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DEVELOPMENTS IN TEXTILE TECHNOLOGY: ITMA 2003 REVIEW PART I: SHORT STAPLE FIBER PROCESSING

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Abstract

This paper represents the first part of two papers in which I review some of the recent developments in staple fiber technology with emphasis on cotton and cotton/man-made blend systems. In this part, the focus is on spinning preparation machinery. A great deal of the review will be based on machinery exhibited at ITMA 2003, in Birmingham, U.K. In addition, other developments that were not exhibited at ITMA will also be discussed.

Introduction

With history in the making, the 14th International Textile Machinery Exhibition (ITMA 2003) was held in Birmingham, U.K., from October 22nd to 29th, 2003. Unfortunately, this time history was not in favor of the technological development side, it was largely economical!! With significantly fewer faces from the U.S. textile manufacturers and with the absence of key machine makers such as Rieter and Saurer, ITMA 2003 seemed to spinning experts like a big vacuum with very little to see. Whether it was the onslaught of the SARS virus, the rapid declining of the U.S. textile manufacturing industry, or the shaking global economy, ITMA 2003 was not like any other ITMA exhibition held since the first ITMA in Lille, France in 1951. Nevertheless, I promised to report on the developments in textile technology, and report I will, under these circumstances.

Since development in machinery is typically associated with the growth of the industry using the machinery, it will be useful to look at the big picture of the status of development of textile machinery in association with the production growth over the last fifty years and until today. Since 1950, productivity has increased by an average of only 3.3% per year in spinning and weaving machines. This growth rate is actually slightly larger than the growth rate of yarn production, which has exhibited an average of only 2.8% per year since 1950 until today (see Figure 1). This amounts to an increase from 8.5 millions tones to an estimated 44 million tones by 2010 (Bachmann, 2003).

Machine makers have accomplished the mission that they have established in the last twenty years; that is progressively higher production speed accompanied with precise automation and material transportation. As a result, it is well realized that substantially fewer machines are required today to meet the same production growth that was required fifty years ago. Indeed, only 20% of new machines are required today to meet production growth of 1950 (see Figure 2). This is a direct result of the higher production speeds as shown in Table 1.

Table 1. Development in Machinery Speed from 1990 to 2001.

Machine Type	1990	2001
Short-Staple: Spindles (millions)	6.3	3.7
Long-Staple: Spindles	550,000	450,000
Open-End	350,000	250,000
Weaving: Projectiles Machines	15000	10000
Weaving: Non-Projectile Machines	60,000	40,000

If one combines the above statistics with the world population growth, on the ground that the textile industry is one of the basic service industries to all humanity, one can obtain more insight into the future situation of both the textile machinery and the textile manufacturing industry. The Census Bureau's projections indicate that the future of human population growth has been determined, and is now largely being decided, in the world's less developed nations (LDCs). Ninety-six percent of world population increase now occurs in the developing regions of Africa, Asia and Latin America, and this percentage will rise over the course of the next quarter century. These countries will have an increasing need to produce and use traditional textiles. Accordingly, the massive growth of textile machinery and textile production is expected to be in these regions. More developed countries such as Europe, America, and Japan will have to shift to highly technical textiles and more innovative textile machinery to achieve the necessary added-value and justify the high cost of production. In summary, textile machinery makers will have to develop innovative research and development plans to produce the right product for the right market. Indeed, China has provided major indication of this trend by destroying 10 million ring spindles between 1999 and 2000 and replacing them by new ones (10% of this capacity has been replaced by modern rotor spinning machines). In addition, it is estimated that India, Pakistan, and Indonesia could still replace 10 million ring spindles.

