Research on the preparation of biodegradable fiber membrane used by cotton stalk bast

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Abstract. In order to improve the cotton bast utilization,the chemical degumming technology was adopted to process cotton bast to remove the hemicellulose, lignin , pectin and other substances in this topic.The method of nitric acid or sodium hydroxide was used to extract the cellulose,which was dissolved into a film in the copper ammonia solution. Finally,the proper film-forming process was selected by testing the physical properties of membrane.

Introduction

At present, the application of cellulose was widely involved in the textile, agriculture, medical treatment, plastics and chemical industry etc. The reasonable use of plant straw was not only helpful to repeated utilization of social resources[1].the development and utilization of cotton bast fiber[2], which were beneficial to solve the pollution of resource waste to environment.

The development and utilization of cotton bast resources could effectively solve the problem of lack of energy in today's society, but also reduced the waste of resources[3].We should make use of the existing production technology and do everything they can to protect our ecological environment ,which fully embody the high added value of natural resources[4].

Experiment

Raw materials and equipment

The experimental materials:cotton stalk bast.

the preparation process of cellulose

the degummed processing of cotton stalk bast

specific degummed process as follows:

Pretreatment→dried→pickled→washed→dried→one alkali cooked→washed→dried→beat fiber →secondary alkali cooked→washed→dried→beat fiber→pickled→washed→ dried → degummed cotton bast fibers.

Pretreatment: boiled cotton stalk bast 1 h in the boiling water at 100 ºC.

Pickled: the concentration of H_2SO_4 was 6g/L,the temperature was 55ºC, the time was 1h,bath ratio was 1:30.

Alkali cooked: the concentration of NaOH was 12g/L, the time was 90min,the temperature was 90 ºC.

Pickling: the concentration of H_2SO_4 was 1g/L,Soaked for 10 min at room temperature.

The above degummed process of cotton bast fiber was shown in Fig1.

Figure 1 the cotton bast fibers after degummed

Extraction of the cotton bast fiber

The method of ethanol nitrate to extract the cotton bast fiber.

The configuration of nitric acid ethanol solution:

First, added 400mL of anhydrous ethanol solution to 1000mL beaker, then added 100mL of concentrated nitric acid in a beaker slowly for several times. At the same time stirred with a glass rod slowly, finally poured it into the dark reagent bottle after been well blended.

Put 2g cotton bast into a 500mL conical flask, and added 50mL with good nitric acid ethanol solution in it. Then installed the spherical condenser pipe, boiled 1h at 100 ℃.And first washed the waste residue twice with anhydrous ethanol solution, then washed it to neutral with hot distilled water, finally dried and weighed it. That the cotton bast fiber was gotten.

The configuration of the copper ammonia solution:

Added the concentration of 5% copper sulfate solution into beaker，then added strong ammonia water from sediment was produced to disappeared. Finally added a small amount of sodium hydroxide solid into it.

In order to prevent oxidation, put the metal copper in the preparation of copper ammonia solution above, and added 1g cotton bast fiber respectively .Then dissolved it on the agitator, and found that the cellulose was dissolved mostly.

Cellulose membrane forming

The above methods to dissolve cellulose solution which was injected into a clean glass with medical syringe. Then spread it out evenly with membrane scraper, and filmed under the natural conditions. After the membrane was dry, washed it with distilled water. Then put the membrane in 10% of sulfuric acid solution and 10% of acetic acid solution successively, and took it out when the membrane become transparent. Afterwards, washed it three times with distilled water and ethanol. Finally, plasticized processing of cellulose membrane by putting the cellulose membrane of different thickness into 30% of glycerin solution. After 4hours, washed it and dried in vacuum oven, saved for the test.

The picture for prepared cellulose membrane was shown in Fig2.

Figure 2 the cellulose membrane

The test of cellulose membrane

the test of thickness

(1)Experimental apparatus: YG(B)141D Digital fabric thickness tester

(2)The relevant parameters: Ballast weight 50cN,Presser foot area 100mm^2, Atmospheric pressure 5kPa, Resolution 0.01mm.Measured the membrane of five different positions, then calculated the average.

infrared spectrum analysis

(1) Experimental apparatus: Spotlight 400 & Frontier Fourier transform infrared spectrometer .

(2) Instrument parameters: The resolution of the instrument was 4cm-1; the number of scanning was 16; the Scanning speed was 0.2cm/s; the scanning range of wavelength was 700-4000cm^{-1}.

the test on the properties of soil moisture

(1) Experimental apparatus: DZ-2BC Vacuum drying oven

(2) Test method: Firstly, put 9kg soil after dried into three flower pots, then added a certain volume of water respectively and made the moisture content of soil were 30%. After that, covered the cellulose membrane and common plastic film in two flower pots respectively, the other one was not covered. Then put it on the balcony. After one week, poured out of the soil, weighed and recorded. Put three soil in the vacuum drying oven at 50 ℃, after 24hours, took it out and weighed. Then returned it to oven, weighed and recorded after 2.5hours. Finally the average moisture content of soil could be calculated. (Started from the covered film between the end of the observation was not watered)

(3)The size of sample：the diameter of cellulose membrane was 100mm

(4) Calculate the content of moisture ：

$$M = \frac{G_0 - G_1}{G_1} \times 100\% \qquad (1)$$

M-the content of moisture G0-the soil weight before baked

G1-the soil weight after baked

degradation of the performance test

(1) Experimental apparatus：Constant temperature oven，Electronic balance

(2) Test method: different thickness and treatment of cellulose membrane were cut into the size of 10cm diameter circle and each of the three pieces was weighed and marked respectively, Then

recorded the data. Afterwards, put the cellulose membrane in the soil evenly, and the PH of soil was 7,the depth of soil was 10cm.

