EFFECTS OF DIFFERENT RETTING METHODS ON THERMAL STABILITY AND MECHANICAL PROPERTIES OF HEMP FIBERS

by

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Different retting methods were employed in hemp retting, treated hemp fibers by various retting methods were characterized by residual gum content, fineness, tenacity, elongation, and thermal gravimetric analysis. The results indicated that alkali-oxygen one bath process was satisfactory, which achieved hemp fiber with 2.14 tex, residual gum content 2.99% and tenacity 54.33 cN/tex.

Key words: *hemp, retting methods, mechanical properties, thermal stability*

Introduction

Hemp is preferred by consumers and used widely in clothing, garment, and composite [1]. Non-cellulose including pectin, hemicellulose and lignin, glue cellulose into stiff sheet bundle fiber, therefore, retting is predominant problem in preparation to degrade pectin-rich middle lamella connecting adjacent fiber cells to release bast fibers [2], the traditional pretreatment method of hemp is chemical retting, which is time-consuming and results in much water pollution.

More biological treatments in textile industry have been focused recently [3, 4]. This method does not step into industrialization due to high cost and unstable properties of retted fiber. Therefore, our specific objectives are to obtain efficient method.

Experimental

Hemp bast came from Hunan province of China, the bast was decorticated manually from core, ingredients in hemp were measured according to GB5889-86, China test standard for ramie composition; the results are given in tab. 1.

Raw hemp was pretreated with urea concentration 10 g/L for 30 minutes followed by ammonium oxalate treatment, the ratio of material to urea solution was 1:30.

Acidic scouring and alkali-oxygen one bath process were employed, sulphuric acid was used for acid scouring with concentration of 1 ml/L for 1 hour at 50 °C. Alkali concentration varied from 8 g/L to 12 g/L, treatment time was also dynamic.

The traditional alkali boiling and microbe retting were also applied in experiments. The fungus screened before [5] is used in the treatment of hemp.

At last the optimal conditions of different retting methods were obtained based on fineness, then hemp bast was treated under optimal conditions of various methods. Retted hemp fibers were tested on stelometer for tenacity, elongation, on cutting and weighing me-

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thod [6] for fineness. Tex stands for the weight in grams per 1000 meters of fiber, and TG represents the thermal gravimetric analysis.

Results and discussion

The constituents in hemp bast are shown in tab. 1. It is obvious that hemp consists more hydrotrope, pectin, hemicellulose, and lignin resulting in fewer cellulose.

Table 1 constituents in hemp bast

Ingredient [%]	Wax	Hydrotrope	Pectin	Hemicellulose	Lignin	Cellulose
hemp	0.5	8.96	8.75	15.96	7.22	59.11

Figure 1 explains the change of fineness. Fineness of hemp fiber reduces with concentration of ammonium oxalate increasing, which indicates that larger concentration is good to refine hemp fiber. Ammonium oxalate can chelate metal ion in pectin resulting in loose fiber structure, fiber becomes finer. Therefore the optimal concentration of ammonium oxalate is 10 g/L.

The result (fig. 2) reflects the relation between treatment time of ammonium oxalate and fiber fineness, fineness drops in company with time prolonging, but fineness falls less slowly in the later. Therefore the suitable treatment time is 120 minunes.

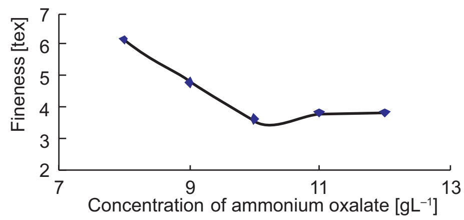

Figure 1. Effect of concentration on fineness

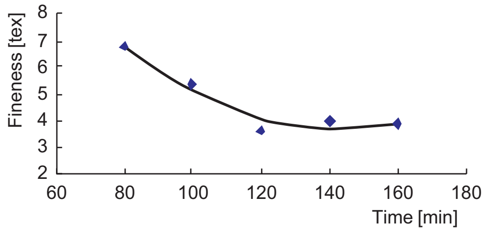

Figure 2. Effect of treatment time on fineness

Figure 3 shows that when concentration of alkali is lower, the fineness goes down with concentration of alkali increasing, while it goes up simultaneously with concentration of alkali when concentration of alkali is more than 10 g/L, which means that the proper concentration of alkali is 10 g/L. Therefore the optimal concentration of alkali is 10 g/L.