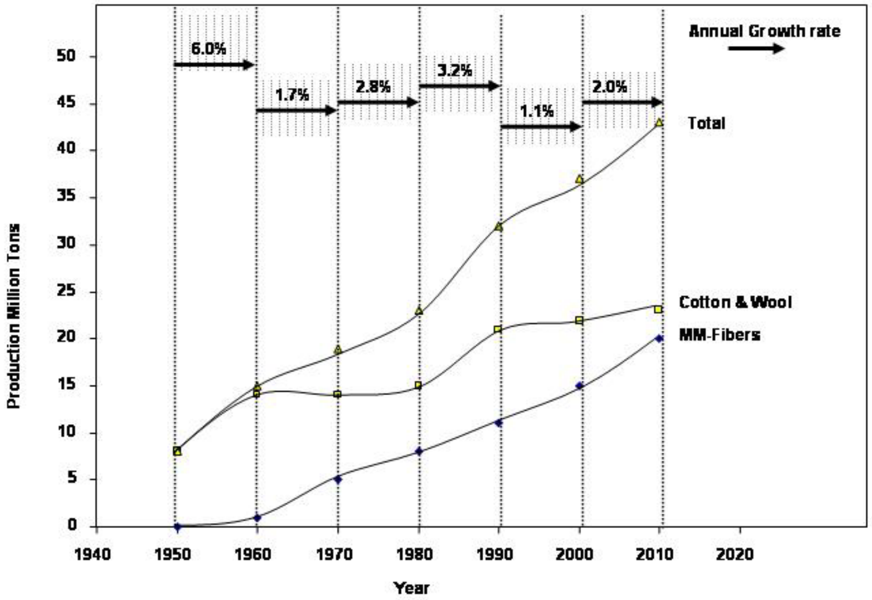

Figure 1. Staple Fiber Yarn Production: Annual Growth 1950-2010 [Bachmann ITB 2/2003].

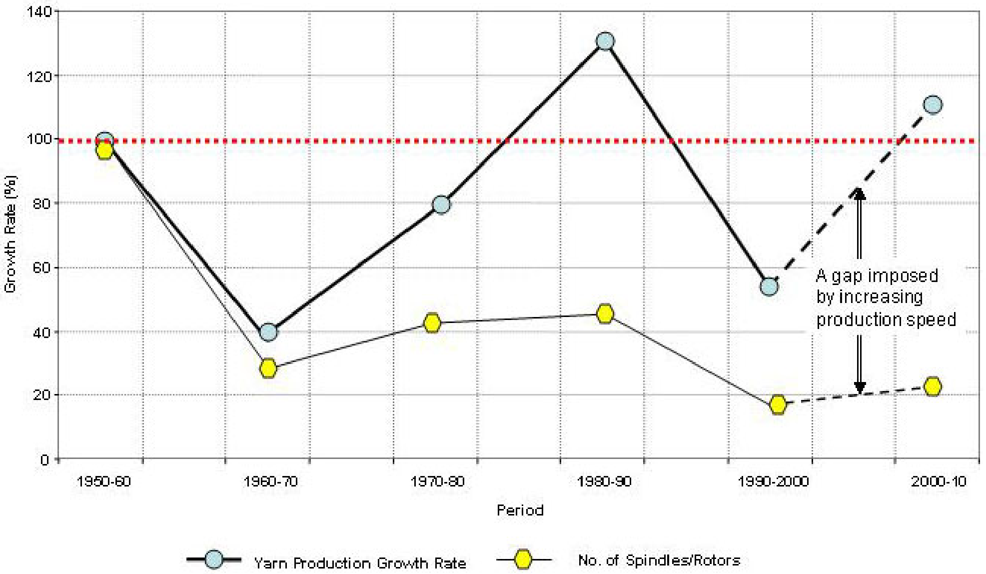

Figure 2. Growth Rate Using Spinning Machine Productivity Index 100% = 1950 [Bachmann ITB 2/2003]. Note: Only 20% of New Machines is required today to meet production growth of 1950.

In light of the above discussion, it is my opinion that the textile machinery maker faces great challenges ahead some of which have been largely met and others will have to be met in the next few years. Given below are some of my expectations, which I believe are shared by many experts in the field.

Expected Trends in the Textile Machinery and Manufacturing Industries

In the next few years, I expect the following trends to take place based on current developments:

Expected Market Trends

- The textile machinery makers located in the U.S. may soon have to either relocate to where the massive market will be or they will have to seek more creative and innovative approaches of machinery design that is directed toward added-value (high technical) textiles.

- The textile machinery makers in Europe may have to rapidly move toward outsourcing its manufacturing basis to keep up with the expected demand of cheaper machinery at a high minimum acceptable performance by the world's less developed nations (LDCs). Over the last twenty years, we witnessed a complete disappearance of the American and British spinning and weaving machinery from the market. I believe we will see other dramatic changes in Europe and Japan that may be reflected in joint ventures with Asian machine makers, outsourcing, or complete relocation.
- We may see more textile machinery produced in Asia, particularly China and Korea. This may create competitive problems to the European and Japanese machinery makers as a result of the strong relationships between the new comers and the new market nations, and the substantial cost advantage. Signs of this trend were witnessed at ITMA 2003.
- The U.S. cotton producer, being the largest in the world, will have to establish new strategies of cotton trade and quality management including a possible change in the current American Cotton Logo and a re-distribution of market emphasis.
- The issue of mixing and blending of different cotton varieties from different areas in the globe with different quality criteria and different prices will become very important and problems associated with this approach will require a great deal of research activities.
- Industrial countries producing cotton, particularly the U.S., will have to emphasize high production (greater yield per acre), and uniquely distinguished quality levels (particularly in fiber fineness, fiber length, fiber strength, maturity, contamination, and color) to meet world prices.

