CIRCULARITY OF CELLULOSIC FIBERS

Future of forestry and forest-based industries in a sustainable bioeconomy

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Structure

MMCF characteristics

MMCF circularity

Photo: Gabriel Farias
Classification of textile fibers

**Classification of Fibres**

**NATURAL**
- **Proteins**
  - Animal-keratin polymer
  - Wool
  - Silk
  - Leather
  - Skins
  - Alpaca
  - Mohair
  - Angora
  - Camel
  - Vicuna
- **Cellulosics**
  - Vegetable-glucose polymer
  - Cotton
  - Linen
  - Ramie
  - Jute
  - Coir
  - Pineapple
  - Grasses
  - Banana
  - Kapok
  - Bamboo
  - Hemp
- **Mineral**
  - Asbestos
  - Metals (e.g., copper, silver, and gold)

**MAN-MADE**
- **Natural Polymer**
  - Regenerated Cellulosics
    - Viscose
    - Modal
    - Lyocell/Modal/Tencel
    - Bamboo
    - Alginate
    - Peat
  - Cellulose Esters
  - Latex
  - Acetate Triacetate
  - Rubber
  - Petrochemicals
    - Poly-vinyl
    - Acrylic
    - Modacrylic
  - Synthetic
    - Polyamide
      - Nylon
      - Tactel, Cordura, Polyester
      - Acrylic
      - Elastane
      - Microfibres—derivatives of polyester, polyamide and acrylic.
    - Chlorofibre
      - PVC (Polyvinylchloride)
    - Polyoolefin
      - Polyethylene
      - Polypropylene
    - Fluorofibre
      - PTFE (Polytetrafluoroethylene)

**In-organic**
- Carbon
- Glass
- Metal
- Ceramics
- Rock wool

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Man made cellulosic fibers

Man made cellulosic fibers, are semi-synthetic fibres because they are derived from natural raw materials but are chemically processed to create the fibres.

They can be classified into a few different categories based on the manufacturing process and properties.

- **Viscose rayon fibres**: These fibres are made by dissolving wood pulp or cotton linters in a solution of sodium hydroxide and carbon disulfide, and then extruding the solution through a spinneret to form fibres. They are known for their softness, drapability, and ability to absorb moisture.

- **Cuprammonium rayon fibres**: These fibres are made by dissolving wood pulp or cotton linters in a solution of copper salts and ammonium hydroxide, and then extruding the solution through a spinneret to form fibres. They are known for their high strength and resistance to shrinking and wrinkling.

- **Modal fibres**: These fibres are made by dissolving beech tree pulp in a solution of sodium hydroxide and carbon disulfide, and then extruding the solution through a spinneret to form fibres. They are known for their softness, drapability, and moisture-wicking properties.

- **Lyocell fibres**: These fibres are made by dissolving wood pulp in a solution of amine oxide, and then extruding the solution through a spinneret to form fibres. They are known for their high strength, excellent drapability, and moisture-wicking properties.
World Fiber Market 2018

- **Synthetics**: 63%
- **Cellulosics**: 6%
- **Natural**: 31%

Source: Andreas Engelhardt, Status and Outlook on Textile Fiber Markets, 2020
Global annual average growth rate

Dynamics in Staple Fibers

![Graph showing the AAGR in % for various decades: 1980s, 1990s, 2000s, 2010-18. Natural fibers show a slight decline, while cellulosics and synthetics show an increase.]

2025 Forecast

- Cotton 0.75%
- Polyester 3.75%
- Cellulosic 4.75%


Source: Andreas Engelhardt, *Status and Outlook on Textile Fiber Markets*, 2020
General market characteristics

- Textile fibers demand is growing (apparel & home textiles)
- Geographic extension of value chains at the global scale
- Fashion driven
- Fast fashion creates waste
- Waste can be recycled
- Recycling ≠ circularity
- Circularity ≠ sustainability
Reuse of textile fibers

< 1% of textiles is recovered for the production of new clothing

< 12% of textiles is recovered for cascading (insulation, mattress stuffing, wiping clothes etc.)

73% of textiles is landfilled of incinerated

Source: Ellen MacArthur Foundation, 2017
Textile fibers

- Cellulosic fibers may deliver resource efficiency compared to synthetic fibers in terms of biodegradability and cotton in terms of land and water footprint.
- However, circularity of cellulosic fibers value chains depends on the emphasis on different criteria in lifecycle analysis studies.
- They are often prepared by the respective businesses themselves and not independent bodies.
- Variety of labels and regulations fogs the understanding of circularity and sustainability.
Textile fibers - consumption

- Production and consumption are particularly interlinked in the fibers industry (apparel/home textiles).
- Production is subject to demand generated by fashion and the fast fashion is shaping consumption patterns.
- Before considering other circular approaches, reducing production and consumption is key.
- Increased traceability improves trust in brands and helps consumers become aware of the environmental impact of the products they buy.
Circularity of cellulose based fibers

- Current recovery technologies allow for 50% of the raw cellulose fibers to be replaced with alternative feedstocks. They can be recovered from agriculture, forestry and municipal residues, recycled textiles and other sources.
- Most garments are produced from a mix of synthetic and natural fibers. Improving capacity to recycle such fibers is therefore essential.
- The content of elastane is an important feature, evidence say that above 7% of elastane is a technical obstacle for recovery of fibers.
- Economic viability and environmental sustainability of the recovery of irregular material streams with inconsistent quality need to be evaluated case by case.
- There use of hazardous chemicals is also extensive. Therefore, the treatment and dyeing of textiles can cause significant pollution, also during the recovery of fibers.
THANK YOU

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