In order to keep the moisture of soil, watered once every two days. After 10,20,30,40days, took the samples out, and washed the dirt and other impurities with distilled water .Finally, dried it to the quality remain the same in the constant temperature oven, weighed and recorded.

(3) calculated mass loss rate：

$$W_7 = \frac{m_0 - m_1}{m_0} \times 100\% \quad (2)$$

W-mass loss rate,%; m_0-the dried quality of sample before soiled,g;

m_1-the dried quality of sample after soiled,g.

The analysis of cellulose membrane

the plasticizing processing of cellulose membrane

In order to prevent the surface of cellulose membrane shrinking before and after dried, put the cellulose membrane in glycerol solution to plasticize processing. It could also make the brittleness of membrane smaller, and increased the flexibility and using value,was easier to save.

the test results and analysis of infrared spectrum

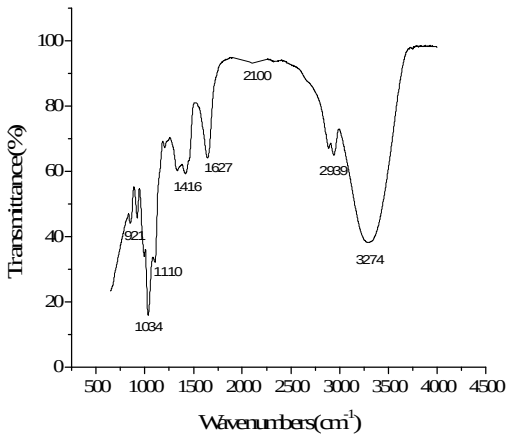

Figure 3 The infrared spectra of cellulose membrane

By figure3 could be obtained that, the absorption peak was caused by c-o keys' stretching vibration, appeared in the 1034 cm^{-1}. This was because that a small number of glycerol solution residued in cellulose membrane surface in the process of the plasticizing.The absorption peak produced by the stretching vibration of C-O-C,-CH and -OH,were appeared in 1110cm^{-1},2999$cm^{-1}$and 3274cm^{-1}.

The test results and analysis of moisturizing performance

Table 1 The determination of moisture content in different soil depth(%)

sample	The depth of soil (cm)		
	0-10	10-20	20-30
A(cellulose membrane)	28.32	28.96	29.24
B(common plastic membrane)	29.16	29.54	29.75
C(bare ground)	26.42	28.43	30.12

By table1 could be obtained that moisture content of covered by cellulose membrane was higher than bare ground. So, it could greatly improve the water retention effect of soil by covered membrane under the soil depth of 0 to 10cm. The moisture content of covered by cellulose membrane was a little less than common plastic membrane. This was because that the permeability and hygroscopicity of cellulose membrane was better than common plastic membrane, and it could absorb the water vapor in the surface of soil well. It could also be concluded from the table that two kinds of membrane which covered in the deep soil, had a small impact on the moisture content of soil. Compared with bare ground, it was conducive to reduce the evaporation of water in soil by covered with cellulose membrane and common plastic membrane.

The test results and analysis of the degradation performance

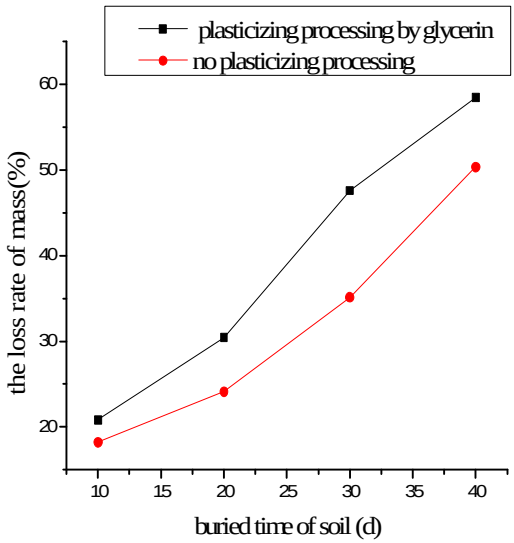

Figure 4 The changes on soil quality of Cellulose membrane after buried

From figure4 could be obtained that through different processing of cellulose membrane, the degradation rate was improved with the increase of soil buried time.In contrast,The degradation performance of plasticized processing by glycerin was better than without plasticizing treatment of cellulose membrane.After soil buried time for 10days,the degradation rate of plasticized processing was 20.8%.However,the degradation rate reached to 58.4% after 40days.This showed that the cellulose membrane could be degraded quickly in short time, and the degradation performance was good.

Conclusions

In today's society, one of the hot topic are resource problems. The utilization and exploiting of cotton bast has a great significance for sustainable utilization of resources. This topic uses the resources of cotton bast reasonably and reduce the pollution of the environment. It can achieve recycling use and is conducive to the protection of the ecological environment and rational use of resources. Cotton fiber is a new kind of natural fiber. The development and utilization of the cotton fiber is actually recycled cotton of by-products resources.

This topic mainly divides into four parts.The first part is the degumming processing of cotton bast.This paper uses a chemical degumming method(mainly for alkali scouring) . The second part is extracting the cotton bast fiber, and choose the nitric acid-ethanol method.The third part is

preparing the cellulose membrane with copper ammonia.The fourth part is analysising the light transmittance ,far infrared spectrum and degradation of performance,moisturizing performance of the cellulose membrane.

References

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