Expected Technological Trends

- Textile machine designers must devote a great deal of innovative effort to deal with major quality problems associated with the immense supply of raw materials (particularly, cotton) produced by the world's less developed nations (LDCs). These include: fiber contamination, and poor overall fiber quality.
- The textile processing line will be further shortened to achieve more efficient production lines. In ITMA 2003, this trend was very obvious with the further developments in direct spinning and card/drawing integration concepts. Remains to be seen are: the complete elimination of the roving process, a more compact combing process (perhaps, through an integrated carding/combing concept), an ultra high-speed ring spinning system, a total elimination of the sizing (slashing) process, and more automated weaving preparation/weaving process.
- Information technology will go beyond managing processing performance to the area of producing textile products by objective design criteria. In other words, the spinning machine will be equipped with expert systems that allow the production of yarns of particular performance purposes (e.g. smooth/harsh, soft/rigid, strong/weak, etc.). Similarly, weaving and knitting machines will be equipped with expert systems that allow the production of fabrics of particular performance purposes (e.g. tactile-friendly, warm/cold, comfortable/protective, etc).
- The textile process will be integrated with the end-product making process (apparel making or high-tech textile machinery) at least at the information level.
- Nonwovens will compete more effectively with woven and knit products in the traditional apparel business.
- Green design based on complete reclamation or recycling will be established in different areas of the textile process including machinery accessories.

Current Developments in Short-Staple Fiber Processing

After the above introduction, we will shift our attention to the current developments in short-staple fiber processing based on ITMA 2003 exhibition and other sources. Only significant new developments will be discussed.

Developments in Opening and Cleaning Technology

In the area of opening and cleaning technology, the most important development exhibited at ITMA 2003 was the compact opening and cleaning line developed by Trutzschler (see Figure 3). This line utilizes the well-established automatic bale opener “BLENDOMAT BO-A” that can operate at a rate of up to 1500 kg/h and handle up to 180 bales laydown (up to 3 bale groups at the same time). The automatic bale opener directly transfers the material to the so-called multi-functional separator “SP-MF”. This separator, shown in Figure 4, represents a unique feature of the line that acts at an early stage to provide critical functions such as separation of heavy particles (at the lower left side of the machine), air separation (middle top of the machine), fire protection via spark sensor to detect burning material at the top of middle duct, metal separation at lower side of machine, and waste re-feeding at the y-duct above the input duct.

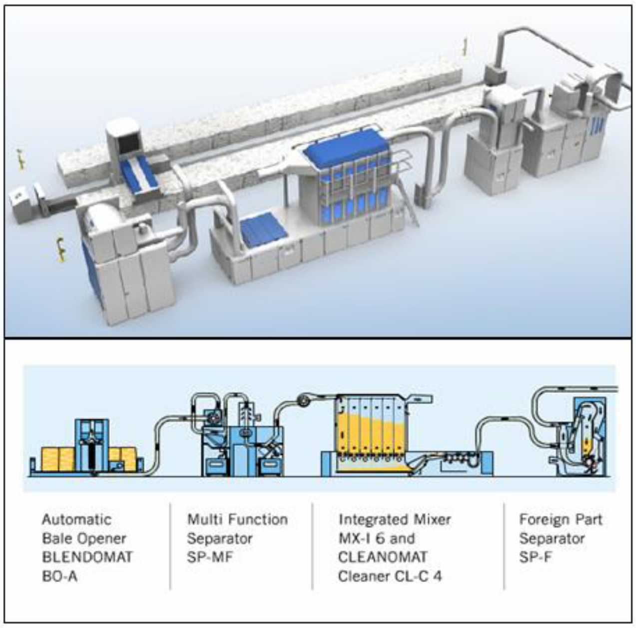

Figure 3. Trutzschler Compact Opening & Cleaning Line.

