



LIST⁺



Kneading - Mixing - Drying

Next Generation Fibers:
*from Lab Testing
to Industrialization.*

Next Generation Fibers

LIST Technology for Cellulose based Fiber

The fashion industry today contributes 10% to the global CO2 emissions worldwide and the rapid growth of the middle class accelerates this trend. As agricultural surfaces for cotton cultivation worldwide have reached their limits and the global sense for sustainability is stronger than ever, there is a huge opportunity for the industry of cellulose based fibers to close the so-called "cellulose gap" with a sustainable processing technology.

Breakthrough of Lyocell

In this context, Lyocell fibers offer several advantages: they are renewable, biodegradable and avoid micro-plastics. In addition, and unlike Viscose fibers or cotton, Lyocell fibers do not request any toxic chemicals, nor herbicides or pesticides. Due to higher fiber strength properties, Lyocell is also used to partially replace the oil based Polyester fibers, which get increasingly under pressure from the civil society and regulators as they are neither renewable nor biodegradable and are said to cause as much as 170 times more CO2 than Lyocell. As a result, a trend has started to implement large production capacities of Lyocell fibers.

Pushing the Capacity Limit

To reach economy of scale in production, Lyocell fiber producers are implementing the largest possible capacities per production line allowed with the current technology. However, the capacities still remain lower than those of Viscose fiber production. But this is now changing: LIST Technology played a central role in the development and implementation of large size new generation Lyocell production facilities.

The LIST Lyocell technology allows:

1. to further significantly increase the capacities per line in the race for economies of scale
2. to operate easier and safer at lower specific energy consumption rates
3. to achieve a differentiation in the increasingly dynamic textile market through superior fiber properties thanks to
 - specifically controlled homogeneities in the spinning solution
 - kneading in any additives

For new players entering the rapidly growing Lyocell market, this new approach allows to compete seriously, even with less experience.



Development Platform for Next Generation Fibers

Another trend to address the growing global demand of sustainable textile is the emergence of all kind of innovative solutions for the pre-treatment and dissolving of wood-based and recycled cotton based pulp. As was recently demonstrated (see next page) LIST provides a state-of-the-art platform for the development of innovative fiber solutions, deploying its full potential because of its specific features, with moderate shear rates for gentle processing compared to the typical extruder:

- large volume reactors
- with excellent mixing and kneading capabilities
- for medium to very high viscosities

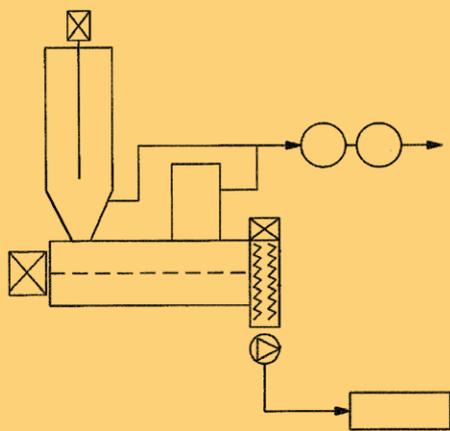
Innovation is key. Experience is instrumental. In the search for next-generation, break-through fiber production solutions, the LIST processing technology is the ideal platform: tested and vetted for over 50 years, yet playing a central role in the development of new technologies and now equipping the most innovative fiber production plants in the world.

Meeting the global Fiber Trends

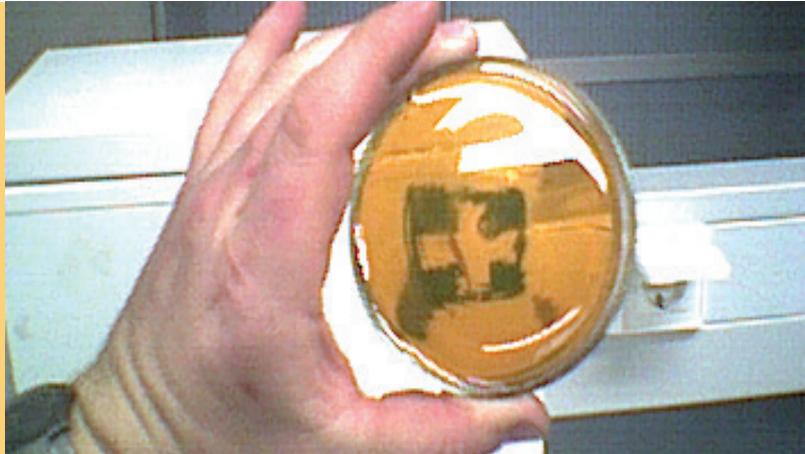
- Increase in requirements for biodegradability
- Recycling trends and directives
- Increasing interest in the use of renewable raw materials
- Avoidance of micro-plastics
- Reduced use of plastic fibers for limitation of carbon footprint
- Declining demand for paper
- Environmental and health challenges of conventional and improved "Viscose" Processing

