ENERGY EFFICIENCY HANGS BY A THIN THREAD

Eastern Switzerland has a long tradition in the textile industry. Small companies still produce textiles today and hold their own on the world market with innovative products. Heberlein AG in Wattwil (SG) is one of them. The 90 employees produce special components for yarn manufacturing machines. One of these components is currently being developed further in such a way that an energy-intensive step in yarn production could use 30% less energy in the future. The potential global energy savings would be substantial.

Heberlein AG in Wattwil (SG) manufactures special components for spinning mills. The quality of yarns can be determined in the test laboratory. Photo: B. Vogel

A technical report about the results of a pilot and demonstration project in the field of industrial processes, which is financially supported by the Swiss Federal Office of Energy. The report has been published in the technical magazine KunststoffXtra (issue April 2022).

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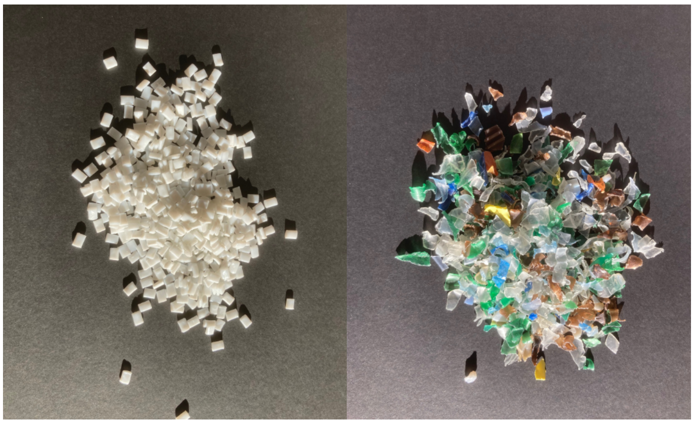
Heberlein AG was founded in 1835 as a yarn dyeing factory. From the mid-1930s, the Toggenburg factory produced a type of viscose synthetic silk called Helanca. From 1950 onwards, the company's activities shifted from yarn production to the construction of textile machines and their components. Such special components - in addition to ceramic parts for medical applications, among others - are still an exclusive feature of the Wattwil-based company today. They are used worldwide in the manufacture of synthetic yarns, particularly in Asia, where most of the Heberlein customers' production facilities are located.

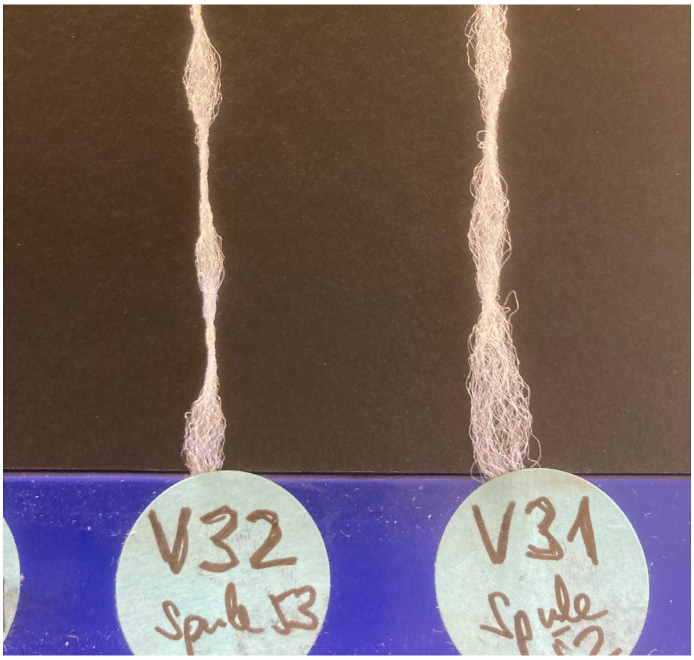
Compressed air bonds plastic fibers

Synthetic yarns belong to the class of synthetic fibers and consist of application-specific processed plastics. The starting material for yarn production in a synthetic fiber spinning mill is plastic granulate. In simplified terms, the yarn is produced in the following way: The granules are heated, then formed into fine plastic fibers (filaments) by means of spinnerets and cooled. Several dozen, or even several hundred, such fibers are bundled into a yarn and, after further processing in the so-called "stretch zone," finally wound onto a bobbin. This is the form in which the spinning mill sells the yarns to its customers.

