

INTERNATIONAL
COTTON
CONFERENCE
BREMEN

2024



20 - 22 MARCH 2024 | BREMEN PARLIAMENT HOUSE

PRESENTATION

Session:

RECYCLING

Title:

Optimization of spinning preparation technology in the processing of recycled cotton

Speaker:

Stephan Baz, German Institutes of Textile and Fiber Research Denkendorf (DITF)
(Germany)

Conference Organisation

Faserinstitut Bremen e.V., Bremen, Germany. E-Mail: conference@faserinstitut.de

Bremer Baumwollbörse, Bremen, Germany. E-Mail: info@baumwollboerse.de



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Optimization of spinning preparation technology in the processing of recycled cotton

Stephan Baz, Bettina Cherdron, Markus Baumann, Götz T. Gresser, Mesut Cetin
37th International Cotton Conference Bremen, March 22, 2024

Agenda

- Presentation of DITF
- Introduction and presentation of IGF 22256 N
- Characterization of primary and secondary raw materials
- Examination of carding elements
- Summary and outlook
- Acknowledgments



Europe's Largest Textile Research Center

Key Figures 2022



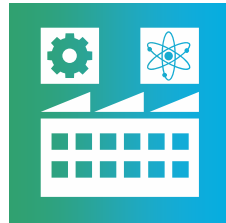
Employees

approx. **220**



Turnover

12 m € public
13 m € industry



Area

25,000 m²



Research

189 public
572 industry



Partners

1158 enterprises
67 % SME

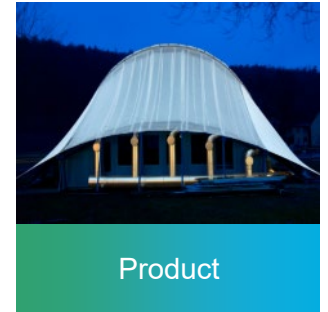
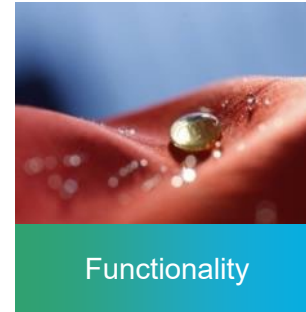
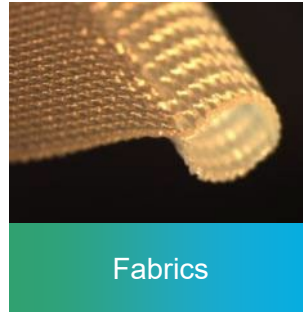
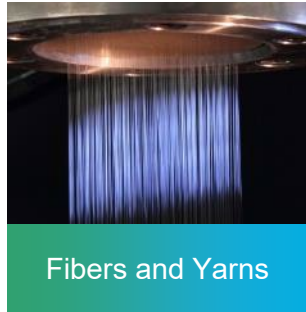


