

# Preparation of Styrene - Modified Waste Bagasse Oil - Absorbing Material

Jin Zhang<sup>1</sup>, Lina Zheng<sup>1,2,\*</sup>, Chenxi Li<sup>1</sup>, Yiwen Pan<sup>1</sup>, Hui Jiang<sup>1</sup>

<sup>1</sup>College of Marine Technology and Environmental, Dalian Ocean University, Dalian 116023, China

<sup>2</sup>Key Laboratory of Near shore Marine Environmental Research, Dalian 116023, China

\*Corresponding author e-mail: 8601375@qq.com

**Abstract.** In this paper, the natural waste bagasse powder was chemically modified with styrene as graft monomer, benzoyl peroxide as initiator and methylene bisacrylamide as crosslinking agent. The reaction temperature was investigated. The effects of reaction time, graft monomer, initiator and crosslinking dosage on the oil absorbency.

## 1. Introduction

At present, the adsorption materials are mainly inorganic, organic and composite materials. In this paper, natural waste bagasse, which has the advantages of low cost, safety, non-toxicity, biodegradability and recyclability, is selected. It is a new type of environmental protection material, which can not only keep the characteristics of oil spill treatment by adsorption method, but also avoid new environmental problems, so it has a broad application prospect. In this paper, the modification conditions were optimized by graft copolymerization, and the optimum reaction temperature, reaction time, amount of graft monomer, initiator and crosslinking agent were determined.

## 2. Experimental reagents and instruments

The reagents and instruments used in the experiment are shown in tables 1 and 2 respectively.

**Table 1.** Main experimental reagents

reagent	Technical level	vender
styrene	AR	Chinese medicine group chemical reagent co., Ltd
methylbenzene	AR	Chinese medicine group chemical reagent co., Ltd
nitrogen	99.9% high purity	Dalian high purity nitrogen plant
methylene bisacrylamide	AR	Tianjin proudly fine chemical research institute
benzoperoxide	AR	Tianjin Fuchen Chemical Reagent Factory
absolute ethyl alcohol	AR	Chinese medicine group chemical reagent co. Ltd
0# diesel oil	0#	No. 0 diesel oil sold on the market
pure water	pure	Chemical Analysis Laboratory of Dalian Ocean University
acetone	AR	Tianjin Damao Chemical Reagent Factory
seawater	filter	Sea area near Dalian Ocean University



**Table 2.** Apparatuses of experiment

instrument	Production model	vender
Collector magnetic agitator	DF-101S	Jiangsu Jintan Zhengji instrument Co. Ltd.
electric drying oven with forced convection	Type 101	Shanghai General Laboratory instrument Factory
Constant temperature water bath oscillator		Shenyang Chemical instrument Factory
Analytical electronic balance		Mettler Toledo instruments co., Ltd.
Diaphragm vacuum pump	GM-0.33 II	Tianjin Jinteng Experimental equipment Co.Ltd.
Mechanical pulverizer of traditional Chinese Medicine	RH-800 type	Zhejiang Ronghao Industry and Trade Co.Ltd.

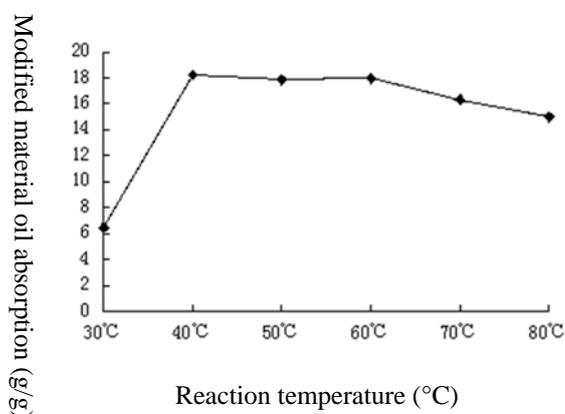
### 3. Empirical method

Bagasse (about 0.5mm in diameter), a 3.00g raw material, was taken from the electronic balance and poured into three flasks of 500mL. The pure water was poured into the flask and put in a constant temperature magnetic agitator. After three bottles of 10min were injected with high purity nitrogen, a quantitative initiator benzoyl peroxide, a crosslinking agent, methylene bisacrylamide, and graft monomer styrene were added at a steady temperature for a certain time. After the reaction, the power supply of nitrogen valve and constant temperature water bath agitator was successively closed, three flasks were removed, filtered by diaphragm vacuum pump, and washed several times with ethanol and pure water. Change to filter out putting the material into a glass culture dish, putting the material into an oven at 60 DEG C for 24h, drying the material for 24h after drying the dried material with toluene, and removing the photopolymer obtained by the reaction to obtain the purified modified material.

