Sustainability in the Production of Rayon

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What is Rayon?

- Rayon is a manufactured cellulose fiber.
Rayon’s Uses

• Production of Textiles
• Production of carbon fiber.
Rayon’s Strengths

- Made from a renewable resource
  - Based on cellulose
    - Wood pulp
    - Cotton linters
- Carbonized rayon has low thermal conductivity
  - Excellent for products such as heat shields and rocket nozzles.
Production Issues

• Several Rayon Methods are cost prohibited in the US

• Result of hazardous production chemicals.

• Harder to acquire American made rayon based products.

• No US supplier of rocket nozzle grade carbon fiber due to EPA regulations.
Characteristics of Polyacrylonitrile (PAN) Fiber

Strengths:

• Can be used in textiles and to create carbon fiber.
• Superior tensile strength

Weaknesses:

• Carbonized PAN has higher thermal conductivity than carbonized rayon.
• Does not provide rocket nozzle or heat shield grade carbon fiber.
• Cannot replace rayon
Several Rayon Creation Methods:

Hazardous
- Viscose Rayon Method
- Acetate Method
- Cuprammonium Method

Green
- Ionic Liquid (IL) Method
Viscose Method

- Cellulose is broken down and is eventually wet spun into a fiber.
- Caustic and acidic chemicals contaminate wash water.
- This process is cost prohibited in the United States
Acetate Method

- Cellulose is dissolved and dry spun into a fiber.
- Acidic & carcinogenic chemicals involved
- Some manufacturing process are cost prohibited in the United States.
Cuprammonium Method

- Cellulose is treated to remove impurities.
- Cellulose is converted to copper cellulose and dissolved in ammonia
- Acidic chemicals contaminate wash water
- Cost prohibited in the United States
What Are Ionic Liquids?

- Organic salts in a liquid state at room temperature
- Almost no vapor pressure
- Very good solvents
IL Fiber Creation Process

- Cellulose is dissolved in IL
- Ionic liquid/cellulose mix is extruded into a water bath
- IL is recovered
Viscose Process versus Ionic Liquid Process

Viscose Process:
- Pulp Activation
- Derivation
- Dissolution
- Spinning
- Products
- NaOH, CS₂, NaOH, H₂O, H₂SO₄

Ionic Liquid Process:
- Pulp Direct Dissolution
- Spinning
- Products
- Ionic Liquid, CS₂, H₂O

The diagram shows the flow of processes and materials in both the Viscose and Ionic Liquid processes, illustrating the differences and similarities in each step.
IL Creation Process (cont.)

Ionic Liquid/Cellulose Mix

Fiber Extrusion

Needle extruder

Fiber

Fiber

Fiber
Our Work at RFAL

- Created fibers from Ionic liquid
- Successfully carbonized fibers
- Recovered Ionic liquid after extruding fibers
- Attempting to produce mass amounts of fiber
Why the IL Process is Better For the Environment

- No extremely harmful chemicals involved
- Water is the only required wash solution
- Waste water is evaporated off
- IL is reusable
- No need for disposal

Caustic Soda

Sulphuric Acid

Acetic Acid
Why the IL Process is More Sustainable

- Only two chemicals involved
- IL is recoverable

IL dissolved in water

Recovered IL
Questions?

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