New textile technologies, challenges and solutions

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Abstract

The fiber, the concept of textiles and their scope of application has widened in recent decades. The textiles have become and are of key importance in numerous, previously difficult to imagine technical applications. It is difficult to find areas where one does not meet with textiles. In the manufacturing of textiles, the approach to textile technology has been replaced by thinking in functions. The links between fragmented and sequential operations are ever closer, an important strive is to shorten the technological process, automatization and connecting online. Earlier, the textile processes were realized by using finely designed, precise mechanisms, today with modern electronics, the air jet is easily controlled and in many cases the mechanisms can be or are replaced. Thusly, speed of the various operations can be significantly increased. The electronic developments of the last decades has been widely adapted by the textile machines, therefore significant progress was attained in the improving of quality and increasing performance, while at the same time, user expectations surpassed all previous conceptions concerning raw materials, fabric properties, and production capacities. The improvement of performance and the widespread use of compressed air, resulted greater energy consumption, and because of this, more attention is being paid to the reduction of this specific energy, environmental protection and recycling of materials.

In the second half of the past century, the use of materials by man showed a tendency for basic changes, namely, the use of polymers took a dynamic upturn.

The quantitative increase of fiber usage in the past has also been undiminished, due mainly to the increase in population and the relating fiber consumption per head. Furthermore, the new demands in the properties of the fibers also brought about changes in quality and in the development of a wide range of special fiber properties. Within the textile technologies, beside the traditional and determining weaving and knitting, the new functional demands, and because of economical production reasons, the nonwoven, braided, and laid up technologies have become more and more significant [1, 3, 10].

Figure 1.
The geographical shifting of textiles production is at the head of world economical rearrangement; that is, it has been relocated to Asia and specifically to China.

Beside the wear apparel and home textiles, the most dynamic development has been at the technical textiles and in the field of fiber reinforcing composites. The textile industry developments, of the advanced countries, today, have been relocated to the areas of technical and fiber reinforced textiles. Consumer demands for products, made from the new, special textiles exceeded all previous imaginations, considering the special effort and professional knowledge required from the beginning of fiber production, to the finished product. The processing technologies are developed by considering the properties of the textiles fibers and the demands, requirements of the consumers.

Major characteristics of the fibers and yarns:

- refinement of the single filament, the use of micro, nano fibers,
- the increasing of the significance of special functioned, bi-component,
- the wide ranges of mechanical properties of the fibers, high performance fibers,
- prominence in protecting functions (fire & chemical resistance),
- increasing ratio of filament processing,
- decreasing of unevenness in the spun yarns, increasing of processing speeds & yarn tenacity,
- development of new, more efficient yarn production technologies & yarn structures,
• by removal of yarn defects, the improvement of yarn quality, the wide use of good quality splicing [14].

Beside the spectacular innovations, attention is also paid to details & processing conditions. Decisive factors affecting the processing of textiles are the contacting of machinery surface with the textiles, its quality, the form of the fiber and its surface treatment. Due to this an essential accompaniment of the mechanical technologies is the chemical treatment of the fibers surfaces, which greatly improves processing and which meet usage expectations.

Air engineering technology in the textile industry is being used in more & more areas with success. Numerous, earlier mechanically carried out operations are being replaced with electronically controlled air currents, having simple & safe handling, with excellent quality and at high speed. The conveying, feeding of the staple fibers, is done solely by air current, but nowadays, these air current processes are being used in more & more areas of textile operations having key importance.

The manufacturing of compressed air is energy demanding (to produce 10 Nm³/h air, having 8 bar pressure, about 1 kWh electrical energy is needed), and because of this, the ever increasing energy costs is compensated by using efficient, sparing air.

In the forming of spun, special structured yarns, the use of air jet, air current is an important part of every operation [10].
In numerous textile technology operations, yarn strength is a decisively important parameter, and because of this, at many development solutions, the yarns strength is measured online, and by the electronical controlling of braking or feeding, the expected optimal yarn strength is realized. [4, 11, 12].
On the two-for-one twisting and the direct cabling machines for example, the great air drag acting on the large diameter balloon, significantly increases energy consumption. In the case of new shaping, by reducing the diameter of the balloon and optimized spindle/pot geometry, significant energy cuts could be attained [5].