### 4. Results and discussions

#### 4.1. Effect of reaction temperature on Chemical Modification of Materials

In this experiment, the reaction time was set as 5 h, the grafting monomer of butyl methacrylate was 18 mL, the initiator was benzoyl peroxide 0.2 g, the crosslinking dose of methylene bisacrylamide was 0.02 g, and the reaction temperature was 30 °C, 40 °C, 50 °C, 60 °C, 70 °C, 80 °C, respectively. The graft copolymerization reaction was carried out and the oil absorption of the modified materials in pure diesel oil was determined at different reaction temperatures in turn.



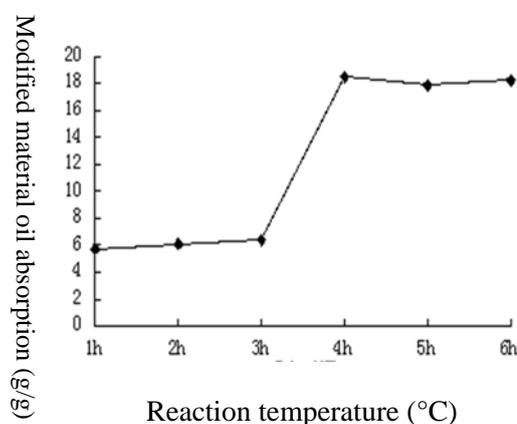
**Figure 1.** Effect of reaction temperature on oil absorption properties of modified materials

It can be seen from figure 1 that the oil absorption of the modified material changes with the temperature of graft copolymerization. When the reaction temperature is 30 °C, the oil absorption of the

modified material is 6.48 g / g, indicating that the graft copolymerization did not proceed smoothly. With the increase of the temperature, the oil absorption of the modified material becomes larger, and the maximum of the modified material is 18.23 g / g when the temperature is 40 °C. However, when the reaction temperature continues to rise, the amount of oil absorbed by the modified materials will decrease gradually rather than increase. The reason may be that when the reaction temperature is too high, the homopolymerization reaction and the chain termination reaction will be accelerated, thus conductance. The rate of graft copolymerization decreases, resulting in the decrease of oil absorption rate of the modified materials.

#### 4.2. Effect of reaction time on Chemical Modification of Materials

In this experiment, the reaction temperature was set at 50 °C, the grafting monomer of butyl methacrylate was 18 mL, the initiator was benzoyl peroxide 0.2 g, the crosslinking dose was methylene bisacrylamide 0.02 g, and the reaction temperature was 1 h ~ 2 h ~ 3 h ~ 4 h ~ 5 h ~6h. The graft copolymerization was carried out and the oil absorption of the modified materials in pure diesel oil was determined under different reaction time.

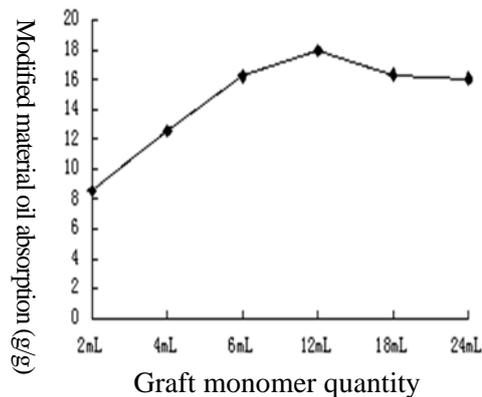


**Figure 2.** Effect of reaction time on oil absorption of modified materials

It can be seen from figure 2 that the oil absorption of the modified material changes with the graft copolymerization reaction time. When the reaction time is 1 h, the oil absorption rate of the modified material is 5.72 g / g ~ 1h-3 h and the oil absorption efficiency of the modified material is basically unchanged. When the reaction time is 4 h, the maximum equilibrium value of the modified material is 18.46 g / g. With the increase of time, the oil absorption of the modified materials remained unchanged, which indicated that the graft copolymerization had reached the maximum equilibrium.

