参赛队员姓名：刘翼鹤

中学：北京市第二中学

省份：北京

国家/地区：中国/北京

指导教师姓名：辛加余

指导教师单位：中国科学院过程工程研究所

论 文 题 目 ： Closed-loop Recycle of Waste Polyester Textile by Chemical Method

参赛队员姓名：Yihe Liu

中学：Beijing No.2 High School

省份：Beijing

国家/地区：Beijing/China

指导教师姓名：Jiayu Xin

指导教师单位 Institute of Process Engineering, Chinese Academy of Sciences

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Closed-loop Recycle of Waste Polyester Textile by Chemical Method

Yihe Liu

Beijing No. 2 Middle School, Dongcheng District, Beijing, P. R. China

Abstract

Polyethylene terephthalate (PET) produced by polycondensation of phthalic acid and ethylene glycol has excellent electrical insulation, fatigue resistance and good dimensional stability. At present, PET has been widely used in many fields, such as electronics, food packaging, clothing, etc. However, due to the large-scale use, PET has caused severe environmental pollution. Besides, the materials used for PET production are also from non-renewable petroleum resources. Thus, recycling of PET is a big issue in the world. The recycling process in this project can be divided into three steps: catalytic depolymerization of polyester textiles, separation and purification of depolymerized monomers, and the polymerization of depolymerized monomers to synthesize polyester. During the depolymerization step, methanol was used as the depolymerization agent, and zinc acetate was used as the catalyst. Distillation was used to solve the problem of the deep color of the monomer and difficulty in decolorization. In the process of polymerization of depolymerized monomers, ethylene glycol was used as the reactant for transesterification reaction, and manganese acetate was used as the catalyst. The obtained product was tested by liquid chromatography and colorimeter, and it was proved to be in line with international standards for food-grade PET.

Keywords: Waste polyester; Recycle; polyethylene terephthalate (PET)

Contents

1 Introduction

1.1 Background

Nowadays, waste recycling staff are more willing to recycle waste plastic bottles, but they ignore waste and old clothes. According to statistics, clothing accounts for the most significant proportion of polyester fiber utilization in my country, accounting for 60% of the total, but packaging material like bottles only takes 28%. The specific data is shown in Figure 1.1 below. Most clothes are made of a kind of material called Polyethylene terephthalate (PET), which is obtained by polycondensation of phthalic acid and ethylene glycol. It has excellent electrical insulation, creep resistance, fatigue resistance, friction resistance, and dimensional stability Feature[1].

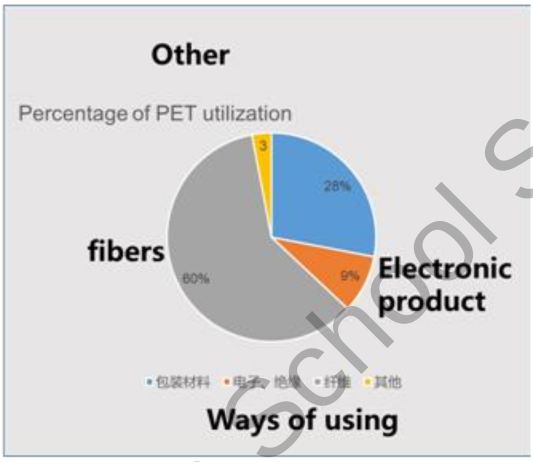


Figure 1.1 Percentage of PET utilization[2]

Such kind of material is also used in making plastic bottles and some technology components, and it also can be recycled. When recycling used bottles, there is a specific recycling system shown in Figure 1.2

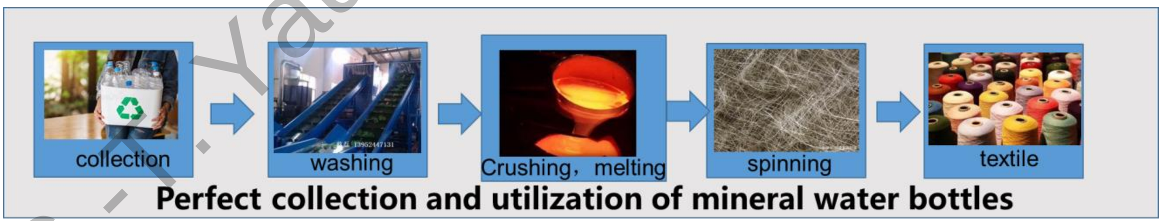


Figure 1.2 Perfect system of recycling PET bottles

But when recycle used clothes, the existing methods are not perfect shown in Figure 1.3. But why people prefer to recycle bottles instead of old clothes is a question worthy of discussion.

Figure 1.3 Missing system of recycling PET clothes

At present, most of the old clothes can be recycled in four ways (disinfected and reused, recycled as building materials, recycled as electronic components, recycled as food packaging). The ways mentioned above both have some adverse effects respectively, as shown in Figure 1.4. Disinfecting and reusing are harmful to the human body. At the same time, it is used singly and cannot be recycled multiple times, which will cause high costs. Making building materials will cause serious environmental pollution problems[2], and recycling as food packaging does not meet food-grade standards and will cause health problems[4].

Figure 1.4 Ways to recycle clothes and their disadvantages[3]

In 2018, Chinese PET production capacity totaled 55.28 million tons, accounting for 59% of global production; PET production totaled 45.42 million tons, accounting for 57% of the global output; total consumption was 42.68 million tons, accounting for 53% of global consumption. As the synthetic material of PET is a non-renewable petroleum resource, the large-scale use of PET will also cause serious problems such as environmental pollution. Therefore, how to realize the virtuous recycling of PET has become a primary problem now[3].

1.2 About PET

The full name of PET is poly(ethylene terephthalate), which is a milky white semi-crystalline linear saturated polyester with a smooth surface. The chemical structure diagram is shown in Figure 1.5 below. The melting point of PET is 255°C-260°C, and the decomposition temperature is 353°C. It has good mechanical performance, high hardness, good chemical stability, and can resist the dissolution of oil, ester, acid and other organic solvents. Secondly, PET is very transparent, very safe and hygienic[1, 4].

