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New Technologies of Sewage Treatment

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Abstract: Recent advancements in sewage treatment technologies have led to more efficient, sustainable, and environmentally friendly solutions for managing wastewater. Innovations such as membrane bioreactors (MBRs), advanced oxidation processes (AOPs), and artificial intelligence (AI)-based monitoring systems are transforming traditional treatment methods. These technologies enhance pollutant removal, reduce energy consumption, and enable water reuse. Furthermore, real-time data analysis and automation improve operational efficiency and system reliability. This paper explores emerging sewage treatment technologies, their mechanisms, advantages, and implementation challenges. Understanding these modern approaches is critical for addressing growing urban wastewater demands while minimizing ecological and public health risks.

Keywords: Catalytic wet air oxidation technology, Sewage treatment, wastewater management, membrane bioreactors (MBRs), advanced oxidation processes (AOPs), artificial intelligence, water reuse, environmental sustainability, real-time monitoring, energy efficiency, modern sanitation technologies.

Introduction. With the continuous improvement of water treatment technology, a number of new sewage treatment technologies has been applied to practice, and in industrial wastewater treatment has achieved good results for the purpose of the water pollution control industry has made tremendous contributions.

Catalytic wet air oxidation technology. Catalytic wet air oxidation method is the latest technology of wastewater treatment. Wet catalytic oxidation method is the development direction of wet oxidation method, and foreign country in the catalyst screening, evaluation, recycling, regeneration and other aspects of a mass of research work. A series of industrial scale production equipment has been established.

Overview. Catalytic Wet Air Oxidation (called CWAO) method is based on the wet oxidation (called WAO) method developed in the mid-eighties and for the international high concentration of organic wastewater treatment of advanced environmental protection technology. Under the effect of a certain temperature, pressure and catalyst, by air oxidation, the organic matter in sewage and ammonia were oxidized and decomposed into CO2, H2O and N2 and other harmless substances, to achieve the purpose of purification. Catalytic wet air oxidation has high purification efficiency, and simple process, and small size, and there was a wide range of industrial applications. Catalytic wet air oxidation (CWAO) suitable for governance coking, dye, pesticide, printing and dyeing, chemical, leather and other industries with high chemical oxygen demand (COD) or with biochemical method cannot degrade compounds (such as ammonia, polycyclic aromatic hydrocarbons, carcinogenic substances BAP) about

industrial organic wastewater. The catalytic wet oxidation method is developed by the wet air oxidation method, which it is due to the use of oxidation catalyst. In a comparatively wet air oxidation more moderate operating conditions is to achieve higher efficiency, which can greatly reduce the investment and operating costs. There is considered to be a wide range of industrial application prospects of new wastewater treatment technology.

Process principle and process. Catalytic wet air oxidation (CWAO) method is very effective in the treatment of high concentration organic wastewater about has toxic and harmful and difficult to decompose. Adding suitable catalyst to reducing the temperature and pressure of the reaction, improving the ability of oxidation and decomposition, shortening the time, preventing the corrosion of equipment and reduce the cost. Application of catalyst is to speeding up the reaction rate, and the main reason, and one of the reduction of the activation energy of the reaction; and the second change the reaction process. There is waste water at high pressure (2 ~ 8MPa) and high temperature (200 ~ 280 ℃), while maintaining the liquid state to pass air, and under the action of the catalyst, the coking wastewater pollutants for complete oxidation and decomposition, and to make it into harmless substance, so that the waste water can be deeply purified. There is such as nitrogen-containing compounds in wastewater ammonia nitrogen, cyanide, thiocyanide, organic oxides by decomposition, the final generation of N_2, CO_2, and SO_4^{2-}.

$NH_3+3/4O_2=3/2H_2O+1/2N_2$

$NH_4SCN+7/2O_2=N2+H_2O+H_2SO_4+CO_2$

Wastewater phenols, hydrocarbons and the composition of the general constitute the COD after catalytic wet oxidation also generates CO2 and H2O and the like.

$C_6H_5OH+7O_2=6CO_2+3H_2O$

Classification by catalytic wet oxidation. Depending on the state of the catalyst, the catalyst can be divided into two types of homogeneous and heterogeneous catalysts. And wet catalytic oxidation is also divided into homogeneous wet catalytic oxidation and heterogeneous wet catalytic oxidation. Homogeneous wet catalytic oxidation process is by adding a soluble catalyst to the reaction solution, and the molecular or ionic level plays a catalytic role in the reaction process, because the catalyst is miscible in water. The need for follow-up treatment is so that if the practicality of the treatment process is poor, there is more difficult to achieve industrial applications. Catalysts for heterogeneous catalytic wet air oxidation are present in solid state, so that the catalyst is simple and easy to separate from wastewater. Heterogeneous catalysts are of noble metal series, copper series and rare earth series three categories, among which the catalytic wet air oxidation using precious metals as catalysts has been applied.

Catalytic wet oxidation process advantages. Catalytic wet air oxidation method in the treatment of high concentration organic wastewater has distinct advantages, such as the process does not produce sludge, and only in the interior of the device will having a small amount of cleaning waste liquid, which needs special treatment. The treatment efficiency is high, and the thermal energy can be recovered. The process is simple and small footprint. Through domestic and foreign scientists' research and practice confirmed that catalytic wet air oxidation is an effective method to treat high concentration refractory organic wastewater and sludge.

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