#### 4.3. Effect of graft monomer on chemical modification of materials

In this experiment, the reaction temperature was set at 50 °C, the reaction time was 5 h, the initiator benzoyl peroxide was added 0.2 g, the crosslinking dose of methylene bisacrylamide was 0.02 g, and the amount of grafting monomer was 2 mL, 4 mL, 6 mL, 12mL, 18mL, 24 mL, respectively. The graft copolymerization reaction was carried out and the oil absorption of the modified materials in pure diesel oil was determined under the condition of graft monomer in turn.

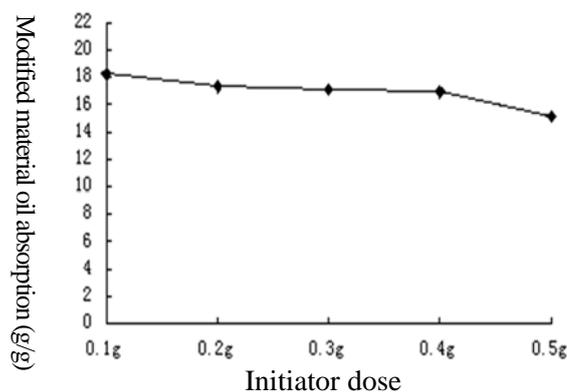


**Figure 3.** Effect of graft monomer content on oil absorption of modified materials

It can be seen from figure 3 that the oil absorption of the modified material is 8.59 g / g when the dosage of styrene is 2mL. With the increasing of the amount of graft monomer, the oil absorption efficiency of the modified material is also increasing. When the amount of graft monomer is 12mL, the oil absorption efficiency of the modified material reaches the maximum equilibrium value of 17.95 g / g. When the amount of graft monomer increased, the oil absorption of the modified material decreased, which may be due to the increase of the rate of transition of the initiator into free radical, the increase of chain growth rate and the increase of grafting rate when the amount of graft monomer increased. However, as the amount of graft monomer continues to increase the gel effect will make the homopolymer chain free radical generated in the local region of graft copolymerization easy to terminate with the active end of the graft chain, and the efficiency of graft polymerization will be gradually slowed down and finally terminated.

#### 4.4. Effect of initiators on Chemical Modification of Materials

In this experiment, the reaction temperature was set at 50 °C, the reaction time was 5 h, the graft monomer styrene was 18 mL, the crosslinking dose of methylene bisacrylamide was 0.02 g, and the amount of benzoyl peroxide was 0.1 g, 0.2g, 0.3g, 0.4g, 0.5g respectively. The graft copolymerization reaction was carried out and the oil absorption of the modified materials in pure diesel oil was determined under different initiators in turn.



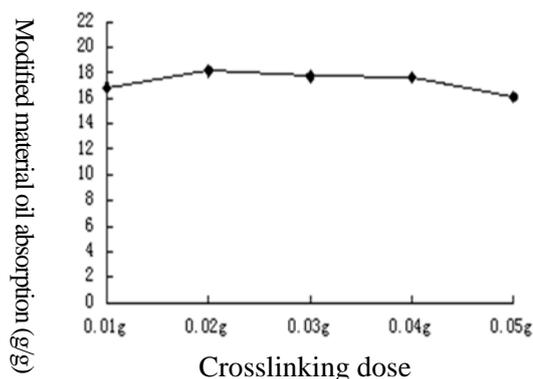
**Figure 4.** Effect of initiation dose on oil absorption of modified materials

As can be seen from Figure 4, when the dosage of the initiator benzoyl peroxide is 0.1g, the oil absorption of the modified material is 18.24g/g., with the increase of the initiating dose, the oil absorption rate of the modified material decreases gradually. The reason is that the amount of initiator can accelerate

the reaction rate, but when the amount of initiator is increased, the primary freedom within a unit time is produced. The increase of base amount will increase the probability of termination reaction of fiber branched chain, resulting in a decrease in the rate of graft copolymerization.

