Mercerization or how a traditional process can reduce the environmental impacts of a shirt

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Summary

- Mercerizing
- Tests in laboratory
  - Dyeing
  - Use phase
  - Lifetime
- LCA
Mercerizing

Mercerizing?
- Optional treatment during the manufacture of cotton textiles
- Changes the macromolecular organization of cellulose

Mercerized fabrics:
- Is dyed more easily
- Dries faster
- Creases less
- Has a better quality

Actions on use phase and lifetime

2 effective levers to reduce environmental impacts of textile products

Life cycle of a shirt
Influence of mercerizing
2 processes of mercerizing → with NaOH or with NH₃

- **Traditional process with** soda (NaOH)
  - Pre-washing
  - Impregnation
  - Stabilization
  - Soda recovery
  - Neutralization washing

- **Alternative process with** liquid ammonia (NH₃)
  - NH₃ impregnation
  - NH₃ evaporation
  - Washing x 2

Assumption: NaOH is 70% recycled

Different influence:
- on the fabrics
- on the life cycle

- Industrial data
- Recycling of NH₃ (more than 99%)
Objective of the study

- **Comparative LCA** between 3 shirts:
  - a untreated shirt
  - a NH₃ mercerized shirt
  - a NaOH mercerized shirt

- **Tests in laboratory** on the 3 fabrics to evaluate differences on:
  - Dyeing step
  - Use phase
  - Lifetime

Life cycle of a shirt
Influence of mercerizing
Tests in laboratory
Dyeing

**Principle:**
- Application of the same dyeing processes on the 3 fabrics
- Study of the color obtained

Best color strength with NaOH mercerized fabric

Less dye is necessary for this fabric
- Only 3.5% of dye

- 8.5% of dye for the untreated fabric
- 7% of dye for the NH$_3$ mercerized fabric

Life cycle of a shirt
Tests in laboratory
Use phase (drying and ironing)

- Measurements are realized to quantify the differences between the 3 fabrics concerning the drying and the ironing.

Drying
- Measure of the residual moisture on the 3 fabrics after washing
- Slight decrease in the amount of moisture with mercerized fabrics (5%)
- Reduction of time in the tumble dryer

Ironing
- Time reduction of 40%
Tests in laboratory
Lifetime

Evaluation of the degradation of shirts during washing:

- Fabrics are washed and dried in tumble dryer **during 250 cycles**

**Evolution of tear strength**

- Mercerizing increases the lifetime by 50%

![Graph showing the evolution of tear strength](image)

**Life cycle of a shirt**:

1. **COTTON PRODUCTION**
   - Spinning
   - Weaving
2. **MANUFACTURING OF THE SHIRT**
   - Mercerizing
   - Dyeing
   - Sewing
3. **USE PHASE**
   - Washing (60°C)
   - Drying (tumble dryer)
   - Ironing
4. **END OF LIFE**

- Washing and drying
- Mercerizing
- Lifetime
LCA
Scope definition

- **Functional unit:**
  - “use and wash a shirt during one day”

- **Assumptions:**
  - the shirts weights 200g
  - shirts are washed after each use
  - drying in tumble dryer

- Calculation of the impacts:
  - ReCiPe method (midpoint)

- Software :
  - GaBi (PE International AG)

- Data sources :
  - GaBi software, ELCD and EcoInvent databases in general
  - **Experimentation**, publications and industrial data for more specific processes
Mercerized fabrics are less impacting → mainly due to lifetime (evaluate with tear strength)

Use phase is the most polluting step

Drying: 40-57% of the impact of the use phase → hypothesis: “systematic use of a tumble dryer”
LCA
Results for shirt production and use phase

- Production of mercerized shirts is more polluting due to the additional step

→ NaOH mercerizing is more impacting

- Use phase of mercerized shirts are less impacting

→ shirts dry faster and crease less (ironing time is shorter)
Conclusion

- Study of the degradation of the shirts during washing → to quantify the lifetime improvement with mercerised shirts.

- Mercerizing:
  - significant increase environmental impacts during the production phase
  - but net environmental benefits on the all life cycle of a shirt

- Future works:
  - Evaluation of the lifetime with additional parameter (in addition to the tear strength) → ex: tensile strength, abrasion resistance
  - Scenarios including real use of shirts, air drying and systematic ironing → evaluation of the new lifetime
  - Soda is recycling (70%) for NaOH mercerizing → in practice it is not systematic → sensitivity analysis
Thank you for your attention.

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