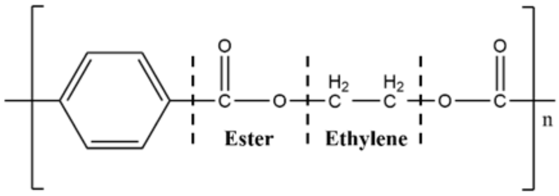


Figure 1.5 The chemical structure of PET

The main raw materials for the synthesis of PET are terephthalic acid, dimethyl terephthalate and ethylene glycol. At present, the primary synthetic PET obtained by synthesizing BHET through the transesterification of DMT and EG, and then polycondensation into PET[5]. At present, the use of PET has been distributed to many fields, and it is widely used in clothes, film sheets, packaging applications, electronic appliances, auto parts, machinery and equipment, building materials, etc.[4]

Because of the high strength, lightweight, and good wear resistance of PET, it is very suitable as a building material and can be used as a chemical synthetic fiber. The product has high tensile strength, anti-distortion strength, and is affordable. Conducive to ensuring the quality and cost of the project. As a new type of material, there will be significant development and more applications [7,8].

In addition, PET fiber with good stability and low cost is the first choice for making ropes. Because of its excellent UV and water resistance, it is suitable for use in marine environments and is very safe, far beyond the performance and function of yarn. The performance comparison chart of yarn and PET fiber thread is as follows, shown in Table 1.1. Due to the global demand for unique and practical cleaning materials, PET will be the first choice in this field in the future, and it will play a significant role in our lives[6].

Table1.1 Comparison of properties of silk thread and PET fiber thread [3].

指标index	产品编号Product number					测试标准/方法 Test standards and methods
	SFS5202A	G3016HI	UFS8602	G3014HQ	FSF50202	
线密度/dtex Linear density	2 269	3 335	6 720	3 332	2 246	ASTM D 1907
断裂强力/N Breaking strength	179.8	270.3	571.0	282.0	184.0	—
断裂强度/(cN·dtex^{-1})	7.90	8.11	8.61	8.47	8.21	—
强度 CV 值/% strength	1.04	0.54	1.20	1.10	0.90	—
断裂伸长率/% Elongation at break	19.6	18.9	11.0	11.5	13.8	Conform to stretch D 885
EASL/%	10.3	10.6	5.0	5.3	7.4	定负荷拉伸@4.0 (cN·dtex^{-1})
热收缩/% Heat yield	1.3	2.8	11.0	11.2	7.7	ASTM D 4974
含油率/% Oil content	0.85	0.68	0.55	1.11	0.76	—
网络数/(个·m^{-1}) Number of networks	5	5	4	5	5	MFG

At the same time, PET material is a better choice for making polyester, like the clothing, with good corrosion resistance, transparency and oxidation resistance. This is where PET is most used. More than 60% of PET is used to make fibers, the world's largest synthetic fiber. Through chemical modification and physical modification, the development of fiber products such as cotton, wool, silk, hemp, leather and other fiber products, and the development of renewable and recycled PET fiber is an important method to improve the value of PET and its sustainable development.

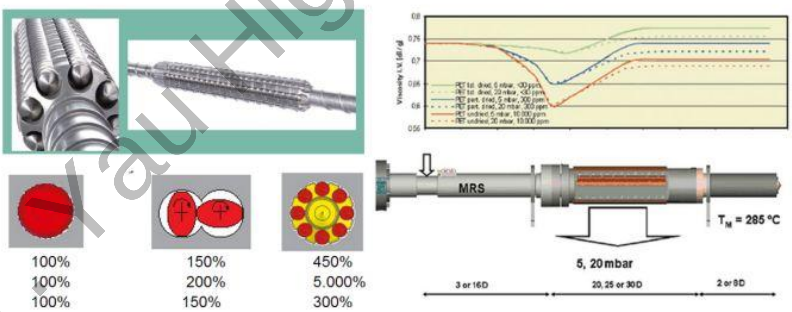
Figure 1.6 Polyester

Figure 1.7 clothe made with polyester

1.3 Recycle of PET

Due to the excellent characteristics of PET, its demand is increasing. Ten million tons of PET are put into use every year, but as much as 40% of PET waste cannot be recycled, most are clothes. The total amount of waste in PET clothes in my country alone is as high as 200 million tons. They are huge and difficult to decompose. At the same time, the raw material of PET is petroleum, a non-renewable resource. The production of PET and PET that cannot be recycled will cause many environmental problems[7].

Today, there are only two ways to recycle PET clothes, and the first is the physical method: old clothes by sorting, crushing, cleaning, granulation, drying, melt processing and moulding. Examples include Gneuss 'multi-rotation Ultra-high surface Ratio Vacuum extruder (MRS) technology and Erema's VACUREMA system. Figure 1.9 is the specific process of the physical recovery of PET. However, the new PET obtained by the physical method has a low yield and is easy to cause secondary pollution, which is not desirable.

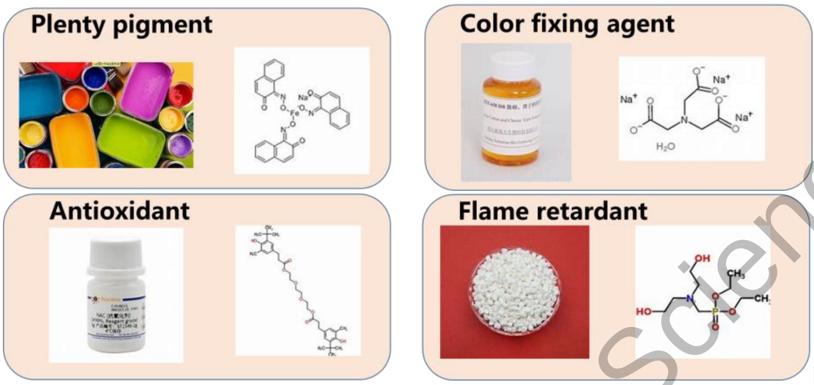


[8]

Figure 1.9 Recycling PET by the physical technology of Gneuss, Germany

The second is the chemical method. Due to the reversibility of polycondensation reaction, the waste polyester can be depolymerized into monomer or polymerization intermediate, and then condensed into high-quality recycled polyester after separation and purification. [5][10] Therefore, through the chemical way, waste PET closed-cycle regeneration, is currently a more effective method. There is already a method of alcoholysis reaction between PET and ethylene glycol. At the same time, due to the variability of chemical recovery, a variety of products with higher added value can be developed during the regeneration process to realize the increased value reuse of waste

PET. However, the chemical recovery process is relatively complex, has technical difficulty, high production cost, and because of the low yield of BHET, it is difficult to decolorize and purify. Because of the complexity of the chemical materials, is shown on Figure1.10like pigment, color fixing agent, antioxidant, flame retardant, which are hard to separate. There is no perfect technology for glycolysis in my country. So at present, there are few successful commercial cases in the world[9].



