Introduction

There are two types of cellulose-based fibers: regenerated or pure cellulose (such as the fibers from the cupro-ammonium process) and modified cellulose (such as the cellulose acetates and rayon).

Acetate fiber is a synthetic fiber, in which the forming substance is cellulose acetate. When no less than 92 % of the hydroxyl groups are acetylated, the term triacetate may be used as a generic description for the fiber.

Application

Acetate is derived from cellulose by breaking down wood pulp (dissolving pulp) into purified cellulose. Cellulose acetate dope is produced by reacting the purified cellulose with acetic acid and acetic anhydride, whilst using sulfuric acid as a catalyst. The cellulose acetate flakes are then dissolved into acetone for extrusion. Then, filaments emerge from the spinneret and the solvent is evaporated in warm air.

Production process

Purified cellulose from wood pulp or cotton linters is mixed with glacial acetic acid, acetic anhydride and a catalyst (sulfuric acid). The mixture is put through a controlled 20 hour partial hydrolysis to remove the sulfate and the required amount of acetate molecules to obtain the product's desired properties. In this step a precipitate of acid-resin flakes is obtained. The flakes are dissolved in acetone and the solution is filtered.

The resulting solution is the spinning dope or spinning solution. The spinning solution is extruded in a column to form filaments which are dried with dry air. The solvent is recovered and purified for reuse. The filaments are stretched and wound onto beam cones or bobbins to obtain the final product.
Fiber Formation Method: Extrusion and Spinning

After being formed, cellulose acetate is dissolved into acetone for extrusion. As the filaments emerge from the spinneret, the solvent is evaporated in warm air (dry spinning) producing fine filaments of cellulose acetate.

The liquid substance of cellulose is forced through a metal cap, or nozzle, called a spinneret. The spinneret is perforated with small holes and a filament is extruded through each one. The extruded filament gets solidified by a liquid bath as it emerges from the spinneret. The number of perforations in a spinneret varies from 1 to 20000 and filaments of equal gauge are produced simultaneously. Subsequently, filaments are twisted together to form yarn.

As the filaments emerge from the holes in the spinneret, the liquid polymer becomes rubbery and then solidifies. This process of extrusion and solidification of endless filaments is called spinning. It should not be confused with the operation by the same name, used for producing natural yarn, where the shorter lengths of natural fiber are twisted into yarn. There are four methods of spinning synthetic fiber filaments: wet, dry, melt and gel spinning.

Stretching and Orientation

While extruded fibers are solidifying, or in some cases even after they have hardened, the filaments may be drawn to impart strength. Drawing pulls the molecular chains together and orientates them along the fiber axis, creating a considerably stronger yarn.

Instrumentation and installation

The K-Patents Process Refractometer PR-43-GP is used in the dissolving tank to monitor the concentration of the dope solution prior to the spinning of the fibers. The cellulose is dissolved in a dope solution, which consists of dissolved cellulose in acetone. Traditionally, the concentration of the dope is measured by taking samples and analyzing them in the laboratory. This method is not optimal as acetone evaporates quickly, giving false results.

The K-Patents refractometer is installed in-line for continuous measurement and control of the dope concentration. A product of high quality is obtained only if the refractive index value is maintained within a pre-determined limit. The refractometer is installed either in a by-pass loop with an external heat exchanger or directly in the dissolving tank.

Another refractometer can be installed in the solvent recovery area to maximize acetone recovery and reduce operation costs.

Typical measurement range in this application is 20-30 % and the process temperature is about 20-60 °C (68-140 °F). Appropriate equipment with hazardous and intrinsic safety approvals are available when required.

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<thead>
<tr>
<th>Instrumentation</th>
<th>Description</th>
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<tbody>
<tr>
<td>K-Patents Process Refractometer PR-43-GP</td>
<td>A general industrial refractometer for pipes and vessel installations. The PR-43-GP can be installed with 2, 3 and 4 inch flange and 3 inch Sandvik L coupling process connections and a variety of flow cells for pipe sizes of 1 inch and larger.</td>
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<tr>
<td>User Interface</td>
<td>Selectable multichannel MI, compact CI or a web-based WI user interface options allow the user to select the most preferred way to access and use the refractometer measurement and diagnostics data.</td>
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<tr>
<td>Measurement range</td>
<td>Refractive Index (nD) 1.3200 – 1.5300, corresponding to 0-100 Brix.</td>
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