Services

approx. **100**
test customers
5 small batch series

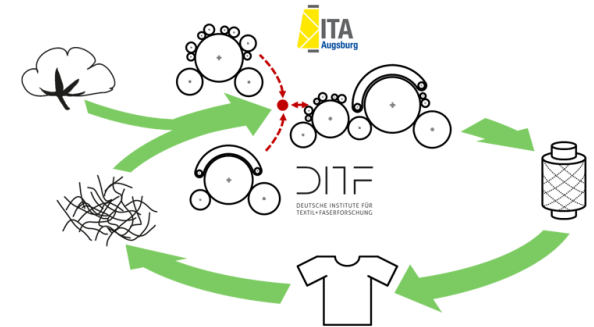
Textile Vertical Integration

FROM MOLECULES TO PRODUCTS



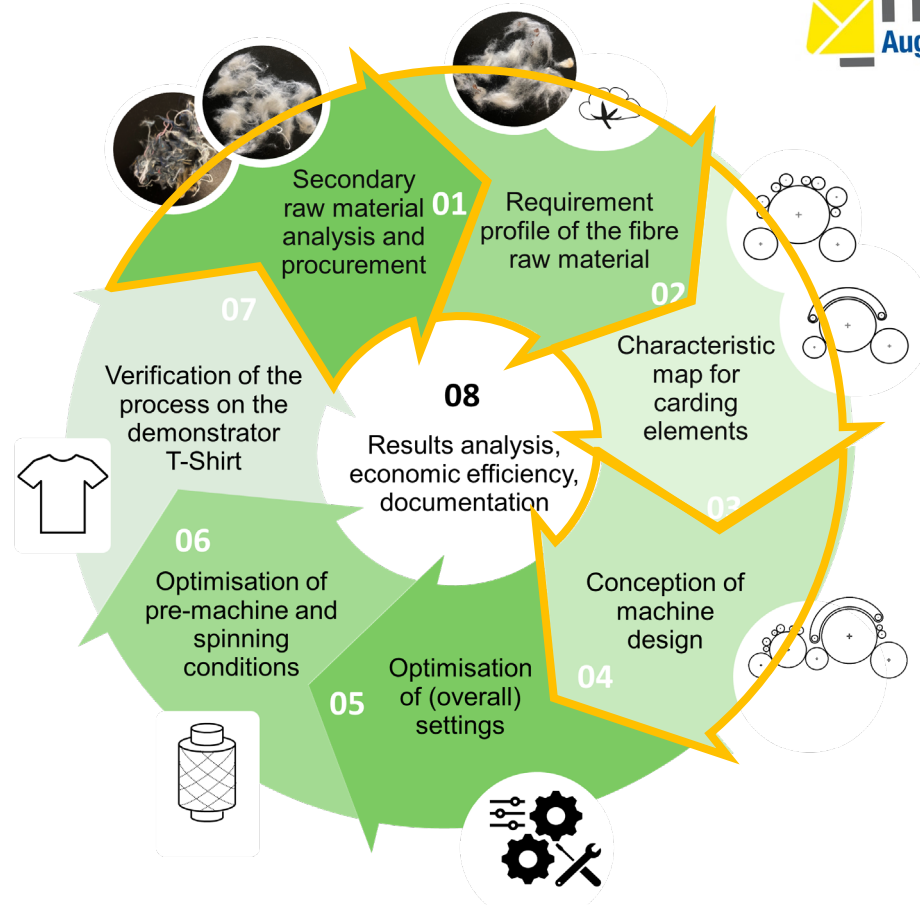
Presentation of the research project

- Project:
 - Development of a new concept for the carding of recycled fibers (RezyCard), IGF 22256 N
- Target:
 - Increasing the proportion of recycled fibers in yarn production
- Achieved through:
 - Adaptation of the carding technology
 - Systematic consideration of the carding principles of revolving flat card and roller carding machine
 - Consideration of changed raw material properties between primary and secondary raw materials