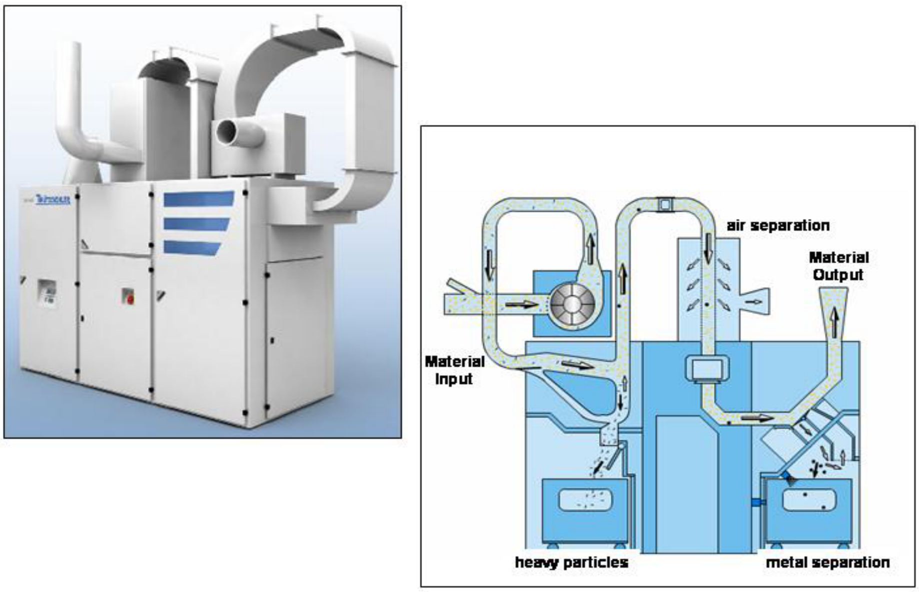

Figure 4. Trutzschler Multi-Function Separator SP-MF.

Following the multi-function separator, Trutzschler recommends a combination of a multi-mixer and cleaning unit using an integrated mixer MX-I 6/Clenomat Cleaner CL-C4. These units do not differ significantly from the previous model generations. The familiar CLEENOMAT system is an intriguing concept, which was discussed in many previous literatures (e.g. El Mogahzy & Chewning, 2002). Some of these features are summarized in Figure 5. In the bottom of the Figure, the Waste control concept developed by Trutzschler is illustrated. This concept was displayed at ITMA 2003 using the so-called WASTECONTROL BR-WCT. This is basically an optical system that monitors the relative quantity of fibers in the waste (trash plus fibers). This system optically distinguishes between dark colored trash particles and light color fibers at exactly defined points in the suction hood. According to this quantity, the deflector blade setting is adjusted via computer control to reach a minimum amount of good fibers in the waste (i.e. an optimum cleaning efficiency).

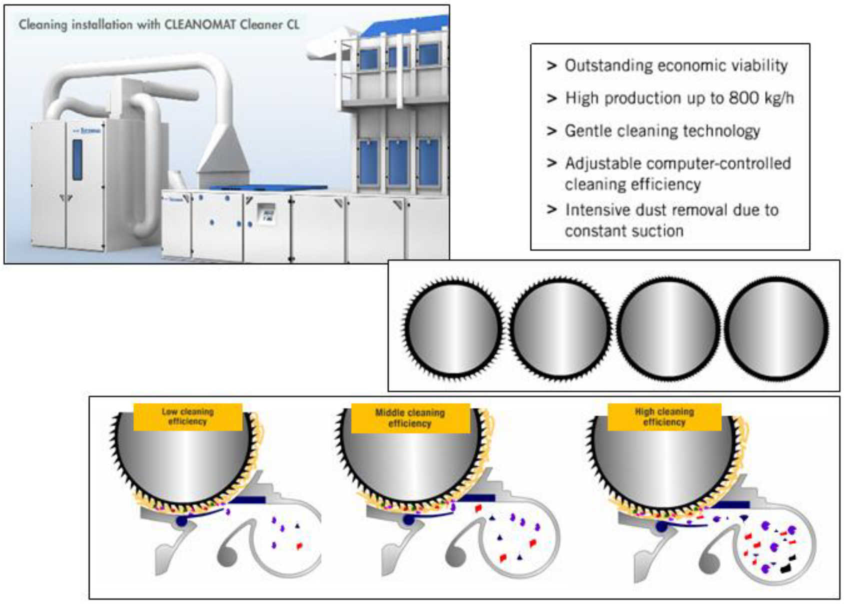

Figure 5. Trutzschler CLEENOMAT System.

The Trutzschler compact line ends with another separator called "SECUROMAT, SP-F" (Figure 6). This unit basically completes the unfinished job of the multi-functional separator "SP-MF" installed in the beginning of the line. It is placed after the integrated mixer MX-I 6/Clenomat Cleaner CL-C4 system. The main purpose of this unit is to detect foreign fibers from cotton by producing a fine fiber flow using a spiked opening roll and detecting foreign fibers using two high-speed cameras that scan the fiber flow on the opening roll. Detected foreign fibers are blown into a waste suction device using impulses of compressive air produced by an air nozzle. There are 32 nozzles used in the system, but only few are activated depending on the quantity of foreign fibers. This approach is claimed to reduce good fiber losses.