Interest in Alternative Processing Technology

- Higher capacities per line
- Mixing in solid and liquid additives
- Need to increase spinning speeds to increase production capacity
- Increasing demands on homogeneity of spinning solutions
- Interest in an alternative, simpler, safer process technology approach with increased high-viscosity mixing capabilities, from laboratory to large-scale industrial implementation.



LIST Lyocell Technology Concept.



Excellent Lyocell spinning solution quality.

How did LIST Technology help bring to life large size industrial production capabilities for the next generation of wood-based fibers?

"When our client got in touch with us, they were looking for a solution partner that could understand their challenges and actively help them bring their innovative ideas out of the Lab. They wanted to test various possibilities and eventually implement the appropriate ones, from process simplification to large-scale intensification with a scale-up warranty.

Various process engineering approaches were considered and needed to be tested: solvents with NMMO, IL, NaOH, and others; cellulose pretreatment: chemical, enzymatic, carbamate, and others; different water moisture of the pulp, from never-dried-pulp to swollen sheets up to ground cellulose. So there was need for a corresponding open technology platform. We do offer that at LIST."

Karsten Güdemann, CEO



What is the LIST "Open Technology Platform"?

The LIST open Technology Platform consists of:

(a) a range of equipment solutions available for full-stack customization at our Test-Center near Basel, Switzerland.

(b) the process engineering know-how of specialists to develop a holistically optimized solution, which also proactively includes third-party technology without reservation.

All of this in the knowledge that otherwise the customer would have to carry out the overall optimization in a time-consuming manner anyway.

Spinning Solutions for Next Generation Wood-made Textile Fibers: An example of how LIST provides customized and project-specific Services

In addition to its Test-Center technical equipment and process engineering know-how, LIST Technology offers a wide range of services to help solve unique, complex and client-specific rheology challenges. In the case of the "Next Generation Fiber" project, LIST deployed the provision of a technology platform for all tasks related to the preparation of spinning solutions:

- 1) Services of all kinds on a laboratory and micro-plant scale
 - (a) Formulation of a development strategy
 - (b) Performance and evaluation of test series at LIST
 - (c) Customer support during test series at the customer's premises
 - (d) Support for test series at technical institutes
- 2) Overall optimization of the spinning solution preparation and implementation – including in partnership with institutes and suppliers of spinning equipment and solvent preparation, and finally also for the entire plant.
- 3) Delivery and start-up of special machines and complete plants on a semi- to large-scale industrial scale for the complete spinning solution preparation or - in partnerships – finally for the complete plant.

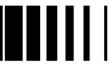
What were the Major Client Benefits in this Specific Project?

- The LIST Competence & Test Center gave our client the possibility of finding their own specific solution after the agitator stopped in their Lab
- One-stop Shop for the development of spinning solution preparation
- Access to a network of complementary technology providers and institutes
- Access to LIST's 50 years of experience in high-viscosity mixing capabilities from laboratory to large-scale industrialization
- Access to LIST's innovative Lyocell spinning solution process for high homogeneity at high capacities.

About: LIST Technology is a Swiss high tech company providing solutions for high viscosity mixing and processing. LIST is a niche company solving very unique, specific and complex rheology challenges with Swiss Engineered solutions, services and equipment. The LIST Competence & Test Center in Arisdorf, Switzerland and the LIST Team of specialists offer Clients the unique possibility of dealing, testing and scaling all features and phases of their specific project, from Process simplification to Large scale industrial intensification.

Note: For obvious confidentiality obligations, LIST Technology does not discard the Identity of its clients or details of its projects.

LIST



Kneading - Mixing - Drying

blockbuster

A Jakob Müller Company



LIST Technology AG - Berstelstrasse 23 - 4422 Arisdorf - Switzerland
+41 (0)61 815 30 00 - info@list.ch - www.list.ch

+LISTengineered