To ensure that the filaments form a compact yarn, an additional process is required before winding: In this step, the filaments are intertwined with the aid of a thin stream of compressed air. This causes the individual fibers to join together to form a compact yarn. Experts refer to this process as 'knot formation' or 'yarn closure.' Knot formation is essential so



Plastic granules (on the left) are the starting material to produce synthetic yarns. These can also be made from recycled plastic (on the right). Photos: B. Vogel



On the left yarn, the knotting of the filaments is better than on the right. Photo: B. Vogel

that the yarn can later be processed at high speed and without breakage.

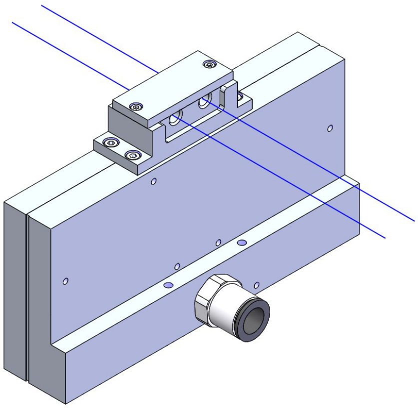
Energy intensive step

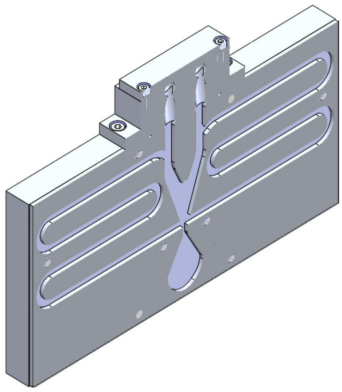
The interlacing process has been used for decades to produce high-quality yarn. The interlacing nozzles required for this come from Heberlein AG in Wattwil, or from one of around ten manufacturers worldwide that have the relevant know-how. "The interlacing process is very energy-intensive; it is responsible for 15 to 30 % of the energy consumption in a spinning mill," says Patrick Buchmüller, head of technology at Heberlein AG.

Against this background, the company launched a development project with the aim of making the interlacing process more energy-efficient with a new procedure. For this purpose, Heberlein teamed up with the engineering office streamwise in Männedorf (ZH). In a preliminary project supported by the SFOE, a new interlacing technology using fluid oscillators was designed and successfully tested on a laboratory scale.

Thirty percent less energy

In a follow-up project lasting several years - financed by the pilot and demonstration program of the SFOE - the use of the technology was studied on an industrial scale. Various versions of an oscillator-based interlacing nozzle (see text box p. 4) were constructed and subsequently subjected to several





A variant of an interlacing nozzle with oscillator: The guide of the two yarns (blue lines) can be seen on the left. The sectional view on the right shows the channels for supplying the compressed air. With the oscillator, the compressed air is directed at the two yarns in rapid alternation, which causes the desired knotting of the yarns. Illustration: SFOE final report

test programs in the Heberlein laboratory in Wattwil, but also at the Institute of Textile Technology at RWTH Aachen University and on an industrial spinning machine.

After the project was completed at the beginning of 2022 and the final report was issued, Dr. Benjamin Rembold from streamwise sees progress: "The developed interlacing nozzles with oscillator function excellently at moderate process speeds from a fluid-dynamics perspective and with fine to medium yarns. For high process speeds and coarse yarns, further tests must be performed and, if necessary, further optimization steps taken." In laboratory tests, 30% energy savings were achieved thanks to the new type of nozzle.

Several years until market maturity

The results of the project have encouraged those responsible at Heberlein to press ahead and develop the interlacing nozzle on for commercial production. "With a view to a product

The most important sales market is China. Chinese customers are also greeted in Mandarin at the company headquarters in Wattwil (SG). Heberlein AG has been owned by the Chinese Jinsheng Group of companies since 2013. The operational management of the Toggenburg-based company is in the hands of Eva Wang, an Australian citizen of Chinese origin. Photo: B. Vogel

Patrick Buchmüller, chief technical officer of Heberlein AG (left), together with project manager Andreas Brunner, who is overseeing the development of the oscillator-assisted interlacing nozzle. Photo: B. Vogel ready for series production, the interlacing nozzle must be made smaller. Also, the new component must be designed in such a way that it can be installed in existing as well as new machines and used for different yarn types," says Andreas Brunner, Heberlein project manager. Brunner expects it will take several years until a market-ready product is available.

The main area of application for the new interlacing nozzles would be in the production of carpet yarns and industrial yarns (for seat belts, airbags, truck covers, etc.). Their use in the textile yarn sector (clothing production) would be difficult because of the high yarn density in the spinning machines used in such applications. In these two first mentioned application fields (carpet yarns and industrial yarns) there would be considerable potential for energy saving, as the following rough calculation shows: an synthetic fiber spinning mill that produces 640 yarns, for example, consumes around 36,000 m³ of compressed air per hour. To produce this compressed air requires around 3,600 kWh of electricity. The factory thus needs about as much electricity per hour for the interlacing of the yarns as an average four-person household requires per year. According to an expert estimate, if the new interlacing technology were to be used worldwide, 360 GWh of electricity could be saved annually, which is equivalent to the annual production of a large hydroelectric power plant.