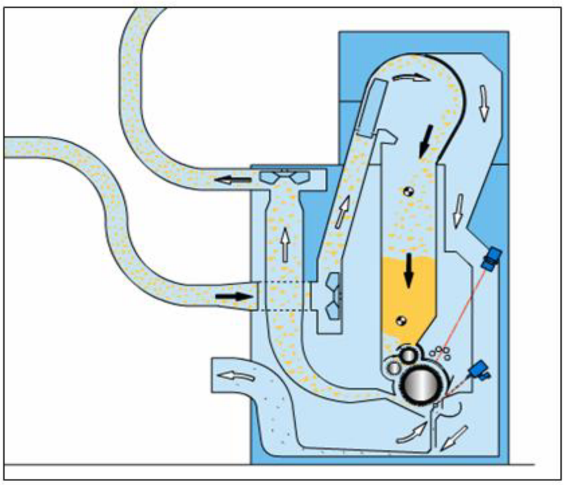

Figure 6. Trutzschler Foreign Particles Separator SP-F.

It should be pointed out that the concept of compacting the opening and cleaning line and providing customized application-oriented settings has been one of the major trends in recent years. Although it was not exhibiting at ITMA 2003, one cannot disregard the Rieter innovative approach of opening and cleaning operations. Figure 7 shows the Rieter line. The concept consists of: automatic bale opening with the UNIfloc A 11, intensive pre-cleaning with the UNIclean B 11, homogeneous blending with the UNImix B 70 and gentle fine cleaning with the UNIflex B 60. Based on mill's experience, the line truly provides high material yield and at the same time maximum cleaning performance. The Rieter concept is based on step-by-step approach in which coarser impurities are removed before the next process stage, rather than being broken up. Finer trash particles that are more difficult to remove, are handled in the final fine cleaning operation. This approach proved to provide efficient cleaning with careful monitoring of progressive nep count increase. In addition, pre-cleaners, blenders and fine cleaners remove dust at the same time, which makes complicated auxiliary machines unnecessary. The entire line and up to the carding machine is fully controlled using the familiar VarioSet system where settings can be adjusted during production, and even automatically when two assortments are being processed simultaneously. The VarioSet allows setting the two cleaning stages (UNIclean B 11 for pre-cleaning and UNIclean B 60 for fine cleaning) to maximum cleaning efficiency with the highest possible degree of fiber preservation using simple codes that are easy to understand by the operator. In other words, it let the user select the necessary cleaning intensity and the required cleaning efficiency with the push of a button. The result of such action can quickly be checked visually.

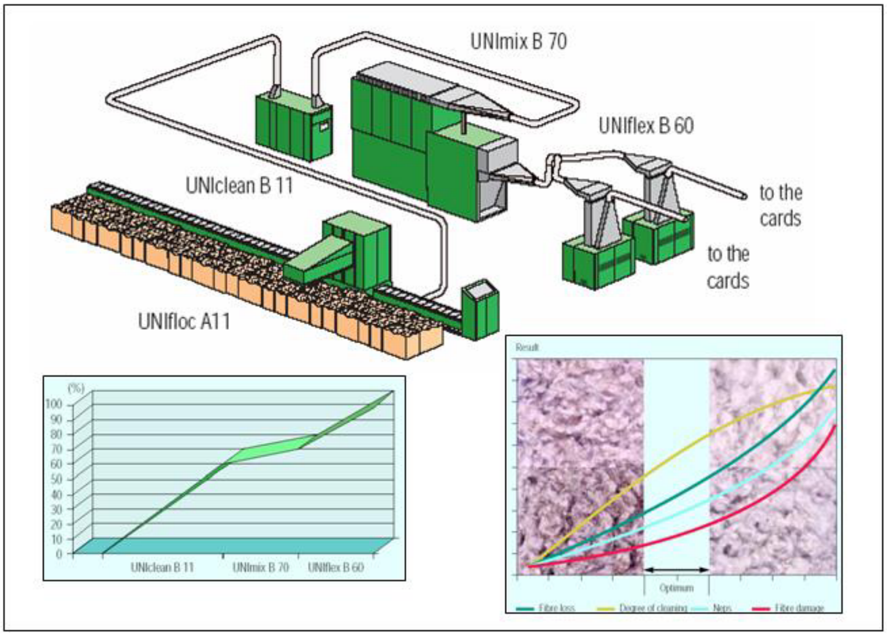

Figure 7. Rieter's Compact Opening & Cleaning Line.

Developments in Carding Technology

At ITMA 2003, Trutzschler introduced the new attractive nontraditional looking TC 03 card (see Figure 8); all doors can be removed and complete accessibility is possible for inspection and different adjustments. The TC 03 is more adaptive to variable cleaning and carding requirements for different materials than previous generations. It is equipped with complete computer display features with symbolic approach that is independent of any particular language to allow personnel to monitor machine performance and detect fault areas.