[10]

Figure 1.10 Some complex chemical materials that are used on clothes

1.4 Research content

Due to the high temperature and energy efficiency of the previous chemical methods, severe environmental pollution, and low yield of alcoholysis product BHET, the content of this paper is mainly to develop a new process for methanol degradation of PET clothes, which reduces the alcoholysis temperature and reduces the reaction time and the amount of catalyst can finally obtain a safe and reliable recycled PET. The specific experiment content is shown in figure 1.3 below, divided into 4 steps. As a result, a closed-loop is the best way to use discarded polyester fiber shown on Figure 1.11

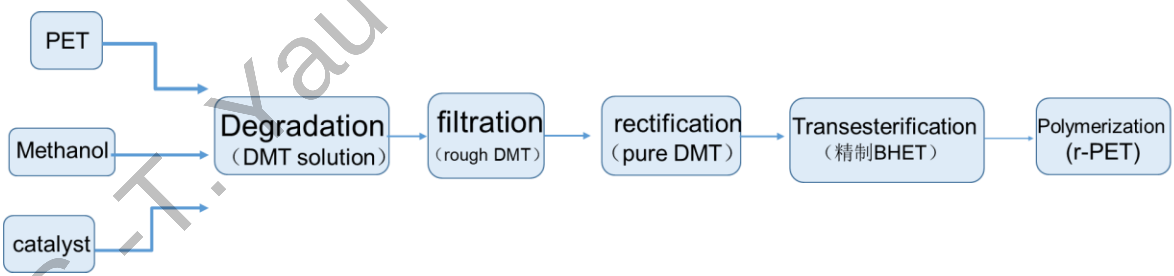


Figure 1.11 A specific closed loop process to recycle PET

Catalytic depolymerization of polyester textiles with methanol

The use of methanol as the degradation solution facilitates the subsequent decolorization and purification, and more effectively prepares high-purity DMT. At the same time, the use of zinc acetate as a catalyst reduces the reaction time and pressure and improves the DMT yield.

(1) Rough DMT decolorization and purification into pure DMT

Due to the different melting points of different substances, we can achieve component separation. Through high temperature and high-pressure equipment, the prepared rough DMT is heated and pressurized, resulting in the separation of components. Finally pure DMT that is separate from the impurity is obtained.

(2) Pure DMT transesterification to prepare BHET

The prepared pure DMT is transesterified with ethylene glycol to obtain BHET, analyzed the reacted oligomers.

(3) Refined BHET preparation of r-PET

Prepare food-grade r-pet through polycondensation reaction, analyze various indicators of recycled PET, realize a completely new process, and allow PET to be recycled on a large scale

2 Experiments

2.1 Materials

PET fiber is provided by Beijing Yingchuang Recycling Co., Ltd. The chromatographic grade and analytical purity of methanol (99.5%), ethanol (99.7%) and ethyl acetate are provided by Tianjin Damao Chemical Reagent Factory. The analytical purity of zinc acetate and urea was purchased from Sinopharm Chemical Reagent Co., Ltd. All chemicals are used without further purification.

2.2 Catalytic depolymerization of polyester textiles

Waste PET fiber is degraded by the methanol degradation process. Add 150 grams of PET fiber, 450 grams of methanol and 0.75 grams of zinc acetate (catalyst) into a high temperature and high-pressure reactor with a stir bar, as shown in Figure 2.2. Stir and mix, and then heat the reactants to 170 degrees Celsius and pressurize to 1.5MPa, stirring power 150RPM. React under this condition for 2-3 hours. The conversion formula of PET is as follows.

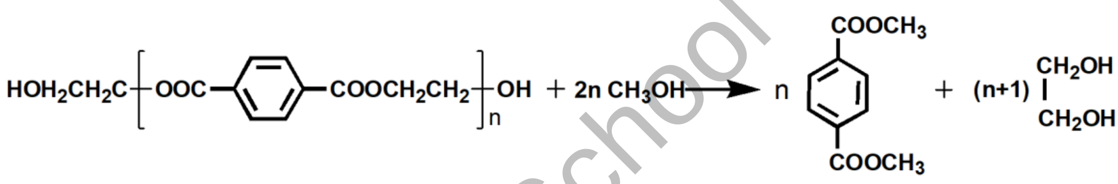
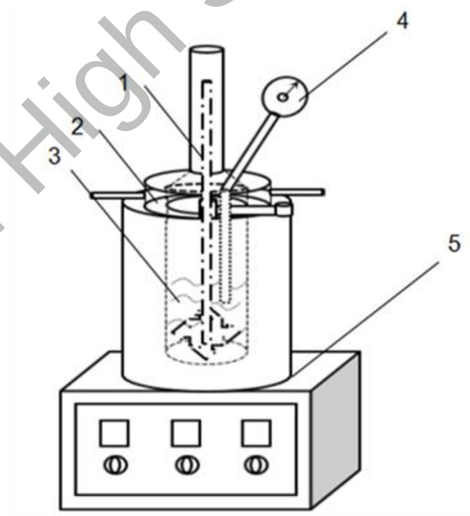


Figure 2.1 The chemical function of depolymerization of polyester textiles



1- Stirring paddle, 2- Jacket, 3- Reactor,

4- Pressure gauge, 5- Heating table

Figure 2.2 High-pressure reactor with a stir bar

The cooling solution is filtered through a vacuum pump, and the filter cake is mainly composed of DMT, which is colored crystals. The conversion of PET is defined as follows,

$$Conversion\ rates\ \text{of}\ PET = \text{initial mass of PET} - \text{final mass of PET} \div \text{initial mass of PET} \times 100\%$$

After the reaction is completed, the primary substances are DMT and ethylene glycol (EG) with a small amount of BHET and MHET. The Figure2.3a, 2.3b, 2.3c, 2.3d below shows the chemical formula and structure of different products.