Presentation of the research project

- Work content

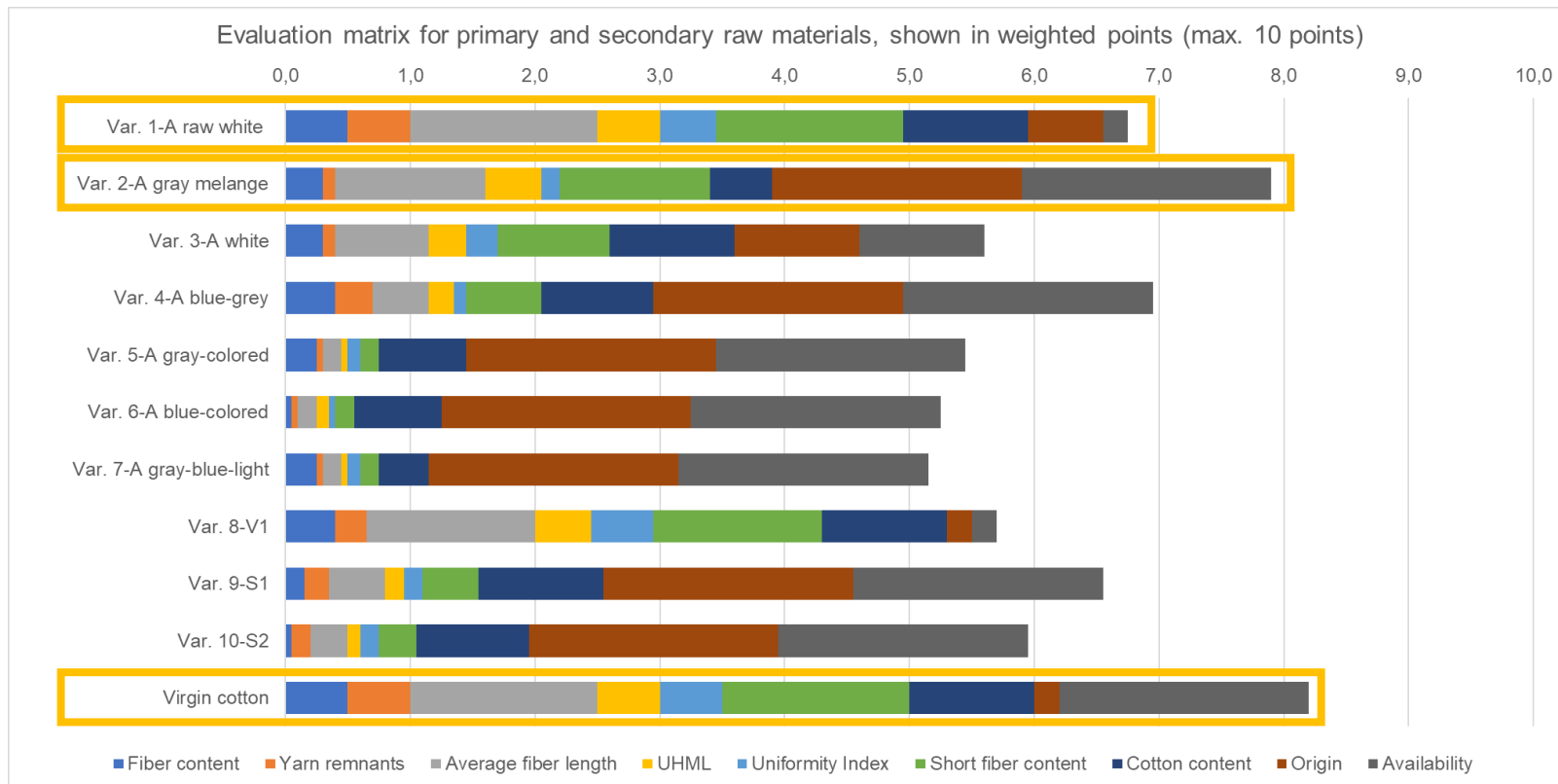


Raw material analysis

- Starting point:
 - Focus on 100% cotton waste at the start of the project
 - Extension to used textiles with a cotton/polyester blend by the project support committee
- Analysis by means of:
 - Fiber analysis (fineness, strength, elongation, crimp)
 - Test routine developed in IGF 21286 BG "Raw material classification" (average fiber length, short fiber content, 2.5% length, yarn remnants, fabric remnants, fiber content)
 - Sliver analysis (adhesion length, number of neps)
 - Opening work



Raw material analysis



Raw material analysis

- Selected raw materials

Virgin cotton
for reference



Production waste
Var. 1-A
100 % cotton

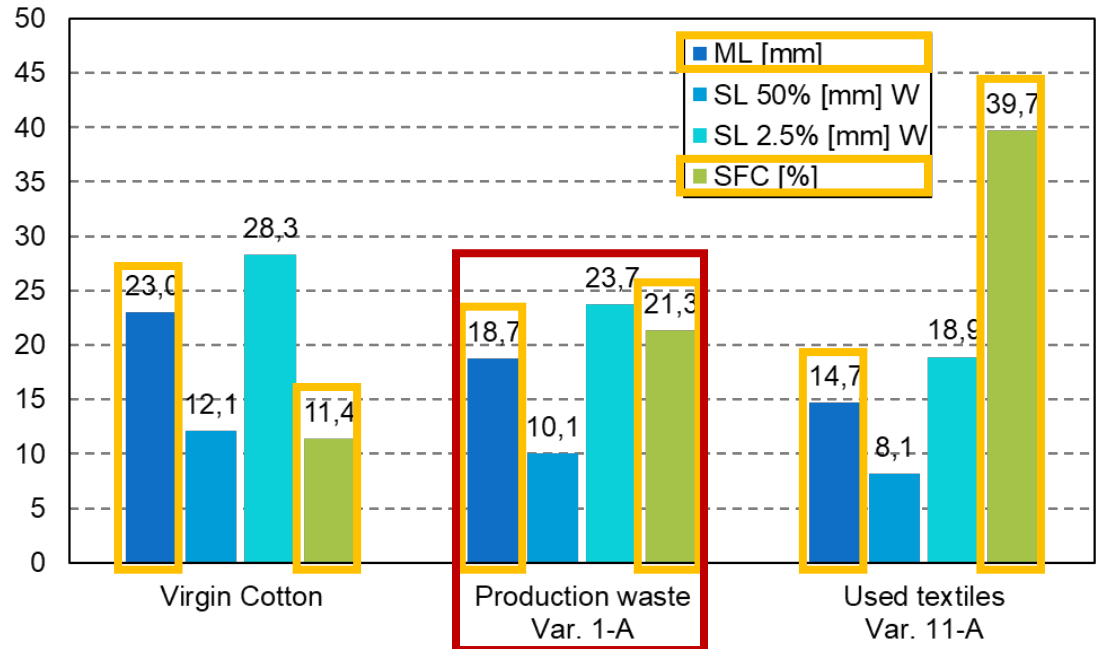


Used textiles
Var. 11-A (replacement for Var. 2-A)
Torn jeans



Raw material analysis

- Requirement profile
 - Fiber length, measured with Textechno Fibrotest
 - ML: Mean fiber length
 - SL 50%: 50% of the fibers are longer than the value, related to the test mass
 - SL 2.5%: 2.5% of the fibers are longer than the value, based on the test mass
 - SFC: short fiber content, fibers < 12 mm



