

Original Article

Preparation of Cuprammonium Biodegradable Rayon Fibers from Different Papers with Schweitzer's Solution.

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Abstract

Rayon is produced by the regeneration of cellulose through the cuprammonium process. The simple paper, Whatman filter paper or filter paper contains significant amounts of cellulose and it can be used to produce rayon fiber, specifically, cuprammonium rayon fiber. Which has application in textile and pharma packaging industries. The cuprammonium process can be useful for preparing rayon from waste papers. The preparation of rayon thread from different paper involves converting cellulose into a liquid compound and then back to cellulose in the form of a fiber. Reaction of cellulose with ammonia, copper sulphate and acid gives viscose, a soluble polymer that can be converted into Rayon. The Rayons were characterized by detecting as its melting point, solubility, density, moisture content, microscopic, element detection and burning test. The results are encouraging, and future work will include the application and study of packaging material for pharmaceuticals.

Keywords: Cuprammonium, Rayon, Biodegradable, Schweitzer's Solution.

1. Introduction

Rayon is derived from French word "rays of light" and was first sold as artificial silk¹. Rayon is semi synthetic or artificial fiber representative of man's attempt to produce silk chemically. It is produced from cellulose, the fibrous material in plants that gives them their structure and strength. Cellulose extracted from wood is a major component of paper because filter paper contain significant amount of cellulose, it can be used to produce rayon fiber, specially cuprammonium rayon. Cuprammonium rayon is produced by a solution of cellulosic material in cuprammonium hydroxide solution at low temperature in a nitrogen atmosphere, followed by extruding through a spinnerette into a sulphuric acid solution necessary to decompose cuprammonium complex to cellulose. This is a more expensive process than that of viscose rayon. Its fiber cross-section is almost round².

Cellulose is a chief structural component to which plants owe their rigidity and form. Cellulose is a natural polymeric material having fibrous structure. It is the principle component of the covering of plant cells. Cellulose represented by the formula (C₆H₁₀O₅) is a linear polymer containing glucose units. Wood, cotton and other plants material are the main source of cellulose. In the pure form cellulose is present in cotton (98%) while in wood it is about 50% of the dry wood³.

Some of the common rayon are viscose rayon, acetate rayon, cup ammonium rayon. Other rayons are cuprammonium rayon, pyroxylin rayon. Some of the natural materials based are casein fiber, alginate fiber, vicara, soyabin fiber amongst the various rayon viscose rayon is most commonly commercially manufactured rayon and find wide application in textile, tire cord industry¹. The name Viscose was derived from the word "viscous" which means sticky spinning solution out of which "Rayon" was manufactured. Thus the innovative cellulosic derivative has taken the present name of "Viscose rayon"⁴⁻⁸. Various types of viscose

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rayon are regular rayon, High tenacity rayon, high wet modulus (HWM) rayon, Flame retardant rayon, super adsorbent rayon¹.

Rayon is the oldest commercial manmade fiber. The process used to make viscose can either be a continuous or batch process. The batch process is flexible in producing a wide variety of rayons having broad versatility. Rayon's versatility is the result of the fiber being chemically and structurally engineered by making use of the properties of cellulose from which it is made. However, it is somewhat difficult to control uniformity between batches and it also requires high labour involvement. The continuous process is the main method for producing rayon. Three methods of production lead to distinctly different types of rayon fibers: viscose rayon, cuprammonium rayon and saponified cellulose acetate. The methods mentioned, the viscose method is relatively inexpensive and of particular significance in the production of nonwoven fabrics^{9,10}.

Some Characteristics of rayon fiber highly absorbent, Soft and comfortable, Easy to dye and drape well. Such fibers are designated as high tenacity rayons, which have about twice the strength and two-third of the stretch of regular rayon. An intermediate grade, known as medium tenacity rayon, is also made. Its strength and stretch characteristics fall midway between those of high tenacity and regular rayon¹¹.

The four methods of manufacturing rayon are the nitrocellulose processes the viscose process, the cuprammonium process, and the process for making saponified rayon. The cuprammonium process duplicated in this activity is one of the earliest methods for producing rayon, but is less cost-effective now than some of the other methods. The cuprammonium process converts cellulose to a soluble compound by combining it with copper and ammonia¹².

It was originally called artificial silk or wood silk. Rayon is a regenerated fiber because cellulose is converted to a liquid compound and then back to cellulose in the form of fiber for ex: cuprammonium rayon is made by dissolving cellulose in an ammoniacal copper sulphate solution¹³.

2. Materials and Methods¹²

Preparation of cuprammonium biodegradable rayon threads from different types of paper material such as whatman filter paper, ordinary filter paper and A4 size printable papers involved following.

A. Preparation of Schweitzer's Solution

Copper sulphate (20g) was weighed and transferred to beaker containing 100ml distilled water and 15ml of dilute H₂SO₄. The solution was stirred to obtain a clear solution. To this 11 ml of liquor ammonia was added drop by drop with stirring. The precipitate of cupric hydroxide is separated out and filtered and washed with water. The precipitate was dissolved liquor ammonia to obtain a deep blue solution of tetra-ammine cupric hydroxide. This is known as Schweitzer's solution.