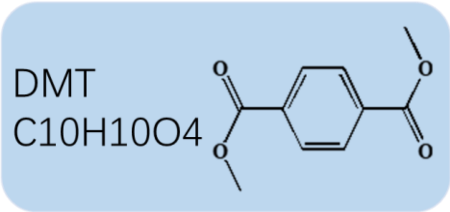


Figure 2.3a DMT

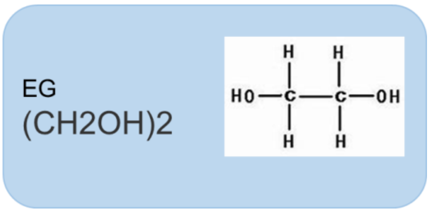


Figure 2.3 EG

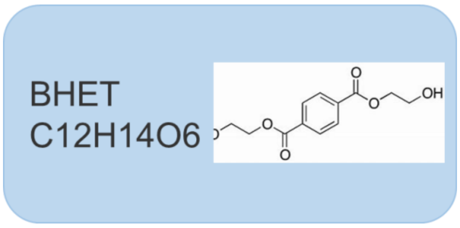


Figure 2.3c BHET

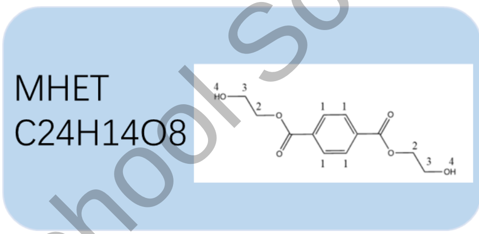


Figure 2.3d MHET

The yield of crude DMT was determined by quantitative analysis by HPLC, filtered with a microporous membrane, and analyzed with a high-performance liquid chromatography. The mobile phase is 70% methanol and 30% ultrapure water, and the temperature of the column oven is 35°C.

2.3 Purification of depolymerization monomers

The rough DMT formed after the methanol degradation of waste PET is purified by vacuum distillation to prepare refined DMT. The specific experimental method is as follows: Put a round bottom flask with 125 grams of rough DMT and crushed stone into a rectifier device and heat to 240°C to dissolve, and vacuum to -0.1MPa, collect the refined DMT obtained by distillation until no distillate is produced When, stop the experiment, the experimental device is shown in Figure 2.4.

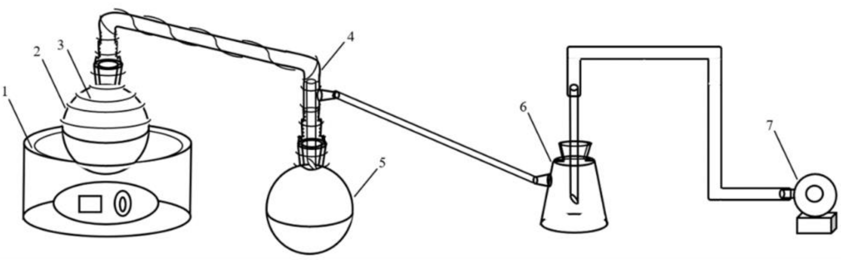


Diagram of distillation and refining plant

1- Heating sleeve, 2- round bottom flask, 3- heating belt, 4- distillation tube, 5- round bottom flask, 6- suction filter flask, 7- vacuum pump

Figure 2.4 Distillation and refining Equipment

The chromaticity value obtained through the chromaticity analysis of the refined DMT is compared with the chromaticity value data of the edible packaging grade and non-edible packaging grade of the PET bottle to see if it meets the standard. The chromaticity values of edible quality and non-edible grade PET are shown in the table below.

Table 2.1 Chroma analysis of obtained DMT

Exquisite DMT chromaticity analysis

specimens	Chroma value		
	a value	B value	L value
PET resin for bottles food packaging grade		≤2	≥80
PET resin for bottles non- food packaging grade		≤2	≥80

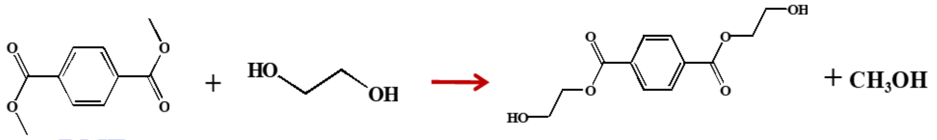
The yield of refined DMT was determined by quantitative analysis by HPLC, filtered with a microporous membrane, and analyzed with a high-performance liquid chromatography. The mobile phase is 70% methanol and 30% ultrapure water, and the temperature of the column oven is 35°C.

The conversion rate of DMT can be calculated by the following formula.

The conversion rate of DMT=initial mass of DMT - mass of remains of DMT ÷ initial mass of DMT ×100%

2.4 Monomer preparation BHET after purification

DMT transesterification to prepare BHET: Put high-purity DMT, 0.5% of its mass, manganese acetate (catalyst) and the corresponding amount of ethylene glycol (EG) into a round bottom flask with magnetic stirring and distillation head. The device of this experiment is shown in Figure 2.6. First, the temperature of the reaction in the equipment is increased to 160°C, the negative pressure is pumped to -0.05 MPa, and the reaction is performed for ten minutes. Then the temperature was raised to 180°C. The negative pressure was pumped to -0.1MPa, and the reaction was carried out for 30 minutes. The product was dissolved in hot water at 85°C, stirred and filtered while it was hot to separate BHET and its oligomers. The oligomer is placed in a vacuum drying box for use. After the BHET is cooled, the crystals are filtered, and then dried in a vacuum image to obtain a refined BHET. The reaction formula of transesterification is as follows.



DMT BHET

Figure 2.5 The chemical function of preparation BHET

Figure 2.6 A round bottom flask with magnetic stirring and distillation head

The conversion rate of DMT can be calculated by the following formula.

The conversion rate of BHET= BHET that produced ÷refined DMT that prepared

2.5 Repolymerization of depolymerization monomer to synthesize polyester

R-PET is prepared from BHET by a polycondensation reaction. It is carried out in a three-necked flask with an overhead stirrer. BHET and 0.1% of its mass of ethylene glycol (catalyst) are put into a beaker. The air and nitrogen in the beaker are carried out at room temperature. Replacement reaction, put it in an oil bath and heat it under the specified pressure, and take out the sample after the reaction is over. (Push in nitrogen during the cooling process to prevent the piece from oxidizing.) The specific reaction equation is as follows

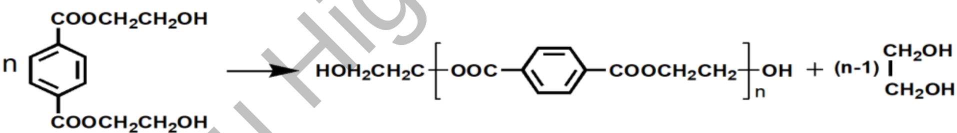


Figure 2.7 the chemical function of BHET's polycondensation reaction

In this experiment, liquid chromatography, gas chromatography, and colorimeter are used to test whether the purity of the refined DMT, BHET, and new PET prepared meet the standard. The specific experimental equipment is shown in Figures 2.8 a, 2.8 b and 2.8 c.