- The **final report** on the project 'Oscillator-based vortex nozzle: Industrial feasibility' is available at: https://www.aramis.admin.ch/Texte/?ProjectID=41462

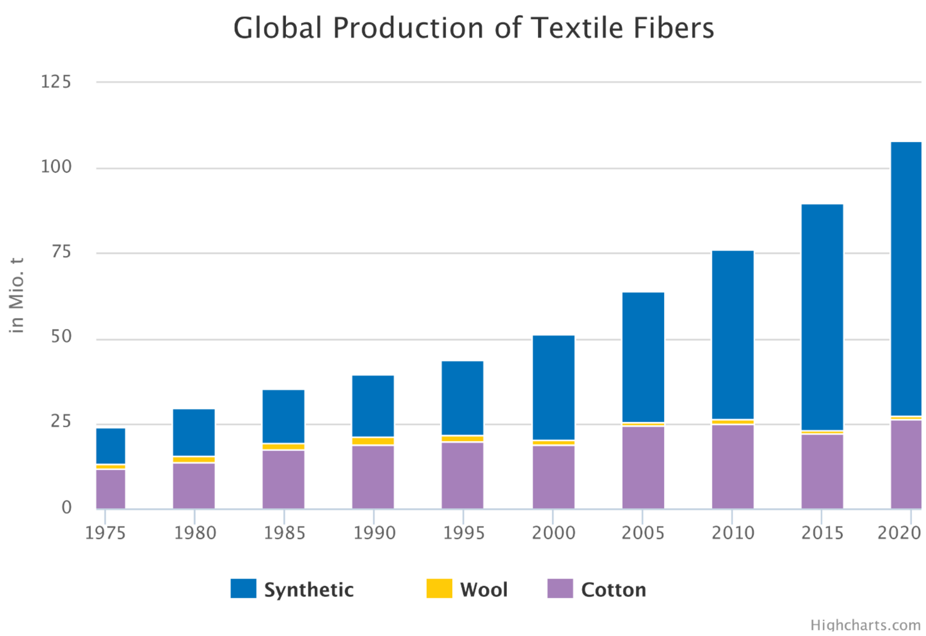
- For **information** on the P+D project, please contact Dr. Carina Alles (carina.alles[at]bfe.admin.ch), head of the SFOE’s Industrial Processes research program, and

View of various yarns on which the new interlacing technology was tested. Photo: B. Vogel

ONE AIR JET FOR TWO YARNS - THAT SAVES ENERGY

In conventional interlacing nozzles, a jet of compressed air with a diameter of 0.5 to 6 mm is used to form knots in bundle of fiber. The innovative idea of the new process is to use a jet of compressed air to form knots in two yarns produced in parallel. For this purpose, the air jet is directed at the two yarns in rapidly alternating turns. The yarns are produced at a high speed of up to 6000 m/min (equivalent to 360 km/h), with a knot being formed approximately every 8 cm. For this to succeed, the compressed air jet must oscillate between the two yarns at a frequency of around 1500 hertz and more.

It is technically very demanding to control the compressed air jet at such high frequencies and to achieve the desired interlacing effect with different yarn types and production speeds. If two yarns can be interlaced with a single jet of compressed air which is split up, this has the advantage that in principle only half as much compressed air is required. In practical terms, the amount of compressed air (and thus energy) cannot be halved, but it can be reduced by around 30%. BV



The production of synthetic fibers has increased significantly in recent years. Synthetic fibers are produced either from synthetic polymers (synthetic yarns), or from natural polymers of plant or animal origin. The latter should not be confused with natural fibers such as wool or cotton. Graphic: Industrievereinigung Chemiefaser e.V.

Dr. Men Wirz (men.wirz[at]bfe.admin.ch), responsible for the SFOE pilot and demonstration program.

↗ Further **technical papers** on research, pilot, demonstration and flagship projects in the field of industrial processes can be found at www.bfe.admin.ch/ec-prozesse.

P+D PROJECTS OF THE SFOE

The project presented in the main text was supported by the Pilot and Demonstration Program of the Swiss Federal Office of Energy (SFOE). With this program, the SFOE promotes the development and testing of innovative technologies, solutions and approaches that make a significant contribution to energy efficiency or the use of renewable energies. Applications for financial assistance can be submitted at any time.

↗ www.bfe.admin.ch/pilotdemonstration

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