Adsorption Behavior of Trinitrotoluene by Rice Husk Carbon

Dan Fu
Department of chemistry, Liao Ning Petrol Chemical Vocational College, Liaoning 121001, China

*Corresponding author e-mail: fudan20030333@126.com

Abstract. Trinitrotoluene could be adsorbed by many materials. The adsorption properties of Trinitrotoluene were studied in this paper by Rice husk carbon (RHC). The influence factors of pH value of Trinitrotoluene wastewater, adsorbent dosage and the ratio of dilution to wastewater were examined. The results of TG–DTA analysis showed that the main temperature ranges of thermal decomposition for the RHC was 324-467 ℃. The study indicates that RHC can be used in wastewater to removal Trinitrotoluene.

1. Introduction
Trinitrotoluene as a kind of energetic material has been widely used in industry, military and other aspects. A large amount of Trinitrotoluene wastewater is generated in the process of chemicals production. The Trinitrotoluene are extremely toxic to human and animal. Therefore, the treatment of Trinitrotoluene wastewater is the major environmental problems to be solved. Nowadays, the methods such as biological, physical and chemical have been widely used to treat Trinitrotoluene wastewater [1-3]. The physical adsorption method is regard as effective. However, its use is limited because of the expensive cost of absorbent.

In recent years, many solid waste materials have been used as adsorbent to treat kinds of wastewater. Studies reveal that these solid wastes such as rejected tea [4], garlic peel [5] and broad bean peels [6] can treat waste water effectively.

Rice husk carbon (RHC) as a solid waste obtained from bio-oil factory In this paper, RHC.is used as adsorbent for removal Trinitrotoluene of industry wastewater. The effect factors of pH, the dosage of adsorbent and the ratio of dilution wastewater are discussed.

2. Experimental and Methods

2.1. Materials
The Rice husk carbon (RHC) used in the study was obtained from Shandong, China. The Trinitrotoluene wastewater was gotten from armament factory. The further dilution solution was used in the experiments.

2.2. Differential thermal experiment
The thermodynamic property of RHC was characterized by TG–DTA. Differential thermal analysis (TG and DTA) of RHC were detected in the temperature range of 25–850 ℃ by using a Stanton Redcroft under air atmosphere.
2.3 The experiments of adsorption
The experiments were done by shaking 25mL Trinitrotoluene wastewater with RHC in SHA-BA water
bath oscillator. During the experiments, the temperature of water bath oscillator was stayed at
45±0.2°C. The concentration of Trinitrotoluene wastewater was adjusted by adding distilled water and
the ratios of concentration were adjusted to 1:50, 1:75; 1:100, 1:125 and 1:150. NaOH (0.1mol/L) or
HCl (0.1mol/L) was used to adjust the initial pH value of Trinitrotoluene wastewater. During
adsorbing, RHC and the supernatant liquids were separated by the method of filtering at various time
intervals. The test wavelength was selected as 420 nm, the initial and residual contents of
Trinitrotoluene in wastewater were tested by the 722SP visible spectrophotometer.

The adsorption efficiency (%) of Trinitrotoluene adsorbed onto RHC was calculated as follows:

\[
\text{Adsorption efficiency (\%)} = \left( \frac{c_0 - c_e}{c_0} \right) \times 100
\]

where \( q_t \) (mg/g) is the dosage of Trinitrotoluene adsorbed on RHC at any time; \( c_0 \) and \( c_e \) (mg/L)
are the initial and residual dosage of Trinitrotoluene at any time, respectively; \( V \) (L) is the volume of
Trinitrotoluene wastewater, and \( W \) (g) is the weight of adsorbent.