Figure 2.8 a liquid chromatograph

Figure 2.8 b gas chromatograph

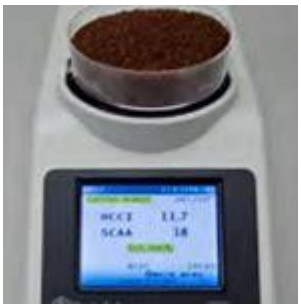


Figure 2.8 c colorimeter

3 Results and Discussion

3.1Catalytic depolymerization of polyester textiles

Through the optimized conditions of the experiment (the reaction mass ratio of methanol and PET is 4 to 1, the mass of zinc acetate is 0.5% of PET, the reaction temperature is 170 degrees Celsius, and the reaction time is 2-3 hours), this experiment also investigates the PET. Whether the raw materials will affect the experiment. The figures of the raw materials are shown in Figures 3.1 and 3.2 below.

Figure 3.1 Real cloth of PET

Figure 3.2 PET fiber with different colors

The experimental results show that all kinds of PET materials can be degraded well, indicating that PET materials have no substantial effect on the degradation of PET, and methanol degradation has good adaptability. The specific experimental results are shown in Figures 3.3 and 3.4 below.

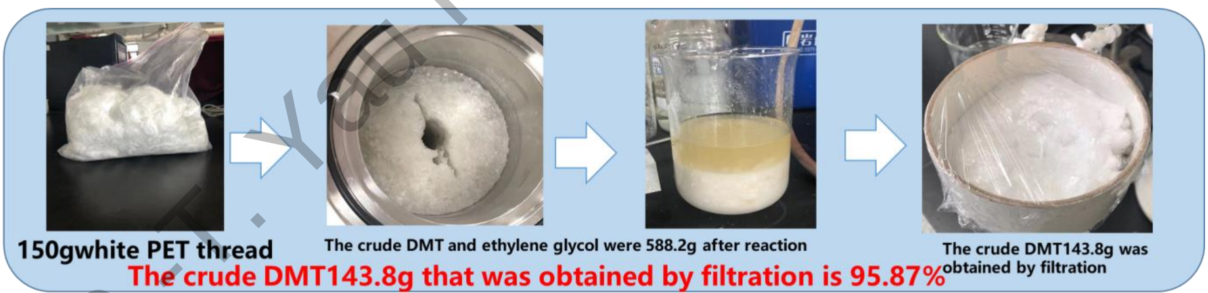


Figure 3.3 Produce Crude PET from DMT thread.

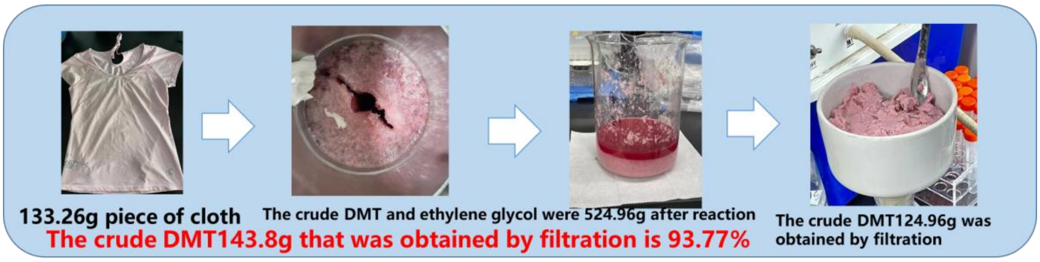


Figure 3.4 Produce Crude PET from DMT thread.

The relationship between the data of temperature and time of the specific experiment and between the data of pressure and time of the particular experiments are as follows.

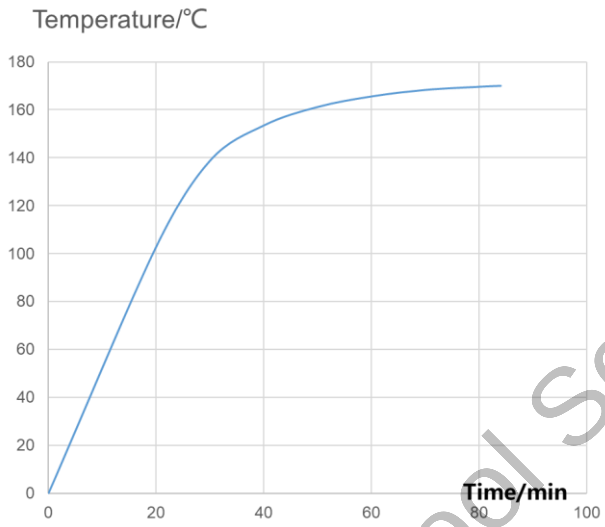


Figure 3.5 A graph of temperature versus time

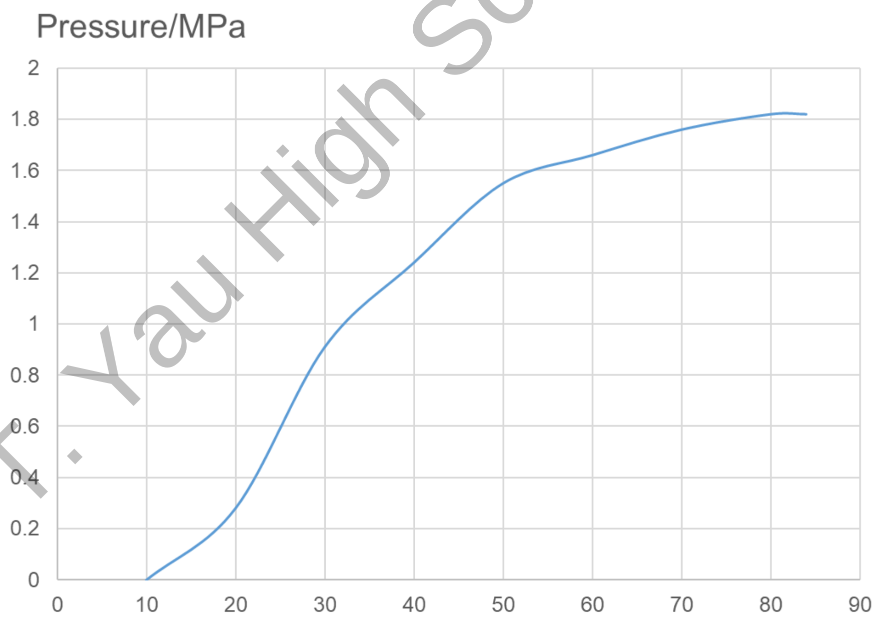


Figure 3.6 A graph of pressure versus time

This experiment can prove that methanol degradation can produce DMT well. PET reacts well with methanol and zinc acetate and can adapt to different types of PET degradation. The specific experimental data is shown in Figure 3.7.