#### 4.5. Influence of Crosslinking Agent on Chemical Modification of Materials

The reaction temperature was set to 50.degree. C. , the reaction time was 5h , the grafting monomer styrene 18mL was added , the initiator benzoyl peroxide was 0.1 g , and then the amount of methylene bisacrylamide in the crosslinking agent was 0.01 g, 0.02 g, 0.03 g, 0.04 g, and 0.05 g, respectively, and the amount of oil absorption in the pure diesel oil was determined in turn.



**Figure 5.** Effects of crosslinking dosage on oil absorption of modified materials

From figure 5, it can be seen that when the dosage of crosslinking agent methylene bisacrylamide is 0.01 g, the oil absorption of the modified material is 16.86 g / g, and when the dosage of crosslinking agent is 0.02 g, the oil absorption of the modified material is 18.17 g / g. The reason is that the proper amount of crosslinking agent can increase the reaction rate, and the excessive crosslinking agent will affect the space structure of the material, thus affecting its oil absorption performance.

## 5. Conclusion

A kind of high efficiency compound oil absorbent material was obtained by chemical modification of bagasse cellulose material with styrene by graft copolymerization. The optimum reaction conditions were as follows: reaction temperature 40 °C, reaction time 4 hours, grafting monomer dosage 12 mL, initiator 0.1 g and crosslinking agent 0.02 g. The maximum oil absorption of the modified material in pure oil system was 18.24 g / g.

## Acknowledgements

This research was financially supported by Dalian Ocean University postgraduate educational reform project (2017) (02D0201 Lina Zheng) and Dalian Ocean University Students' innovation and entrepreneurship program plan project (2017 and 2018).

## References

- [1] Abdullah, M. A, Anisa, U.R., Man,Z.,Physicochemical and sorption characteristics of Malaysian Ceiba pentandra (L.) Gaertn. as a natural oil sorbent, *J. Hazard Mater.* 2010, 177, 683 - 691.
- [2] Ding, B., Lin, Wang, X., Yu, J., Yang,J., Cai,Y., Investigation of silica nanoparticle distribution in nanoporous polystyrene fibers,*SoftMatter*, 2011, 7, 8376 - 8383.
- [3] Lin, J., Cai, Y., Wang,X., Ding,B., Yu,J.,Wang,M.,Fabrication of biomimetic superhydrophobic surfaces inspired by lotus leaf and silver ragwort leaf,*Nanoscale*, 2011, 3, 1258 - 1262.
- [4] Lin, J.Y., Shang, Y.W., Ding, B.Yang, J.M., Yu,J.M., Salem,S.,Al-Deyab, Nanoporous polystyrene fibers for oil spill cleanup, *Marine Pollution Bulletin*, 2012, 64, 347 - 352.
- [5] Warr, L.N Perdrial, J.N., Lett, M.C., Heinrich-SalmeronA., Khodja, M., Clay mineral enhanced

- bioremediation of marine oil pollution. *Applied Clay Science*, 2009, 46, 337 - 345.
- [6] Kausar H., Sariah M., Saud H.M., et al. Development of compatible lignocellulolytic fungal consortium for rapid composting of rice straw [J]. *International Biodeterioration & Biodegradation*, 2010, 64 (7): 594 - 600.
- [7] Zhu Haitao, Qiu Shanshan, Jiang Weiet al. Evaluation of Electrospun Polyvinyl Chloride/Polystyrene Fibers As Sorbent Materials for Oil Spill Cleanup [J]. *Environmental Science & Technology*, 2011, 45 (10): 4527 - 4531.
- [8] Kaparaju P., Felby C. Characterization of lignin during oxidative and hydrothermal pre-treatment processes of wheat and corn stover [J]. *Bioresource Technology*, 2010, 101 (9): 3175 - 3181.
- [9] Suhong Chen, Qinyuan Yue\*, Baoyu Gao, Qian Li, Xing Xu, Kaifang Fu. Adsorption of hexavalent chromium from aqueous solution by modified corn stalk: A fixed-bed column study. *Bioresource Technology*, 113 (2012) 114 - 120.
- [10] Suhong Chen, Qinyan Yue\*, Baoyu Gao, Qian Li, Xing Xu. Removal of Cr (VI) from aqueous solution using modified corn stalks: Characteristic, equilibrium, kinetic and thermodynamic study. *Chemical Engineering Journal* 168 (2011) 909 - 917.