Raw material analysis

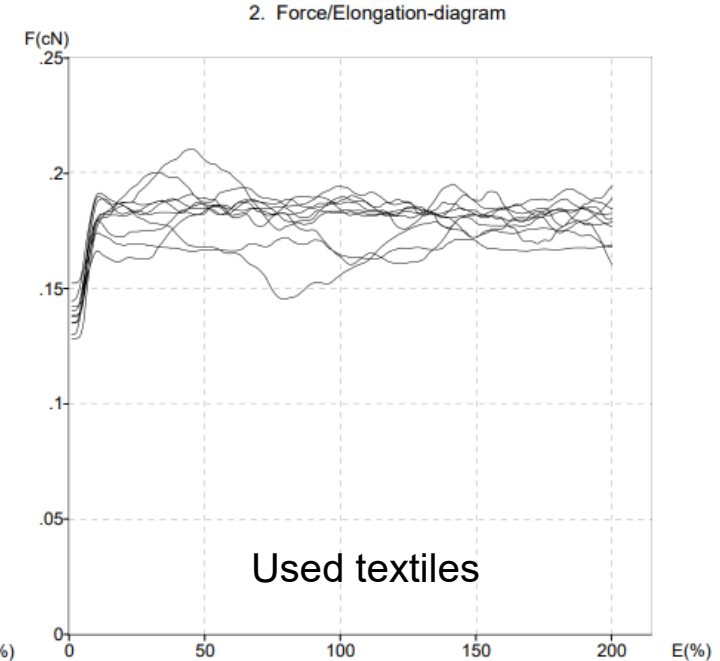
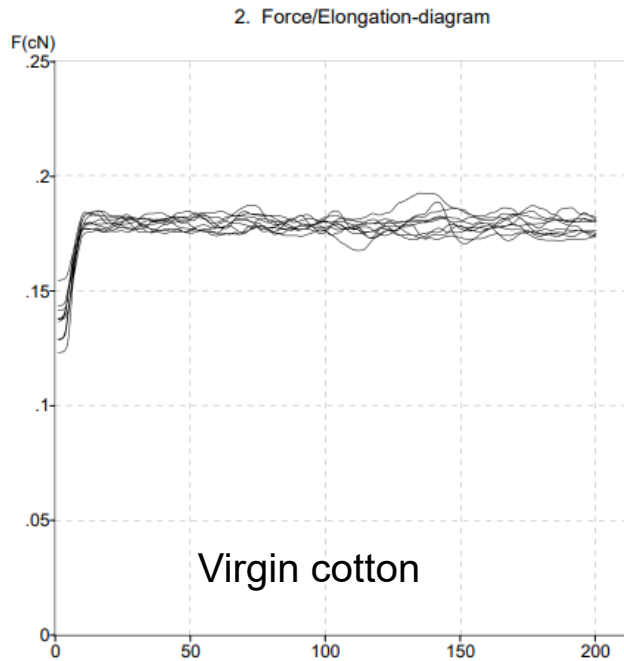
- Requirement profile

- Fiber properties
- Sliver properties
- Processing property

Raw material variant	Virgin cotton	Production waste Var. 1-A 100 % CO	Used textiles Var. 11-A Torn jeans
Fiber fineness [micronaire] / [dtex]	4,4 / 1,7	4,4 / 1,7	4,7 / 1,85
Fiber strength [cN/tex]	30,6	36,85	27,5
Fiber elongation [%]	10,44	8,04	8,53
Fiber length (ML / SL 50% / SL 2.5%) [mm]	23,0 / 12,1 / 28,3	18,7 / 10,1 / 23,7	14,7 / 8,15 / 18,9
SFC [%]	11,4	21,3	39,7
Fiber crimp [number of sheets/cm]	3,2	2	2,8
Fiber crimp Resistance KR [%]	64,27	76,21	78,78
Fiber neps [number/g]	154	600	363
Adhesive length [m]	18,3	10,6	6,4
Opening work [W*s]	945,7	518,3	485,6