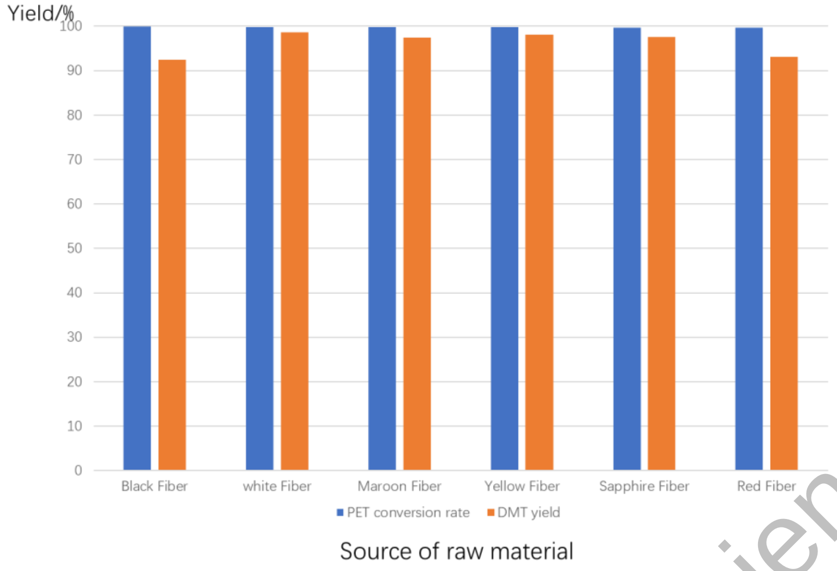


Figure 3.7 the data of PET conversion rate and DMT yield

3.2 Purification of depolymerization monomers

The experimental results show that the rough DMT made of various PET materials can be rectified well, indicating that PET materials have no substantial influence on the purification of its crude DMT, and the purity of the refined DMT made from different types is also very high. The specific experimental process and results are shown in Figures 3.8 below. The different kinds of refined DMT prepared are of high purity and reach the standard.

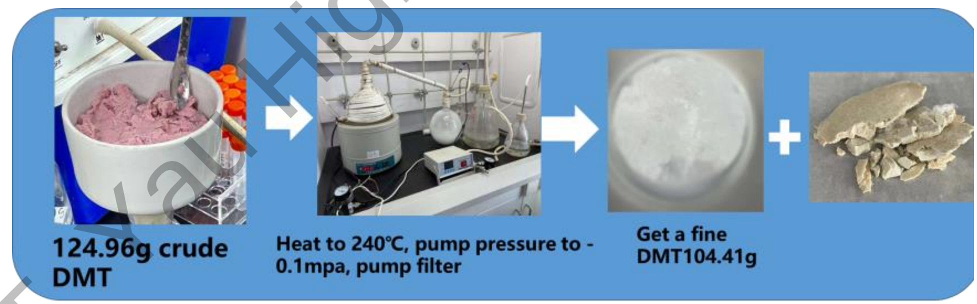


Figure 3.8 Result of Purification of a natural PET cloth

Table 3.1 Six colors to obtain the purity of refined DMT

Kinds of PET	purity/%
Black polyester thread	100
White polyester thread	99.52
Maroon polyester thread	100
Yellow polyester thread	99.56
Sapphire polyester thread	99.68
Orange polyester thread	99.38

To test whether the purity of the crude DMT and the refined DMT after rectification are qualified, this experiment uses HPLC to test its composition. The test results are shown in Figures 3.9a and 3.9b below. It meets the expectations of this experiment.

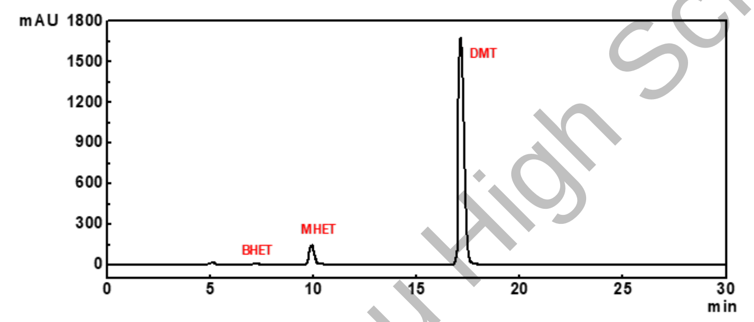


Figure 3.9a HPLC spectra containing impurity DMT

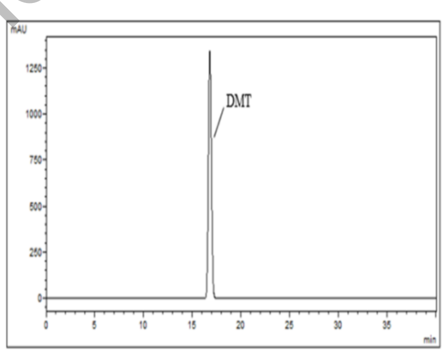


Figure 3.9 b HPLC spectrum of refined DMT

At the same time, we also use chromaticity analysis to see if different dark pigments are removed. As shown in Figure 3.7, the chromaticity values of DMT refined from other PET are all up to standard.