When treatment time of alkali-oxygen one bath process is less than 120 minutes the fineness of retted fiber declines with time going up, while the trend is opposite when time exceeds 120 minutes (fig. 4). The result shows that 120 minutes is appropriate for alkali-oxygen one bath process.

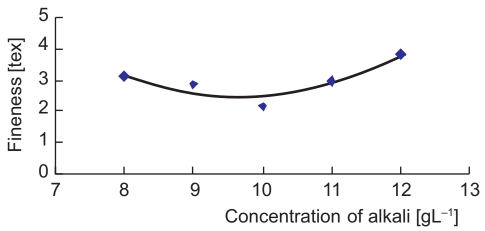

Figure 3. Effect of concentration on fineness

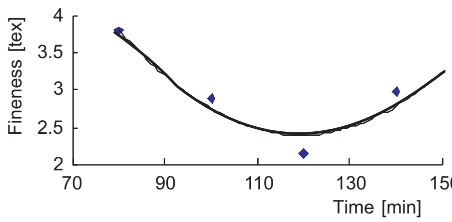

Figure 4. Effect of treatment time on fineness

Shapes of hemp fiber treated under optimal condition by alkali-oxygen one bath process are shown in figs. 5 and 6. Lumen exists in retted fiber. There are still remained gum between fibers.

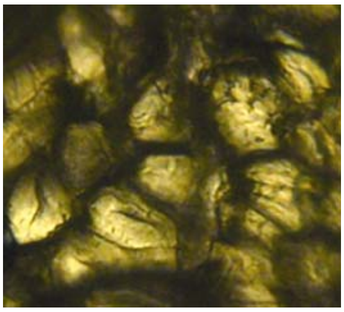

Figure 5. Transverse shape (500×)

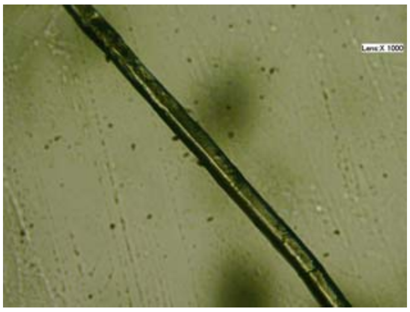

Figure 6. Lengthwise shape (500×)

Residual gum contents and mechanical properties of treated fibers are listed in tab. 2. Samples 1 to 4 are denoted for retted hemp fiber under optimal conditions by alkali-oxygen one bath process, ammonium oxalate treatment, alkali boiling and microbe retting, respectively. Sample 1 consists the fewest residual gum content followed by sample 3 and sample 4, while sample 2 has the most residual gum content, sample 2 is the finest fiber and provides the highest tenacity. In addition, there are few differences in elongation because hemp fiber is stiff resulting in small elongation. Therefore, alkali-oxygen one bath process is more satisfactory relatively.

Table 2. Residual gum content and mechanical properties comparison

Sample	Sample 1	Sample 2	Sample 3	Sample 4
Residual gum content [%]	2.99	17.23	5.68	8.75
Fineness [tex]	2.14	3.64	2.54	2.95
Elongation [%]	3.79	3.97	3.05	3.58
Tenacity [cN/tex]	54.33	37.94	32.42	43.48

Thermal stability tests of raw and retted hemp are shown in fig. 7. All samples have loss of weight about 5% at 105 °C due to evaporation of water. Weight of raw hemp reduces fast at about 280 °C, which happens at about 330 °C of retted hemp fibers consisting of more cellulose.

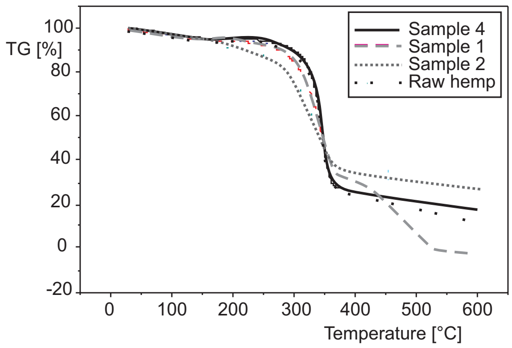

Figure 7. TG of raw hemp and retted hemp

Conclusions

Alkali-oxygen one bath process is the most effective method yielding the finest and strongest fiber. This article supplies possibility to seek an efficient retting method, but more effort is demanded for further research on large scale application in textile industry.

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