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THE MANUFACTURE OF RAYON

Although rayon was originally intended to imitate the natural product silk, at that time very expensive, it has since become important in its own right as a textile fiber. Over one billion pounds of rayon were produced in the United States in 1948. Total world production was somewhat more than twice this amount.

Since 1937, the word "rayon" is defined by Federal law as the generic term for textile fiber or yarn produced chemically from cellulose or a cellulose compound by the cellulose nitrate, cuprammonium, cellulose acetate, viscose, or other processes, and the term also includes fabrics made from the yarns.

In the manufacture of rayon under these four processes, a solution of cellulose or a cellulose compound is forced through a perforated cup, called a spinneret, to be almost instantly coagulated by suitable means in the form of continuous filaments or fine threads. For textile yarn, the threads from a single spinneret are automatically twisted together to form a strand of yarn. This form is called continuous-thread rayon and is used directly for the weaving of fabrics or, when specially made, for tire cords. For staple fiber, the threads from a number of spinnerets are gathered together as a rope for subsequent cutting. Staple fiber comprises short lengths, which may be uniform or varied as the use requires. It was developed to blend rayon with other textile fibers, such as cotton and wool, for spinning into yarn. Staple fiber comprised about one-fourth of the total rayon produced domestically in 1948.

Although wood is now the chief source of cellulose for rayon, cotton cellulose is also an important one owing to the high strength its cellulose imparts to rayon yarn. For example, cotton cellulose is used widely in mixture with wood pulp cellulose in the manufacture of the tire cord grade of yarn. Where necessary, cereal straws can be used as a source of cellulose. Cellulose pulps for rayon, whether made from wood, cotton, or other plants, must be nearly pure "alpha" cellulose, that is, free from lignin, resins, fats, waxes, and essentially free from forms of cellulose less stable than the alpha cellulose. In addition, these pulps must meet many exacting requirements with respect to chemical and physical requirements.

Because of a great difference in natural chemical composition, wood requires considerably more extensive chemical treatments than cotton when used as a source of cellulose for dissolving pulps.

Practically all rayon wood pulp is made from softwoods by the acid sulfite cooking process and subsequently purified by special techniques. Procedures have been developed, however, whereby the sulfate process can be used and it has also been demonstrated that hardwoods can be converted by this process to satisfactory rayon pulps.

Rayon is no longer made in the United States by the cellulose nitrate process and but very little by the cuprammonium process. The amount made by the cellulose acetate process is only about one-third that made by the viscose process.

In the cellulose nitrate process cotton or wood pulp is converted to a cellulose nitrate by treatment with a mixture of nitric and sulfuric acids. The cellulose nitrate is dissolved in an alcohol-ether mixture, and threads are formed by forcing the solution through the spinnerets, after which they are coagulated almost instantly by the evaporation of the ether and alcohol. The product undergoes various refinements including bleaching and denitration with an alkaline sulfide to render the yarn less inflammable. It has been variously known as Chardonnet, Lehner, tubize, collodion, pyroxylin, or nitro-cellulose silk.

In the cuprammonium or Despaissis process cellulose, in the form of cotton linters or wood pulp, is dissolved in a solution of basic copper sulfate and ammonium hydroxide. The solution of cellulose is forced through the spinnerets into water and then into dilute sulfuric acid, the filaments being stretched as they are solidified. They are then thoroughly washed and dried. Most of the copper and ammonia are recovered. Rayon made by this method has been known as cuprammonium, Despaissis, Pauly, or glanzstoff silk.

Cellulose acetate is prepared by treating cotton or wood pulp with acetic acid and acetic anhydride in the presence of a suitable catalyst, usually sulfuric acid, and precipitating the acetate in water. The cellulose acetate is then dissolved in acetone to make the spinning solution. The filaments coming through the fine holes of the spinneret are coagulated by evaporation of the acetone in a current of warm air.

In the viscose process either cotton linters or wood pulp or a mixture of the two is first steeped in strong sodium hydroxide solution to form alkali cellulose. The alkali cellulose is then pressed, shredded, and treated with carbon disulfide to form cellulose xanthate. The xanthate is dissolved in a dilute sodium hydroxide solution to make the viscose spinning solution. The viscose is forced through the spinneret and the filaments coagulated in a bath containing sulfuric acid, sodium sulfate, zinc sulfate, and sometimes glucose. The yarn is then washed, dried, and treated with alkaline sulfide solutions to remove residual sulfur or sulfur compounds, and, if necessary, bleached.