degrade organic compounds from coal chemical wastewater. Activated carbon and resin can be used to adsorb pollutants and improve COD removal efficiency. The adsorption process will not produce secondary pollution, and the water quality requirements for coal chemical wastewater are relatively low. The cost is relatively low, and it is widely used in coal chemical wastewater treatment. Secondly, technicians can also use physicochemical methods to treat coal chemical wastewater. On the basis of adding activated carbon materials, catalysts such as Fe (OH) 3, Fe (OH) 2, and Fe2O3 can be added to oxidize the organic matter in the wastewater into small molecule organic matter, which facilitates further decomposition of harmful substances, purification of wastewater, and reduction of pollutant concentration in coal chemical wastewater. At the same time, technicians can also use flocculation method to treat coal chemical wastewater, adding inorganic flocculants to the wastewater, using flocculants and adsorption neutralization reactions to destabilize and optimize difficult to degrade organic matter, and then performing solid-liquid separation treatment to further remove COD from coal chemical wastewater and return the wastewater to normal color, thereby improving the quality of coal chemical wastewater treatment.

2. Applying oxidation treatment technology to improve the quality of wastewater treatment

Firstly, coal enterprises should actively introduce ultrasonic oxidation technology, utilize ultrasonic cavitation effect to purify pollutants in wastewater, and efficiently and quickly remove difficult to degrade organic compounds in coal chemical wastewater. Technicians

can first detect the composition of coal chemical wastewater, adjust the power and frequency of ultrasonic equipment based on the wastewater composition, degrade coal chemical wastewater containing phenols, gradually remove difficult to degrade organic compounds in the wastewater, and also use ultrasonic catalysis to accelerate the reaction between organic solvents and difficult to degrade organic compounds, improving the removal rate of organic pollutants. Secondly, technicians can use electrocatalytic technology to treat coal chemical wastewater, accelerate the treatment speed of difficult to degrade organic compounds, adopt advanced electrodeposition method, use polytetrafluoroethylene material to make electrodes, combine electrodes with oxidants, break the electronic balance in coal chemical wastewater, and remove difficult to degrade organic compounds in wastewater, so that the wastewater meets national discharge standards. Due to the high cost of electrocatalytic method and the high level of operation required for technical personnel, there are not many coal enterprises currently applying this technology. The application of electrocatalytic oxidation method in the treatment of difficult to degrade organic compounds in coal chemical wastewater still has great development prospects.

3. Reasonably use biological treatment technology to avoid secondary pollution

Biological treatment technology refers to the use of screened and highly efficient degradation bacteria and the commonly used A/A/O combination process in the industry to treat organic pollutants in industrial wastewater, which can effectively improve COD removal rate. At present, the commonly used biological treatment technologies in coal chemical wastewater treatment include aerobic activated sludge method, contact oxidation method, biofilm method, etc., which use microorganisms to decompose and treat difficult to degrade organic compounds in wastewater, gradually breaking down these pollutants into small molecules that can be degraded. For example, technicians can use the aerobic activated sludge method to treat difficult to degrade organic pollutants in coal chemical wastewater. A biofilm is added to the reactor to adsorb and degrade organic matter in the wastewater. Then, through microbial action, other harmful substances in the wastewater are removed, and further treatment of coal chemical wastewater is carried out to reduce its environmental damage, laying a good foundation for the recycling of coal chemical wastewater. Compared to the aerobic activated sludge method, anaerobic biological treatment technology has lower costs and a more stable treatment process. However, the generated sludge scale invisibly increases the cost of sludge treatment in coal enterprises, which can easily lead to equipment failures in coal chemical wastewater treatment.

4. Applying membrane treatment technology to improve the quality of coal chemical wastewater treatment

Membrane treatment technology refers to the use of polymer materials to treat refractory organic compounds in coal chemical wastewater, which has the advantages of low energy consumption, good stability, and strong anti pollution ability. At present, coal enterprises mainly use reverse osmosis membranes to treat wastewater, effectively absorbing and degrading organic pollutants in wastewater, and achieving significant removal rates of ammonia nitrogen and COD in wastewater. For example, technicians can use reverse osmosis membranes to treat high salinity coal chemical wastewater, effectively removing salt substances from the wastewater, with a high desalination rate. During the treatment process, it is necessary to regularly clear the blocked pores of the reverse osmosis membrane. In addition, coal enterprises can also introduce nanofiltration technology to delay the treatment of coal chemical wastewater, effectively removing COD and ammonia nitrogen pollutants in the wastewater. However, nanofiltration technology has a small membrane area, high cost, and is not suitable for large-scale use, with great development prospects.

IV. Conclusion

In short, coal enterprises should establish a green development concept based on energy conservation, emission reduction, and the “dual carbon” background, attach importance to the treatment of difficult to degrade organic matter in coal chemical wastewater, introduce advanced sewage treatment equipment and excellent environmental protection talents, sample and analyze coal chemical wastewater, and choose sewage treatment technology based on the content of toxic and harmful substances in the wastewater and the type of difficult to degrade organic matter. Technicians should actively utilize traditional treatment techniques, oxidation techniques, membrane treatment techniques, and biological treatment techniques to decompose and remove pollutants from coal chemical wastewater, ensuring that the wastewater meets national discharge standards and recycles coal chemical wastewater that meets standards, promoting sustainable development of coal enterprises.

Reference:

[1] Jiangbin Wang, Hongzhou Qian, Hongwei Zhu, et al. Characteristics of Solid Waste Composite Enhanced Coagulation for the Removal of Refractory Organic Compounds from Coal Chemical Wastewater [J]. Energy Engineering, 2022, 42 (03): 59-64+82.

[2] Chengcheng Zhang. Research on the treatment of refractory organic compounds in coal chemical wastewater [J]. Shanxi Chemical Industry, 2021, 41 (04): 205-207.

[3] Yongchao Zhao, Shuai Yang, Shujie Yang, et al. Study on the COD treatment of high salinity wastewater in coal chemical industry using ozone catalysis adsorption combined method [J]. Industrial Water and Wastewater, 2023,54 (06): 18-22.

[4] Zhengnan Fang. Treatment of High Concentration Sodium Chloride Wastewater from Coal Chemical Industry by Freezing Solution Crystallization Method and Its Resource Utilization [D]. East China University of Science and Technology, 2023.

[5] Hong Wang, Xingmin Wei. Application of ozone/activated carbon/MBR technology in advanced treatment of coal chemical wastewater [J]. Shanxi Chemical Industry, 2023,43 (04): 210-212 .

This article is a study on the degradation of pharmaceutical wastewater under low-temperature conditions using aerobic granular sludge. Project number: 2024JYTKPT-03. The project "Dust Treatment after Sludge Drying" is a great creation. The project number is 2024430038.