Table3.2 of the chromaticity value of DMT from different PET resources

Name of the specimen		Chroma value		
		a value	b value	L value
DMT from black fiber	1	3.88	5.52	54.71
	2	8.82	0.34	75.11
	3	-0.2	0.45	92.03
DMT from white fiber	1	-0.05	0.96	88.30
	2	0.01	0.95	90.38
	3	-0.12	0.06	93.25
DMT from maroon fiber	1	12.34	5.01	53.70
	2	14.15	0.58	63.62
	3	-0.17	0.19	92.73
DMT from yellow fiber	1	8.22	23.14	75.36
	2	1.84	14.02	82.30
	3	-0.20	0.14	93.03
DMT from sapphire fiber	1	-4.11	-14.26	55.37
	2	-2.94	-2.83	75.95
	3	-0.16	0.02	93.44
DMT from white fiber	1	20.20	19.35	68.23
	2	9.08	10.38	75.12
	3	-0.07	0.21	92.06

At the same time, this experiment carried out chromaticity analysis on the manufactured DMT product, and then compared the chromaticity of PET resin for bottles of edible packaging grade and non-edible packaging grade to see if it meets the standard. The specific data is shown in Figure 3.7. The result Both are higher than the international requirements for PET resin.

Table 3.3 Chroma analysis of obtained DMT

Exquisite DMT chroma analysis

Specimen	Chroma value		
	A value	b value	L value
Exquisite DMT	-0.06	-0.09	93.25
Bottles with PET resin food packaging grade		≤2	≥80
Bottles with PET resin non-food packaging grade		≤2	≥80

Meet standard international standards

3.3 Monomer preparation BHET after purification

Through experiments, we conducted experiments on the influence of the quality, time, and temperature of the catalyst NaOH on the formation of BHET. We concluded that the best conditions for preparing BHET are 0.5% NaOH as the catalyst and react at 120 degrees Celsius for 20 minutes. Reaction at 140 degrees Celsius for 20 minutes, 160 degrees Celsius for 20 minutes, and 180 degrees Celsius for 5 minutes. As shown in Figure 3.7, As shown in Figure 3.7., NaOH and Mn(OAc)2 catalysts have good catalytic effects. Under the same conditions, the yields of BHET can reach 73.5% and 75.3%, respectively. In addition, DBU also has better activity, but its price is higher, and its stability is not as good as NaOH and Mn(OAc)2·4H2O catalysts. Therefore, NaOH and Mn(OAc)2·4H2O catalysts with lower prices and better activity were selected as the catalysts for DMT transesterification to prepare BHET, and the reaction conditions were optimized.

Table 3.4 the DMT conversion by using different catalysts

Table Effect of reaction conditions on the preparation of BHET by catalytic conversion of DMT using NaOH catalyst

Entry	Reaction temperature (℃)	Reaction time (min)	EG: DMT (weight)	catalyst (%)	BHET yield (%)	DMT conversion (%)
1	120-140-160-180 [a]	20-20-20-5 [b]	2/3	0.5	22.9	99.6
2	120-140-160-180	20-20-20-5	1	0.5	40.1	100.0
3	120-140-160-180	20-20-20-5	2	0.5	73.5	100.0
4	120-140-160-180	20-20-20-5	3	0.5	84.3	100.0
5	120-140-160-180	20-20-20-5	4	0.5	84.5	100.0
6	120-140-160-180	20-20-20-5	3	0.1	73.7	100.0
7	120-140-160-180	20-20-20-5	3	0.3	81.1	100.0
8	120-140-160-180	20-20-20-5	3	0.7	83.9	100.0
9	120-140-160-180	20-20-20-5	3	0	0.0	0.0
10	120-140-160-180-200	20-20-20-20-5	3	0.5	20.5	100.0
11	120-140-160	20-20-5	3	0.5	75.9	100.0
12	120-140	20-5	3	0.5	66.2	100.0

Through liquid chromatography analysis, as shown in Figure 3.9, this experiment found that the purity of the BHET prepared in the experiments is very high. Although there are few impurities, They can still be used to polymerize new PET.

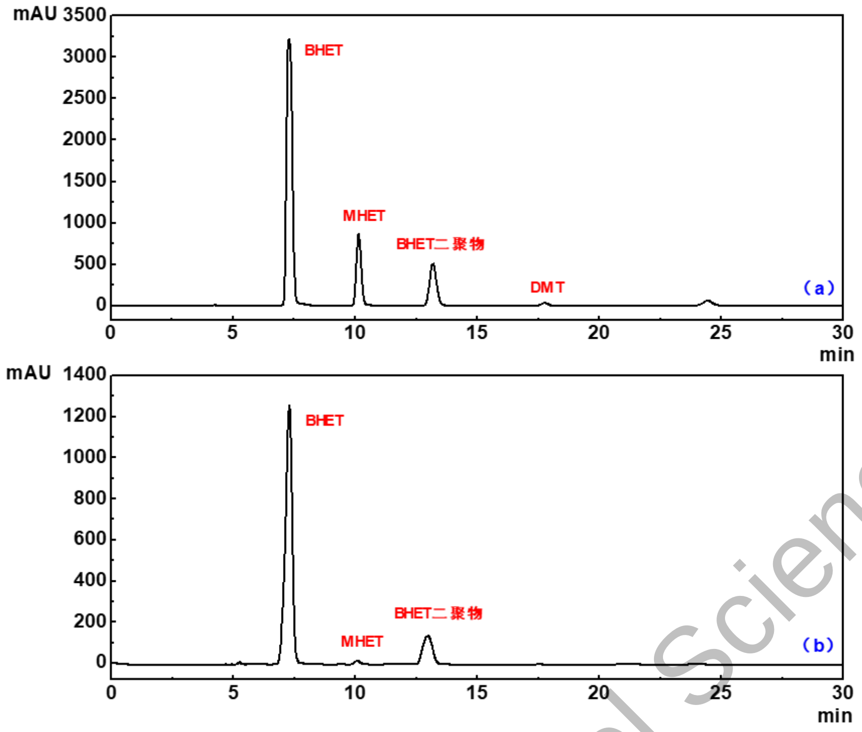
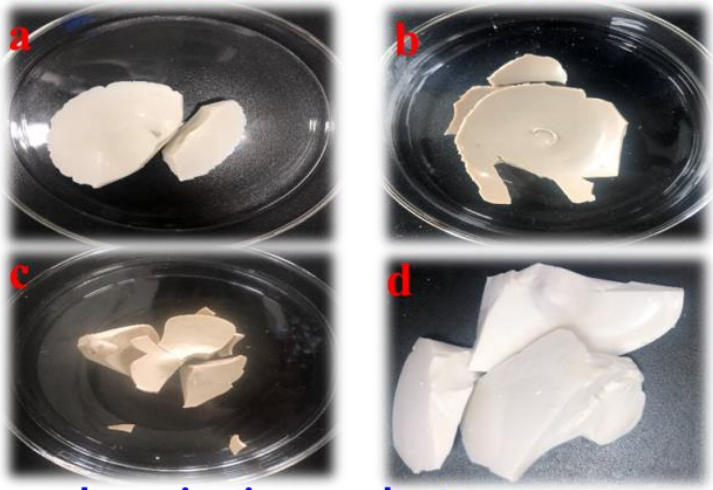