Raw material analysis

- Requirement profile
 - Fiber-metal friction



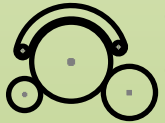
Map creation for working elements of revolving flat card and roller carding machine



Optimization of the **carding process** for gentler and more efficient carding of secondary cotton raw materials

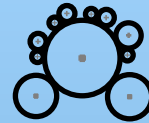
- Analysis of the working elements in the carding process:

Revolving flat Card (Trützschler DK 803)



- Flat clothing metallic wire vs. flexible
- Gap size at extraction point
- Feeding weight (flock size)
- Revolving flat speed (carding intensity)
- Distance doffer to main cylinder (transfer factor, carding intensity)
- Number of fixed carding elements

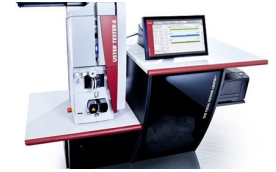
Roller Card (DILO CompactCard)



- Surface speed (carding intensity) of licker-in, worker, stripper, main cylinder
- Feeding weight (flock size)
- Distance doffer to main cylinder (transfer factor, carding intensity)
- Number of working elements (worker, stripper)
- Hypothesis: gentler fiber opening than revolving flat card

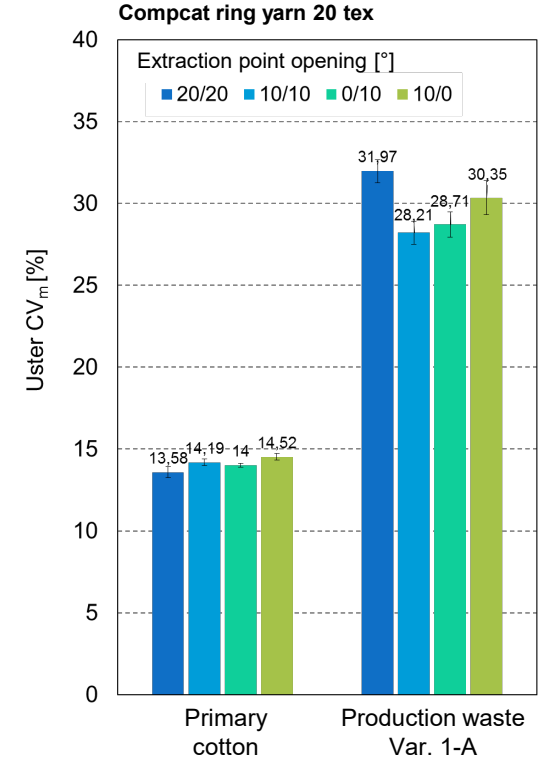
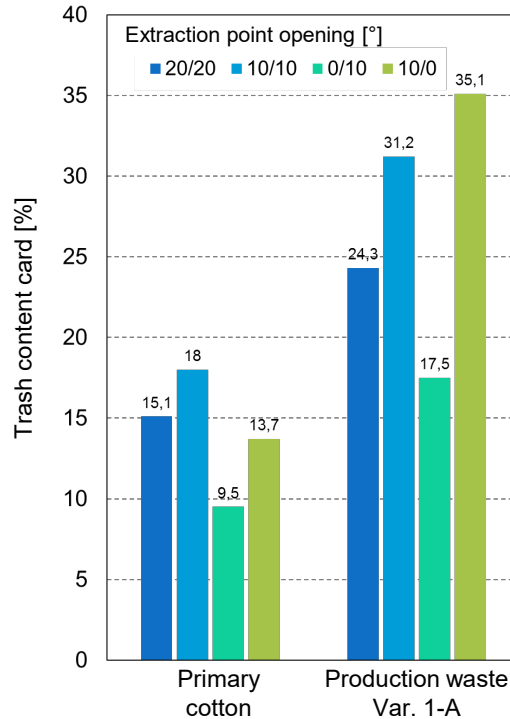
Map creation for working elements of revolving flat card and roller carding machine

- Analysis of the machine parameter variation by means of:
 - Trash measurement, gravimetric (revolving flat card)
 - Yarn piece content using Textechno MDTA 4 (roller card)
 - Fiber length distribution using Textechno Fibrotest (both carding principles)
 - Yarn evenness using Uster Tester 6 (both carding principles)
 - Dynamometric yarn parameters using Uster Tensorapid 5 (both carding principles)
- Boundary conditions for yarn production:
 - Card sliver production
 - 2 draw frame passages, 2nd passage regulated
 - roving production using a flyer
 - Yarn production using a compact ring spinning machine,
Yarn count 20 tex / Nm 50