The TC 03 maintained the use of the concept of "WEBFEED" 3-licker-in system, which was pioneered by Trutzschler in its previous DK models. It consists of three taker-in cylinders of the same diameter (typically, 175 mm or 6.9 inch) to apply a gradual opening effect on the fiber mat. The first roll is equipped with short needles (i.e. fully-spiked cylinder instead of the conventional metallic wires), which gently pluck the tufts from the SENSOFEED (the feeding system). The second and third rolls are covered with metallic wires. One of the practical merits of the 3-licker-in system is based on the idea that the use of needle rolls in the beginning doubles the maintenance interval in the pre-opening area as compared to single taker-in systems. The underlying concept of the WEBFEED is to introduce a thin fiber web to the main carding zone (cylinder/flats area) instead of the traditional small tufts. This thin web is produced through the progressive opening of the three taker-in rolls. This is achieved through progressive increase in clothing fineness, progressive increase in peripheral speed, and an increase in clothing angle from the second to the third taker-in. In addition, each taker-in is equipped with direct suction to prevent a build-up of contaminants and sticky particles.

In contrast with the DK 903, the TC 03 has substantially increased the pre- and post-carding area from 50% to approximately 90% active area (see Figure 8). This is claimed to provide more gradual carding adapted to the material being processed. The key development here is the availability of different carding and cleaning elements from a variable modular system that can be placed on the enlarged areas in variable configurations to meet various optimum needs for different raw materials.

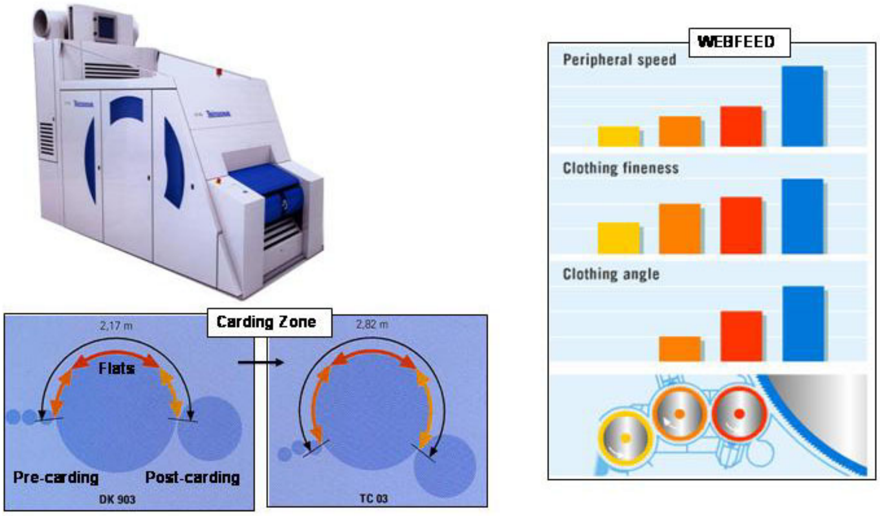

Figure 8. Trutzschler TC 03: Important Features.

From a quality viewpoint, the Trutzschler TC 03 card utilizes sensory systems that primarily aim at achieving reproducible machine settings and consistent performance. For example, the machine can be equipped with sensor-aided flat setting systems ("Flat control FTC") and the “Nepcontrol NCT” system that were used previously in the DK 903 card.

Similar to the waste control system used in its opening and cleaning line, Trutzschler also introduced a waste sensor for carding at ITMA 2003. This is called the "WASTE CONTROL, TC-WCT” waste sensor, which was presented as a proto-type. This system is an optoelectronic sensor used for the relative measurement of trash and fiber content in the cad cleaning roll (suction) hood as shown in Figure 9. The extractor hood knife or guide vane setting can be manually or fully automatically optimized so that the highest possible content of dirt can be extracted without excessive good fiber loss. Also presented was a mobile instrument for determining the fiber length parameters of cotton and man-made fibers on the basis of a modified Fibrograph principle. The unit, called the TC-LCT "Length-control", equipped with a fiber length-measuring instrument, enables fiber length distribution and fiber hooks in carded and drawn slivers to be optimized in a simple and easy way.

In an attempt to make settings of machine components (in correspondence to quality changes) largely robust against operator skills, Trutzschler maintained the use of the PFS precision flat setting system, familiar from the DK 903, together with a separate flat drive. In addition, Trutzschler introduced extra elements, which make possible simple and reproducible machine setting. These include integrating in the card control unit two controlled drives to the three pre-opener rollers and the cylinder, rendering pulley changes and mechanical intervention unnecessary. Also added feature is manual or motorized setting of the knife at the extraction point of the first pre-opener roller (TC PMS precision knife setting system), where optimum cleaning results can be achieved by a lever or push-button (Fig 10). All motorized adjusting components are constituents of an optional equipment package (optimization package), which quite significantly simplifies card-setting operations and make an effective contribution to minimizing waste.