![Figure 7.](image)

In the near past, at weaving, the uses of air jet weaving machines have become determinative. Beside the safe insertion of the high speed weft, great efforts are devoted to the reduction of air usage [2].

![Figure 8.](image)

In the optimization of the air jet for use in the various textile operations, the simulation of air flow is a great help. By using computer aided simulation, in the field of textiles planning, significant time and costs saving can be attained.

By increasing the output of the textile machines, electrical power usage also increases, which in turn increases the heat load of the production floor. Due to this, the high relative moisture
content (65 - 80%), desired for textile processing can only be upheld by the large displacement of air. This again, significantly increases the energy consumption of the air engineering equipments. By the cooling of the textile machines, and the exhausting of the heat from the floor, energy consumption of the air engineering can be greatly decreased.

Textiles produced by various technologies can be well seen in the attached picture.

![Textile fabrics diagram](image1)

*Figure 9.*

Due to consumer demands and production technologies, the main changes in the characteristics of the textile products are as follows:

- Processing of yarns encompassing a wide range of properties, tows, (from the sensitive elastomer yarns, to the thick, brittle carbon fiber tow).

- Great width range (from the several cm wide ribbons to the 35 m wide fabric, and the 19 m wide nonwoven web)

![Textile production machine](image2)

*Figure 10.*

- From the light, small area density cloths to the production of heavy, strongly woven technical fabrics.

- From the simple knitted goods, to the variously oriented fiber, yarn layered fabrics.

- Formation of complicated 3D fabric structures.
On the high performance machines, for the production of fabrics, cloths, having excellent parameters, the wide range use of electronics is imperative.

Besides the weaving with air jet weaving machines – depending on the yarns being processed or the item produced, – rapier, projectile or water jet weft inserting machines are also used.

With knitting (weft and warp) due to the smaller movements required to form the fabric, a higher capacity may be attained. In the details however, here too, special problems are solved. For example; in the case of the latch needle, because of its high operating speed, the needle’s take-up speed may reach the 200 km/h, thusly needle breaks (occurring because of the high cycle number) are decreased by the soft forming of the needle stem [7].

At the chemical fibers, in order to improve the processing, crimping of the yarns is necessary, and in the case of under garments, it’s also a consumer demand. Because of this, yarns and threads containing elastomers, the use of blended yarns with various types of crimps is more and more significant.

The technical textiles, especially the composite reinforced textile fibers have low elongation (ε = 1-3%), and high stiffness, brittleness. Due to this, in the processing of the fibers and yarns their bending must be on one part be avoided. On the other part, embedded in the cloth or matrix, the straight fiber position is desirable.
Stitching type warp knitting machines are especially suitable for the formation & fixation of yarn cloths, laid in the various directions. The stiff, straight formed, one or several variously laid, untwisted glass or carbon fibers (straddled by cross directional laid thin glass yarns or web) are fixated by the warp machine’s PES stitching yarn [8].

Demand is significantly high for the braided products, especially in the field of technical, composite, hoses & structural materials. In addition, variously sized dimensional structures are also being developed.

Thanks to the efficient, short manufacturing processes and versatile applications, production of nonwoven felt products in the past decades shows a fast increase, and this tendency, expectedly will continue, their share of all the fibers usages nears the 20%. The nonwoven technology is highly automated and efficient. Practically, in on line operation finished felt can be produced from the fibers [9].
In textile technologies, the wide range use of air engineering, electronics and controlling technology on the machines, more and more of the special metallic elements are being replaced with higher efficient textile reinforced plastics, the so called composites. However, the language used in the general field of engineering and textiles, the use of measuring units is still not harmonized.

The use of composite machinery elements on textile machines exposed to special stress, is more and more frequent;

- On spinning machines and cross beds, the long highly stiff, light weight rolls.
Figure 17.

- The needle moving rod on the wide warp machine, to ensure sufficient stiffness to the drive shaft and to avoid lengthwise growth due to heat dilation [8].

- At the weaving machines, the fast moving gripping arm, gripping ribbon, harness motion arms, heald frame, and etc. [6, 13].

Figure 18.

With the reduction of prices and production time for carbon fiber reinforced plastics, the use of textile reinforced composites is of key importance in more and more areas, (aeronautics industry, wind blades, transportation, automobiles, sporting goods, etc.) and in which dynamic increase is expected. The efficient textile technology processing of the special propertied stiff, brittle fibers, tows is the great challenge of the future.
References