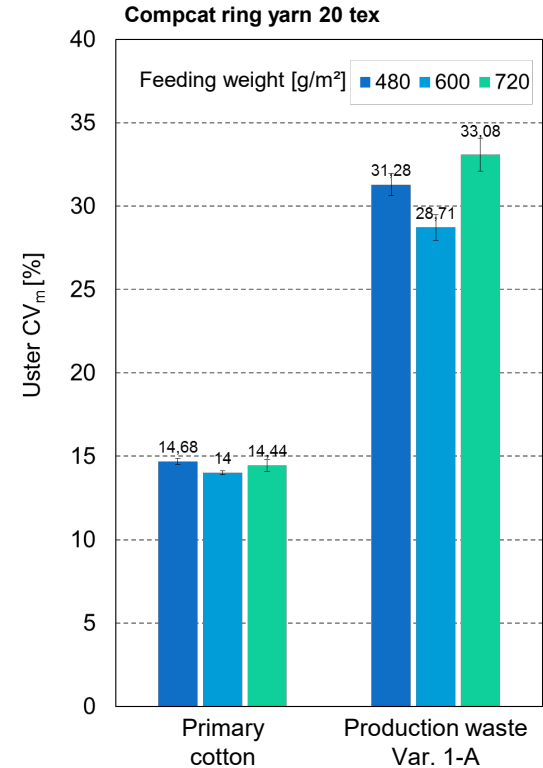
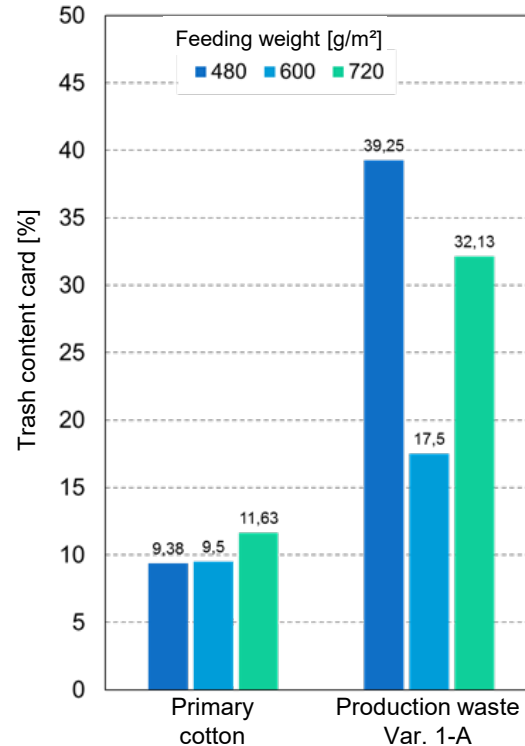
Map creation working elements of the revolving flat card

- Examination of the extraction point at the licker-in
 - Opening extraction point 1 / point 2
 - 0° extraction point closed
- Extraction point setting 0°/10°
 - leads to the lowest waste percentage.
 - Short-fiber recycled material mainly remains in the process.