3. Results and Discussion

3.1 Thermal result of RHC
TG–DTA curve of RHC has been shown in Fig.1. A large exothermic peak can be seen from the DTA
curve at 324 °C, accompanied by slight weight loss being 0.6%. This is due to desorption of water
molecules on the surface of RHC. A small exothermic peak in the DTA graph appears at 467 °C. The
main weight loss about 11% is observed between 324 °C and 467 °C in the TG curve. This indicated
some oxygen containing groups existed on the surface of RHC completely decomposed in the
temperature range 324 °C - 467 °C. Maybe the products as CO, NOx and CO2 are released. Beyond
this temperature the TG curve shows a steady drop and reaches a residual value of 87% at 850 °C.
TG–DTA results suggests that the stability of the RHC is ascertained up to 324 °C. Hence the
adsorption and pre-treat temperature of RHC is below 324°C in order that the adsorption ability can
not be influenced.

![Figure 1. Thermal property of RHC](image-url)
3.2 The result of pH value influencing Trinitrotoluene adsorbed on RHC

The pH value of wastewater is the most important influence factor for Trinitrotoluene adsorption on RHC. The influence of pH value on Trinitrotoluene adsorbed on RHC is shown in Fig. 2. Adsorption efficiency of Trinitrotoluene decreases with the pH value increasing between 2.02 and 6.03 as shown in Fig. 2. However, the adsorption efficiency of Trinitrotoluene almost does not change when pH values are between 6.03 and 11.98. The possible reason is that the compositions of Trinitrotoluene wastewater are complex. The surface functional groups and structures of RHC can change at different pH value. Acid conditions are beneficial to Trinitrotoluene adsorption. In all further experiments, the optimum pH value was selected as 2.

![Figure 2. Effect of pH value on Trinitrotoluene adsorbed on RHC](image)

(RHC 0.7 g; dilution 1:100; shaking time 180min; temperature 45°C)

3.3 The result of adsorbent dosage influencing Trinitrotoluene adsorbed on RHC

An important factor for researching adsorption capacity of adsorbent was the dosage of adsorbent. The adsorption efficiency of Trinitrotoluene influenced on dosage of RHC was showed in Fig. 3. The results show that adsorption capacity of Trinitrotoluene increases with adsorbent dosage increasing but adsorption capacity is almost a constant when the adsorbent dosage exceeds 0.7 g. The result shows that the surface area increases with the increasing of the amount of RHC. But the Trinitrotoluene can not interact well with RHC if the adsorbent is excessive. Therefore, the optimum RHC dosage for all further experiments was selected as 0.7 g.

![Figure 3. Effect of RHC dosage on Trinitrotoluene adsorbed on RHC](image)

(pH 2.00±0.02; the dilution ratio 1:100; shaking time 180min; temperature 45°C)
3.4 The influence of the wastewater diluted proportion on Trinitrotoluene adsorbed on RHC

Fig. 4 indicates the influence of the wastewater diluted from 1:50 to 1:150 on the adsorption of Trinitrotoluene. It was seen that the efficiency of adsorption was fast for the first 60 min, thereafter it changed slowly and finally reached almost constant. The finding is because the amount of Trinitrotoluene per unit volume decreases with the increasing of dilution ratio, and then Trinitrotoluene could easily interact with RHC, hence resulting in higher adsorption efficiency in the high dilution proportion. The adsorption equilibrium time is 180 min in all dilution ratios as shown in Fig. 4.

![Figure 4. Effect of the dilution ratio on Trinitrotoluene adsorption on RHC](image)

**Figure 4.** Effect of the dilution ratio on Trinitrotoluene adsorption on RHC
(0.7 g RHC; pH 2.00±0.02; shaking time 420 min; temperature 45 °C)

4. Conclusions

It is proved that Rice husk carbon (RHC) is an effective adsorbent to dispose Trinitrotoluene from wastewater. TG–DTA results suggests that the stability of the RHC is ascertained up to 324 °C. The optimum adsorption conditions are: pH 2; adsorbent dosage 0.7g/25mL. The adsorption efficiency increases with the increasing of the dilution ratio.

Acknowledgements

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