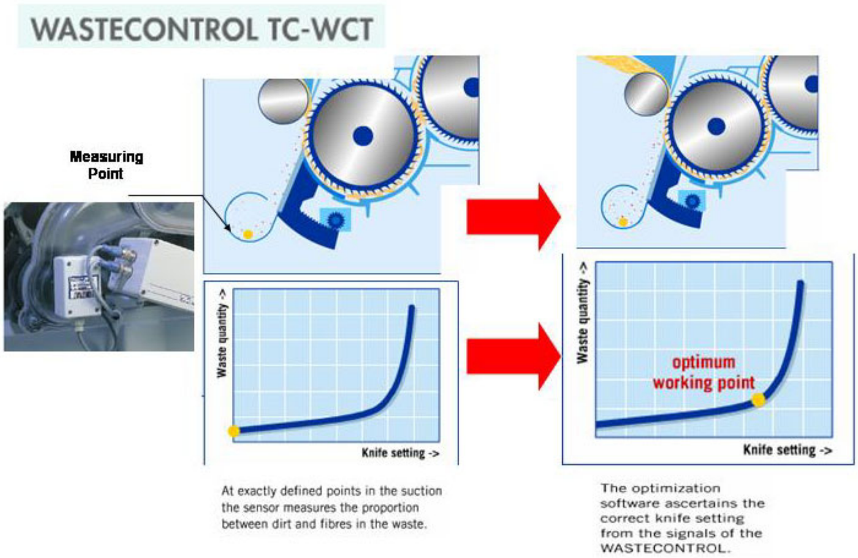

Figure 9. Trutzschler TC 03: Features of the WASTECONTROL TC-WCT.

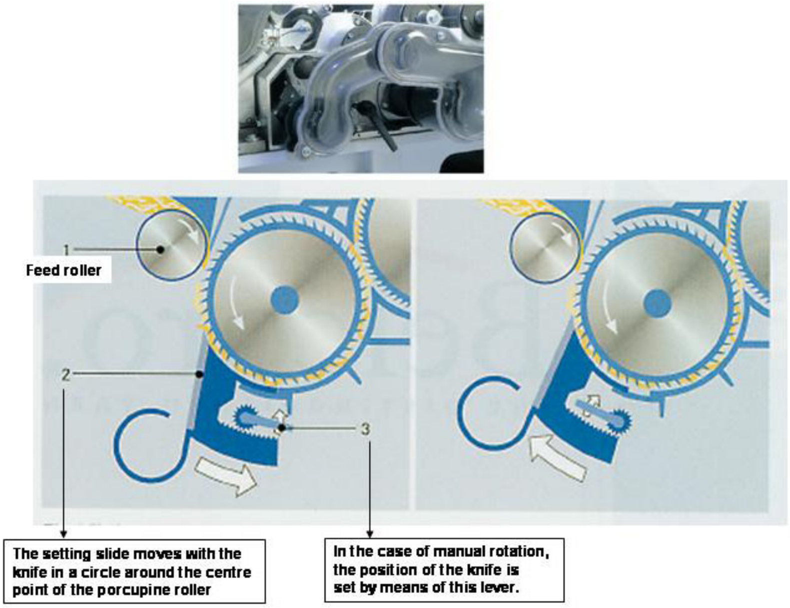

Fig. 10. Knife setting in the model TC 03 Card licker-in zone.

At ITMA 2003, Marzoli introduced a prototype of its new C601 as an extension development of its previous C501 card. Marzoli still adheres to the single licker-in system supported with many carding and extraction segments. The licker-in is of a larger size of 350 mm diameter and with new positioning of the mote knives and carding segments. Both India and China had companies exhibiting in ITMA 2003 (models LC300A card by the Indian LMF, and FA232A card by the Chinese CTMC) with traditional carding features.

A review of carding development will obviously be incomplete without a brief look at Rieter C-series cards. Merits of Rieter cards are very evident by the more than 15000 C-series cards that were sold since 1981. In recent years, Rieter introduced the C 60 with an entirely redesigned geometry different from conventional cards. The main difference is the increase of the working width to 1500 mm, which permitted higher production rates at a highly acceptable sliver quality. This increase in width was achieved at the same floor space as a conventional card due to its compact construction. According to Rieter, a productivity increase of up to 50% can be realized in the same carding floor area. In addition, the C 60 has a reduced cylinder diameter, which increases in conjunction with higher cylinder speeds the centrifugal forces during the carding process, leading to more trash extraction.