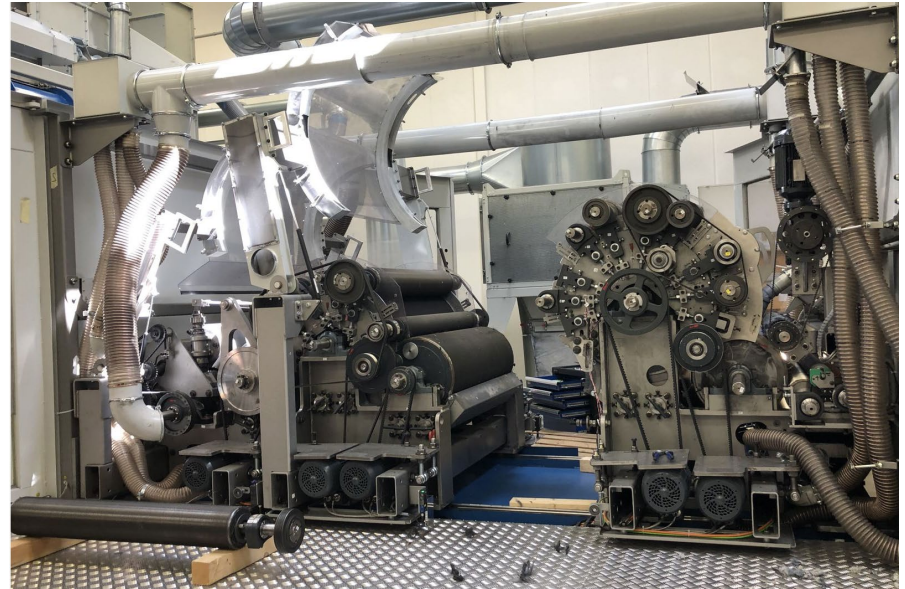
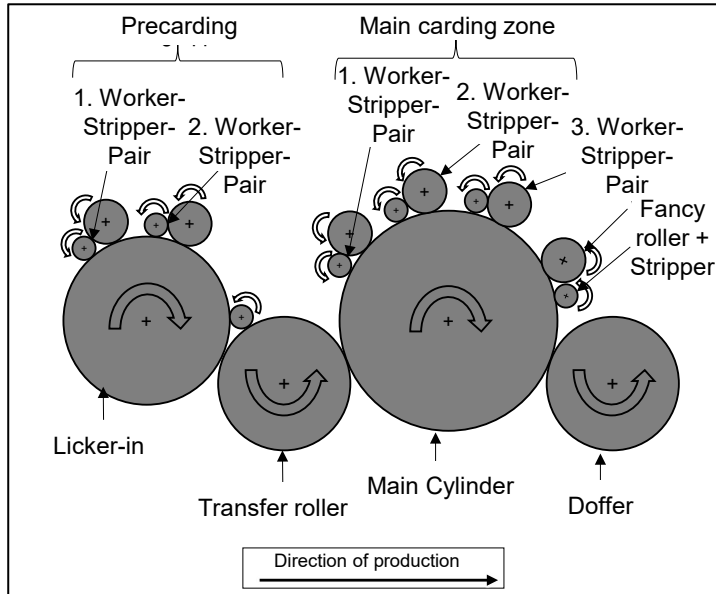
Map creation working elements of the revolving flat card

- Examination the flock size and the feeding weight
- Optimum feeding weight at 600 g/m² for improved sliver and yarn values.



Map creation working elements of the roller card

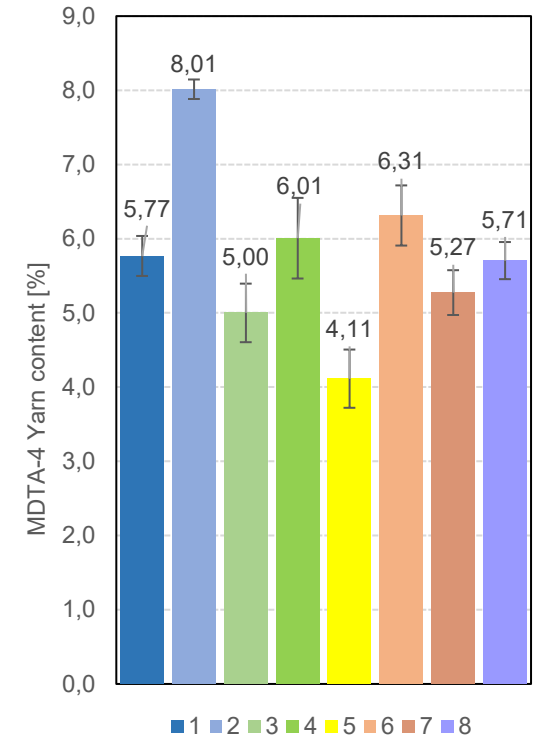
- Structure of the DILO CompactCard at ITA Augsburg



Map creation Working elements of the roller card

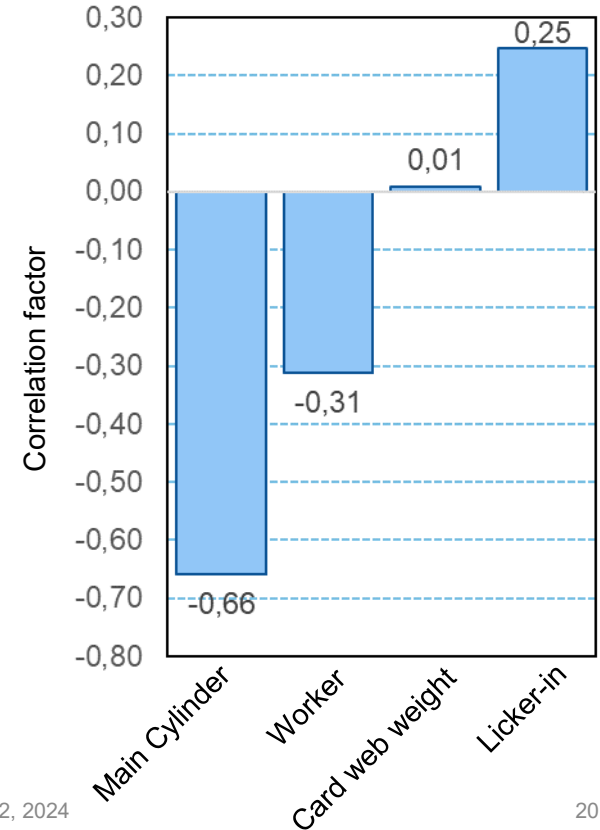
- Investigation of roller circumferential speed and card web weight in relation to the yarn content in the card web.
- Varied parameters:

No.	Cylinder speed [m/min]	Worker speed [m/min]	Stripper speed [m/min]	Card web weight [g/m ²]	Licker-in speed [m/min]	Transfer roller speed [m/min]
1	1200	10	70	10	450	550
2	600	10	70	40	450	550
3	1200	10	70	40	300	455
4	600	80	130	40	300	455
5	1200	80	130	40	450	550
6	600	80	130	10	450	550
7	1200	80	130	10	300	455
8	600	10	70	10	300	455



Map creation working elements of the roller card

- Influence of variable parameters on the yarn content in the nonwoven:
 - High main cylinder speed correlates strongly negatively with the yarn content in the card web
 - Lowest yarn content with high level of all variable parameters
 - Main cylinder speed 1200 m/min, Card web weight 40 g/m² .
 - No significant shortening of the fibers visible in the carding process
 - Measurement with Fibrotest, high variance of measurements within a measurement sample



Summary

- Differences in raw material and fiber properties between primary and secondary fibers
 - Average fiber length of the secondary fiber approx. 20 % shorter, short fiber content significantly increased, thus:
 - Reduction of the required opening work by 30 %
 - Reduced sliver adhesion, approx. 40 % lower
 - Secondary raw material contains yarn remnants instead of dirt such as shell neps
 - Secondary raw material has reduced crimp
 - Fiber-metal friction at the same level, but with a greater coefficient of variation
- The recycled fibers require a gentle opening process
 - Reduces the loss of high-quality fibers
 - Less intensive cleaning as there is virtually no dirt and trash
 - Blade/knife setting of the card can be selected less aggressively
 - Combination of the working elements of a roller card and a revolving flat card offer the potential for a fiber-friendly carding process

Summary

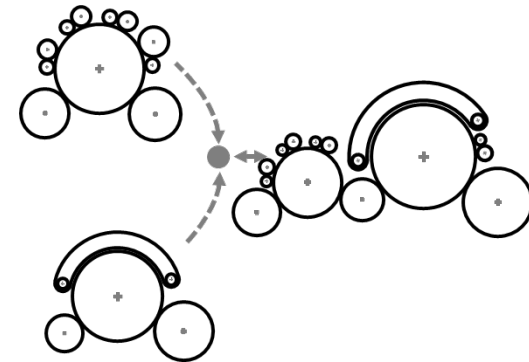
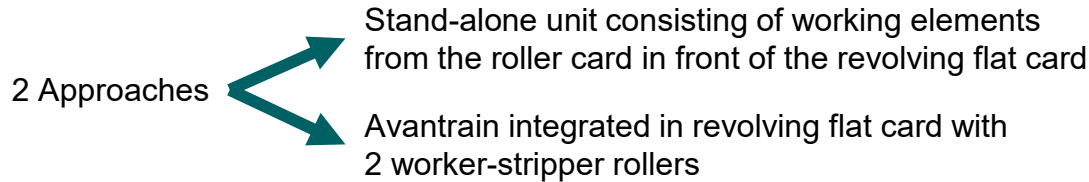


- The yarn content could be reduced in all test settings on the card.
 - Working elements of the carding machine additionally dissolve fiber material
 - without significant fiber damage
- The results show that the RezyCard project's approach can be successful.

Next steps

- Extend the map of the working elements:
 - Reduction of the carding elements used
 - Variation of individual work elements on the roller carding machine
 - Use of secondary raw material from used clothing

- Machine design concept



- Optimization of yarn quality
- Production and laboratory testing of the fabrics

Acknowledgments

The IGF project 22256 N of the research association Forschungskuratorium Textil e.V., Reinhardtstraße 14-16, 10117 Berlin was funded by the Federal Ministry for Economic Affairs and Climate Action via the AiF within the program for the promotion of joint industrial research IGF on the basis of a decision by the German Bundestag.

We would like to thank for the funding and the support from the project partners.



Supported by:



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Thank you for your attention!