Green Treatment of High Explosives Contaminated Wastewater

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Abstract: A green treatment technology (Supercritical Water Oxidation—SCWO) was applied to treat explosive wastewater. The SCWO degradation rules of explosive wastewater were investigated. The experimental results show that SCWO is a high-efficiency, clean treatment and disposal technique for high explosives wastewater. Temperature serves as the main influence factor in removing COD of wastewater. Above the water critical point, the COD removal rate obviously increases with temperature increasing. At 550℃, 24MPa and 120s, the COD removal rate of wastewater is over 99.98%.

Key words: supercritical water oxidation; explosive; wastewater treatment
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The wastewater of production and use high explosives is toxic and mutagenic which has been classified as an environmental hazard. Among the high explosives, TNT, RDX, HMX are predominantly manufactured and used in weapons that are three of the most common and are identified with possible human carcinogens[1]. Currently TNT contaminated water is treated by incineration, activated carbon adsorption, biodegradation, oxidation with hydrogen peroxide/ozone, photocatalytic oxidation which are very inefficiency and are very difficult to meet the more rigorous effluent standard[2].

Supercritical water oxidation (SCWO) is a high temperature and pressure technology that uses the properties of supercritical water in the destruction of organic compounds and toxic wastes[3]. The objective of this study was to investigate the oxidative degradation process of TNT wastewater by SCWO.

1 Experiment

1.1 Materials

There were two types of wastewater in the research. One was TNT simulation wastewater prepared in laboratory. The other was the actual effluent from a TNT manufacturing plant. The oxygen was used as oxidation agent in SCWO process.

1.2 Experiment apparatus

The schematic of SCWO experiment apparatus is shown in Fig.1. SCWO system is mainly made up of seven sections that are reactor, heating apparatus, gas feed, plunger type floe control pump, process cooler, gas-liquid separator and waste water tank, heat. When the reactor get preset temperature, the oxygen was added to the reactor vessel as opening gas inlet valve. The explosive waste water was pumped by a high pressure pump into the reactor vessel.

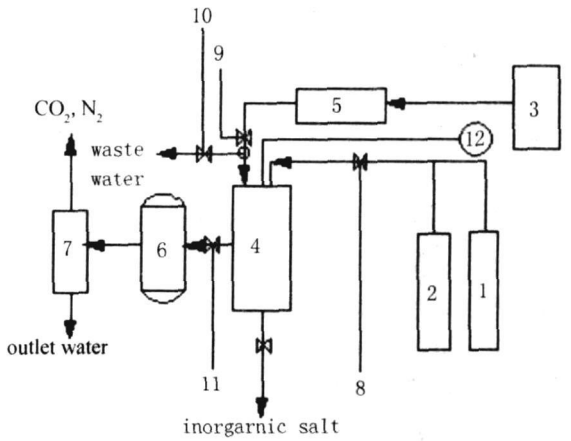

Fig.1 Process chart of SCWO
1-oxygen cylinder, 2-nitrogen cylinder, 3-waste water container, 4-reactor, 5-high pressure pump, 6-cooler, 7-separator, 8-importable gas valve, 9-importable water valve, 10-drive unloaded valve, 11-discharge water valve, 12-pressure meter

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2　Results and discussion

This paper selected COD to judge the degradation efficiency of TNT wastewater in SCWO and the consistency of TNT wastewater was analyzed using HPLC. In order to investigate the influence factors of SCWO, reaction temperature (T), pressure (P) and residence time (t) were acted as the main factors. The experimental results were shown in Fig. 2 and Fig. 3.

2.1　Temperature Variations

Temperature varied from 450℃ to 600℃ at a fixed pressure of 23MP, residence time of 90 s, oxygen excess (O_2) of 300%. The removal rate of COD varying with reaction temperature was shown in Fig. 2.

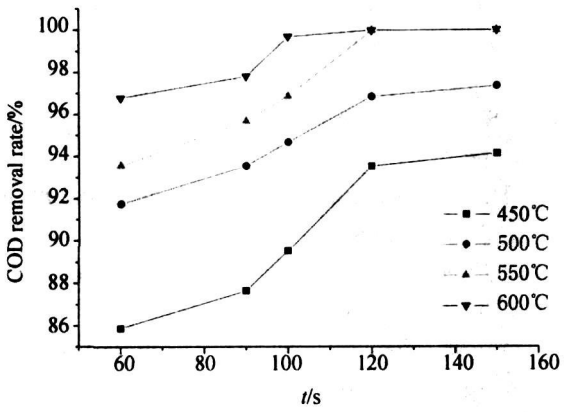

Fig. 2　Effect of temperature to SCWO

2.2　Pressure Variations

Pressure varied from 22MPa to 28 MPa at a fixed temperature of 500℃, residence time of 120 s, oxygen excess (O_2) of 300%. The removal rate of COD varied with pressure in Fig. 3.

2.3　Residence time variations

The residence time is the most obvious factor affecting COD removal rate. With the reaction time longer, the removal rate of COD continuously increased, which were shown in Fig. 2.

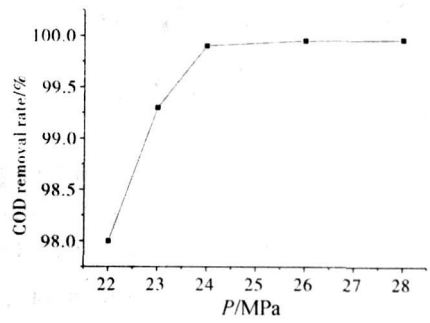

Fig. 3　Effect of pressure to SCWO

3　Conclusions

This study focused on treatment of TNT contaminated wastewater by SCWO. The experimental results show that temperature, pressure and residence time are the main influence factors of COD removal rate in SCWO TNT wastewater. The optimal technological conditions of SCWO TNT wastewater are at 550℃, 24MPa and 120 s. The COD removal rate may exceed 99. 96% under this technological conditions.

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炸药废水的绿色化处理工艺研究

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摘　要：采用超临界水氧化技术处理炸药生产废水，探讨了超临界水氧化降解炸药废水的规律。结果表明：反应温度是影响炸药废水 COD去除率的主要因素，在超临界条件下， COD的去除率随着温度的升高而增加。在反应温度为 550℃、压力 24MPa 反应停留时间为 120 s的条件下， COD去除率可以达到 99. 98%以上。

关键词：超临界水氧化；炸药；废水处理

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