Application of Nano Purification Materials in Wastewater Treatment

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Abstract. Industrial wastewater pollution is a difficult problem that a country faced in the process of industrialization. Wastewater pollution directly affects the source of drinking water flowing through cities, and affects people's health and quality of life. This present study briefly introduced the application of new purification materials and the development of water treatment technology. Graphene materials are selected as an example to discuss the important role of nano purification materials in wastewater treatment. Our company designed a workshop wastewater pretreatment device based on nano graphene materials and applied for a patent. Tests show that the device could be applied to improve wastewater treatment effects and reduce wastewater pollution to the environment and surrounding water quality.

Keywords: wastewater pollution, purification materials, wastewater pretreatment device.

1. Introduction

Wastewater refers to the general term of water discharged during residents’ activities and runoff rainwater. It includes domestic sewage, industrial waste water, and other polluted water such as the inflow of the first rain path into drainage pipes and canals. It generally refers to that it difficult to recycle or reach the first-level after a certain technical treatment. After pollution, it is difficult to reach a certain standard after purification [1]. A large amount of waste water be generated in the workshop. Insufficient treatment of impurity hazards in the waste water and discharge of substandard waste water could cause serious pollution to the environment and water quality. Besides, wastewater is easily penetrated into the groundwater, causing the surrounding residents to affect the health trouble due to water quality. Therefore, the effective purification and treatment of wastewater is significant to people's production and life.

The application of new purification materials has played a vital role in promoting the development of water treatment technology. Especially the breakthrough brought by the innovation of separation materials. Membrane technology has a wide range of applications in many fields such as sewage treatment, seawater desalination, and industrial separation. With the continuous improvement of separation materials, it continues to promote process improvement and cost reduction [2]. In addition,
in the past ten years, nanotechnology has continued to regenerate. Nanomaterials have gradually played a huge role in many water treatment processes such as filtration, adsorption, electrochemistry, and so on, which greatly improve the disposing efficiency of the process, reducing operating costs, and extending the service time [3].

The development of nanotechnology extremely increases the specific surface area of the adsorbent, improves the adsorption rate, and effectively removes trace pollutants or metal ions in the water. Nanotechnology has become one of the main development directions of adsorbent materials. At the nanometer scale, nanomaterials usually exhibit specific properties under the small size effect compared to the normal scale. These characteristics are currently researched for water and wastewater treatment. For example, the British company CustoMem has produced a new type of biomaterial composition that could selectively capture micro-pollutants such as pesticides, drugs, and high-performance chemicals (Figure 1a) [4]. MetaMateria has developed a unique high-density nano-porous ceramic material for the removal and recovery of phosphorus and metal ions or trace compounds (Figure 1b) [5].

![Figure 1. Application of new purification materials](image)

Graphene is a two-dimensional material with a hexagonal honeycomb lattice composed of carbon atoms and sp2 hybrid orbitals. Graphene has a large specific surface area and abundant pore structure, which becomes the basis for its good adsorption performance. Graphene oxide has many hydroxyl groups, carboxyl groups, epoxy groups and other oxygen-containing groups. Graphene is a hydrophilic substance and has good compatibility with many solvents. It interacts with many solvents through electrostatic interaction, hydrogen bond or π-π bond. Pollutants are combined to remove organic pollutants in dye wastewater [6]. In the process of removing methylene blue (MB), methylene blue is adsorbed through electrostatic interaction and π-π bonds [7]. Graphene-based carbon materials and their composites become high-quality purification materials for adsorbing heavy metal ions, dyes, antibiotics, pesticides, crude oil, and so on, in the water treatment process. They are used in the treatment of trace pollutants and pollutants that are difficult to remove by conventional processes. (The principle of graphene adsorption and filtration is shown in Figure 2). It is reported that the Czech Graphene UPSE company has developed a variety of new materials based on graphene, specifically for the field of water and gas treatment, which have excellent removal efficiency, highly efficient removal of pollutants within the range compared with traditional technology). Functional graphene specifically for composite materials and new materials markets, currently developing nanofiltration and electro-oxidation technology. It is reported a superhydrophobic graphene material, specifically for oil spill recovery and hydrocarbon adsorption, which cleans up spilled oil, solvents, or hydrocarbons [8, 9].
Our company designed a workshop wastewater pretreatment device based on nanographene materials and applied for a patent, which is applied to improve the wastewater treatment effect and reduce the pollution of wastewater to the environment and surrounding water quality.

2. Experiment

Wastewater treatment steps

1. Supply 50L of wastewater to the workshop into the precipitation tank and put 50g of flocculant.
2. The controller turns on the high-speed motor, and the output shaft drives the agitator through the turntable to fully stir the waste water and the purification agent. After the waste water and the flocculant are fully stirred and reacted, the electric control valve is opened to allow the purified waste water to enter the inner cavity of the precipitation tank. Settling at the bottom for 2 hours.
3. Turn on the water pump, and supply the waste water to the connecting pipe through the connecting pipe, and supply it to the graphene grid and the activated carbon adsorption grid, thereby filtering and adsorbing the impurities and hazards in the waste water.
4. The wastewater flows to the bottom of the inner cavity of the filter box through the cooperation of the deflector, and enters the high-density nano-porous ceramic filter cartridge. The filter cartridge isolates the hazardous substances in the wastewater on the outside, and the treated wastewater enters the filter cartridge inside.
5. Finally, open the manual valve to discharge the waste water through the drain pipe, thereby completing the waste water treatment operation.
3. Results and discussion
Applied the workshop wastewater pretreatment device designed to treat the wastewater, and samples were sent to assay, and achieve good treatment results. The results showed (Table 1) that all the indicators of the treated wastewater reach the factory's sewage discharge standards. Our purified wastewater achieve good treatment results. In the table, pH stands for pH, COD stands for chemical oxygen consumption, SS stands for average concentration of suspended matter, TDS stands for total soluble solids, EC stands for electrical conductivity, and turbidity stands for light absorption of wastewater.

Table 1. Determination of purified workshop wastewater

| pH | COD (mg/L) | SS (mg/L) | TDS (mg/L) | EC (uS/cm) | Turbidity (NTU) |
|----|------------|-----------|------------|------------|----------------|
| 7.36 | 586        | 126       | 1600       | 1492       | 19.8           |

Our company's workshop wastewater pretreatment device could quickly and fully mix wastewater and flocculant, so that to achieve the purpose to rapid separation of wastewater and solid hazards. Filter components enhance the filtering effect of wastewater. In particular, the combination of graphene mesh and activated carbon adsorption grid further improves the wastewater treatment effect.

With the combination of nano-porous ceramic filter cartridges, wastewater can be filtered again, reducing suspended solids in the water and reducing the turbidity of wastewater, and alleviating the impact of industrial wastewater on urban drinking water sources.

4. Conclusion and prospect
As a new type of purification material, graphene could be used in sewage treatment and has a wide range of application prospects. Our company designed a workshop wastewater pretreatment device based on nano-graphene materials, which could effectively treat factory wastewater. Later on, our company will continue to research other purification materials with similar properties to graphene, such as carbon nanotubes, fullerenes and their composites. We also aim to optimize the selection of nanomaterials with obvious comprehensive advantages in terms of purification effect, production cost, application convenience. Hence, we could continue to develop air and water purification devices based on different purification materials, and play a part in protecting the environment. In addition, the next application research and development goal of our company's products is to retrofit and upgrade research on industrial waste water and waste gas devices to make them suitable for civilian use to ordinary consumer.

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