B. Preparation of Cellulose material

2g of paper materials cut into small pieces and transferred to conical flask to this tetra-ammine cupric hydroxide solution was added. The flask was capped and kept for 15 days, during this period the paper is dissolved completely.

C. Formation of Rayon Thread

Distilled water (50ml) was taken in beaker, to this 20ml conc. Sulphuric acid was added drop wise and the syringe (10ml) was filled with the solution. The beaker contain sulphuric acid, was cooled in ice. The tip of the syringe was immersed in sulphuric acid solution and pressed gently. In acid bath, the fiber was formed slowly (fig no. 1). The fiber was decolorized and become strong enough (fig no. 2). The solution was filtered and washed with distilled water, to obtain rayon fiber.

Reaction

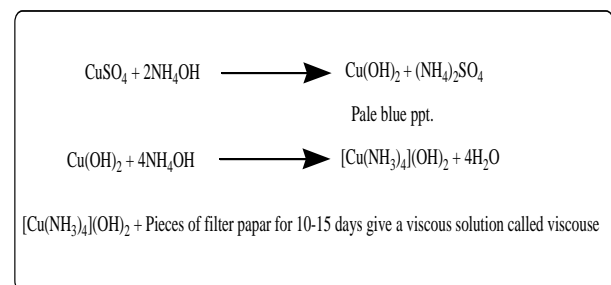




Fig. 1. Rayon fibers before decolorization.



Fig. 2. Rayon fibers after decolorization.

Results and Discussion

Rayon fiber was prepared from different paper involved converting cellulose into liquid compound. Viscose fiber rayon was obtained, when ammonia reacted with copper sulphate and acid. The result of analysis of rayon fiber was shown in Table no.1. The solubility test was performed for identification of rayon. The density of rayon obtained whatmann filter paper, ordinary filter paper and A4 size paper was found to be 1.47-1.50, 1.44-1.46 and 1.50-1.54 respectively. Density and moisture content were compared with standard value of rayon fiber (density of rayon fiber = 1.54-1.64 and % moisture content of rayon fiber = 11-13). The melting point of rayon fiber in literature was found to be above 150°C. The melting point of viscose rayon was obtained satisfactory. Thus all the parameter of test as ordinary filter paper A4 size paper were in accordance with whatman filter paper rayon. The yield of rayon was from 84 to 94 %.(as shown in table no.1)

Conclusion

Rayon fiber was prepared from material viz. whatman filter paper, ordinary filter paper, A4 size paper. These fibers were characterized by

various tests. These fibers will have application of in pharmaceutical packaging and surgical product.

References

1. G.T. Austin. Cyclic Intermediates and dyes, Shreve's Chemical Process Industries V th Edition, McGraw Hill International editions, (1984) 772.
2. J. Gordon Cook, Handbook of Textile fibers, II Manmade Fibers, 82.
3. Preparation of rayon thread from filter paper by Cynthia Ruscotto, eHow contributor.<http://www.ehow.com/prin>
4. www.fibersource.com/ftutor/rayon.htm.
5. Time-Life. Inventive Genius. New York, (1991) 52.
6. http://en.wikipedia.org/wiki/viscose_rayon.
7. Viscose rayon the oldest manmade fiber- versatile fiber yarn <http://www.swicofil.com/viscose.html>.
8. Ghezelayagh Ava. A Comparison of the Chemical Structures and Production Methods of Silk and Artificial Silk. http://cosmos.ucdavis.edu/archives/2008/cluster8/ghezelayagh_ava.pdf.
9. Ed. A. Vaughn. The Technical Needs: Nonwovens for Medical/Surgical and Consumer Uses, TAPPI Press, 61-66.
10. J. Lunenschloss, and W. Albrecht. Nonwoven Bonded Fabrics, (1985).
11. B.Z. Shakashiri. Chemical Demonstrations: A Handbook for Teachers of Chemistry. University of Wisconsin: Madison. I st Edition, (1983) 247.
12. <http://picsedu4iit.files.wordpress.com/2009/11/chemistry-projects-part-1.pdf>.
13. Tencel Anon. High Performance Cellulose Fiber, High Perform. Textiles 9(7), 1 (1989).

Table 1. Analysis of rayon fibers.

Tests	Rayon fibers obtained from		
	Whatman filter paper	Ordinary filter paper	A4 size paper
Solubility in acetic acid	Soluble	insoluble	Soluble
10% Sodium hydroxide	Soluble	soluble	soluble
Organic solvent	Acetone	Ethyl acetate	Acetone and chloroform
Density(g/cm³)	1.47-1.50	1.44-1.46	1.50-1.54
Melting point(°C)	230	210	198
Percentage of Moisture content	7-8.2	8-9.5	9-10.5
Percentage yield	93.57	84.77	92.11

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