Figure 3.9 liquid chromatography analysis of BHET

3.4 Repolymerization of depolymerization monomer to synthesize polyester

Using the previously prepared high-purity BHET as a raw material, this experiment conducted experiments on the effect of different catalysts on the polymerization of new PET. It was found that 0.1% or 0.05% of the mass of ethylene glycol antimony was the most effective catalyst. The reaction was replaced with N2 at room temperature. After three times of the system, r-PET was prepared by polycondensation under different reaction conditions. The specific reaction conditions and results are as follows:

The reaction conditions are as follows: the amount of ethylene glycol antimony catalyst is 0.1% of the mass of BHET. The reaction system was melted at 150 ℃ under normal pressure for 30 min and then pre-polymerized at 260 ℃ for 30 min, evacuated to -0.05 MPa and pre-polymerized for 30 min, then evacuated to -0.1 MPa and pre-polymerized for 30 min, the temperature was raised to 280 ℃, vacuum to -0.1 MPa and polycondensation for 60 min.



Re-polymerization products

rPET from diffetent catalyst	Mn (g/mol)	Chromatic value		
		L	a	b
[Bmim]OAc	38413	79.3	3.6	12.9
$Zn(OAc)_2$	40309	86.5	1.5	7.0
ZnO	37084	94.3	1.1	2.0
5% ZnO/SBA-15	37593	93.7	0.9	1.3

Figure 3.10 The influence of different catalysts on the chromaticity value of new PET

4 Conclusions and Perspectives

In this experiment, a new methanol degradation process for PET clothing was developed to reduce the temperature of alcoholics. Reduce the reaction time and the amount of catalyst, and finally obtain safe and reliable recycled PET. Among them, we found that a closed loop is the best way to use waste polyester fiber, which is divided into four steps. (1) Catalytic depolymerization of polyester textiles with methanol, (2) Rough DMT decolorization and purification into pure DMT, (3) Pure DMT transesterification to prepare BHET and (4) Refined BHET preparation of r-PET. As shown in Figure 4.1 below. In each experimental step, waste polyesters of various colors can be degraded into DMT monomers, the degradation conversion rate is >99.9%, the crude DMT monomer yield is >95%, and the crude DMT is distilled It can be completely separated from residual impurities, and the purity of refined DMT is >99.9%. Through transesterification and polymerization, DMT monomer can be re-polymerized into PET. Regenerated PET can meet the spinning requirements. This solution can degrade and purify waste PET -Re-polymerization to obtain recycled PET, the performance of recycled PET is basically the same as that of virgin PET.

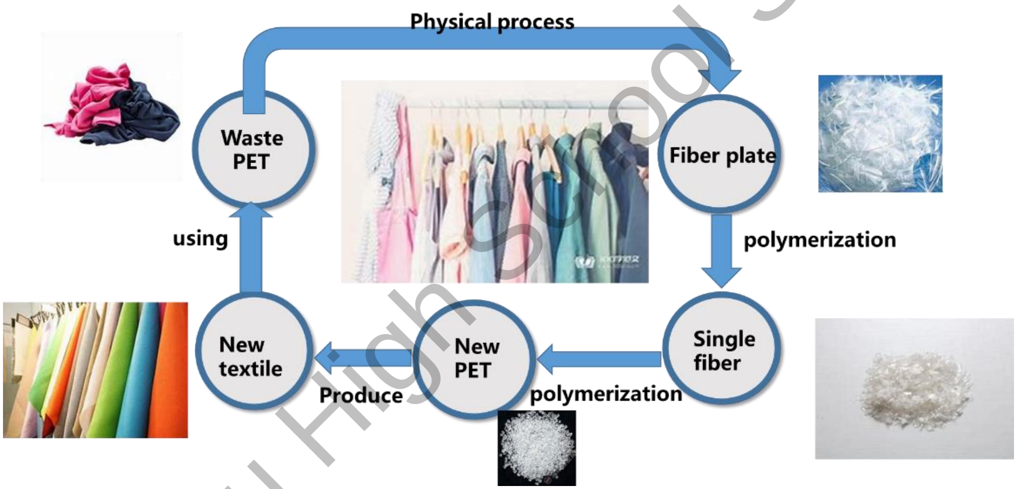


Figure 4.1 Closed-loop Recycle of Waste Polyester Textile

However, this research still needs follow-up development. The new process of waste polyester fiber recycling has been proven feasible, and more in-depth research is needed to meet the needs of industrial production. Secondly, research and development of devices/instruments that can classify waste textiles according to their composition. Separate utilization. At the same time, in the future, each city will establish several waste polyester cellulose recycling plants to greatly reduce oil consumption. Finally, it is hoped that waste polyester textiles in trash bins will not be burned anymore, but can be used better than mineral spring. Larger water bottles, easier to collect resources.

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Resume of Team Member

The author（student）

Yihe Liu

Brief Introduction

I am Yihe Liu, a high school student at Beijing Number.2 middle school.
My major academic interests are chemistry and biology.
Phone +86 15117963849
E-mail liuyihe2005@126.com
Sex male
Date of birth June 14, 2005
Birthplace Hebei, China

Prize

The Canadian Science Olympiad Bronze Award in 2021
The third prize of Big Science in Australia in 2021

Education

2011.9~2017.7 a primary student at Beijing Yucai school
2017.9~2020.7 a secondary high school student at Beijing Yucai school
2020.9~present a High-school student at Beijing Number.2 middle school

Resume of Instructor

Dr. Jiayu Xin

Associate professor

Brief Introduction

He was financially supported by Ministry of Education, Culture, Sports, Science and Technology of Japan and obtained the Doctor Degree in Energy Science in 2009 from Kyoto University. He started to work as an assistant in Prof. Suojiang Zhang's group, Institute of Process Engineering, Chinese Academy of Sciences from 2009. Dr. Xin has published more than 50 peers reviewed papers and 20 patents, and received Youth Award of Enze Min Energy and Chemical Engineering Award, The Young Star of Scientific Award and so on. His current research interests include ionic liquid catalysis, biomass conversion and supercritical fluids, PET recycle.