With its traditional integrated concepts of processing, Rieter designed the C 60 with the trend of smaller diameter rotors and higher rotor speeds in rotor spinning in mind. This trend makes it critical to reduce trash content in the input sliver. This objective was largely achieved in the design of the C 60 licker-in module, which aimed at providing an optimum trade-off between trash removal and gentle fiber handling, meanwhile producing slivers at production rates of up to 150 kg per hour. In contrast to the Trutzschler "WEBFEED" 3-licker-in system, Rieter uses a multi-step unidirectional feeding system (see Fig 11). This system is represented by a licker-in module, consisting of a feed roll and 3 rollers, with different clothings, diameters, and speeds. In this system, the feed roll and feeding trough delivers the material to the first roller, which applies gentle fiber opening. Subsequently, the material is transferred to a second roller, which continues to open the fiber tufts. At the third step, a larger licker-in terminates the fiber preparation and transfers the web onto the main cylinder. The familiar unidirectional feeding system ensures a gentle material opening with the option to adjust the nipping distance of the feeding trough to the staple length. This design allows the fiber mass to be presented to the first step in the licker-in module in such a way that trash particles can be cleaned out efficiently while ensuring minimal fiber damage. In addition, carding segments and mote knives are used to extract trash particles from the raw material at all three steps.

In the pre-carding area, the C 60 uses 6 carding units to separate trash, dust and short fibers. The guiding element and the associated mote knife are responsible for the extraction of the impurities into the central suction system of the card, which consists of 16 suction points. In the main carding area, active carding is achieved by higher centrifugal forces that facilitate the separation and extraction of trash, short fibers and seed-coat fragments. The flat module consists of 79 precise flats to guarantee a high degree of nep and impurity removal. The modular concept allows a complete exchange of the flat module in a very short time. It is also possible to change single flats on the machine if necessary. In the post-carding area, the remaining, tiny trash and dust particles are removed from the process by a combination of 2 carding elements, one guiding element and a mote knife. In the doffing area, a newly designed doffer securely gathers the web from the cylinder. The subsequent sliver formation is made by two cross aprons, which unites the web and delivers the sliver close to the nipping point of the take off rolls.

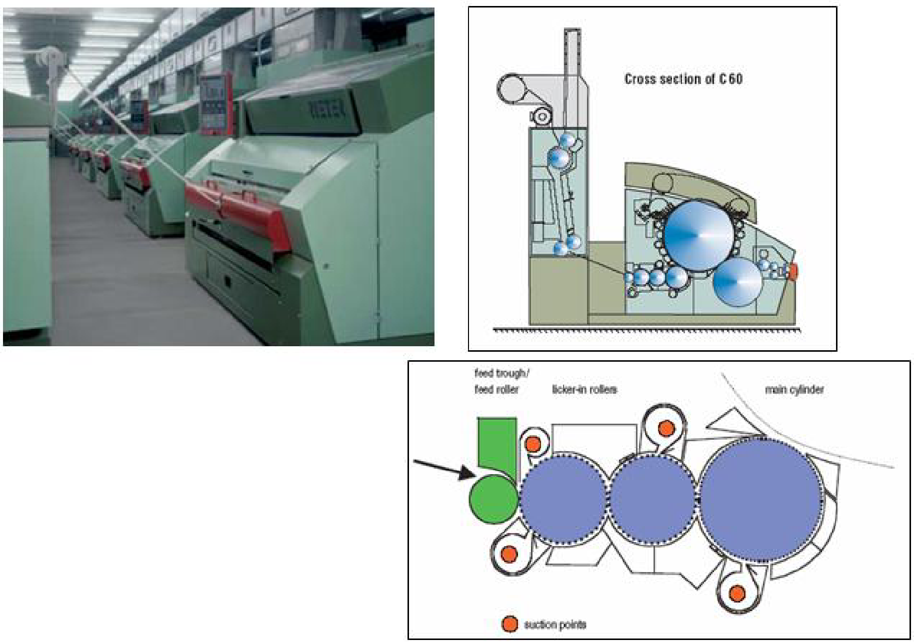

Fig. 11. Rieter C 60 Card.

Developments in Drawing Technology

One of the highlights of the ITMA 2003 was the Trutzschler Draw Frame TD 03. The new development introduced in this machine was the so-called AUTODRAFT system in which a separate servo drive for the middle drafting cylinder was achieved (see Figure 12). This allowed setting the break draft by simply pressing a key at the operating terminal and the possibility to execute a test run with the material supplied in the form of a set, automated routine, in which the break draft is varied within broad limits. The optimum break draft is determined and displayed to the machine operator as a result of measuring and analyzing the drafting force in the break draft zone (Figure 13). Typically, the draft force is measured and an ideal point is calculated from about 600 meters of sliver and optimization time takes about 40 seconds. Within a minute, the control system displays the optimum break draft to the operator. AUTODRAFT is thus a form of machine intelligence for self-adjustment of the optimum technological operating point; another robust design against operator skills.

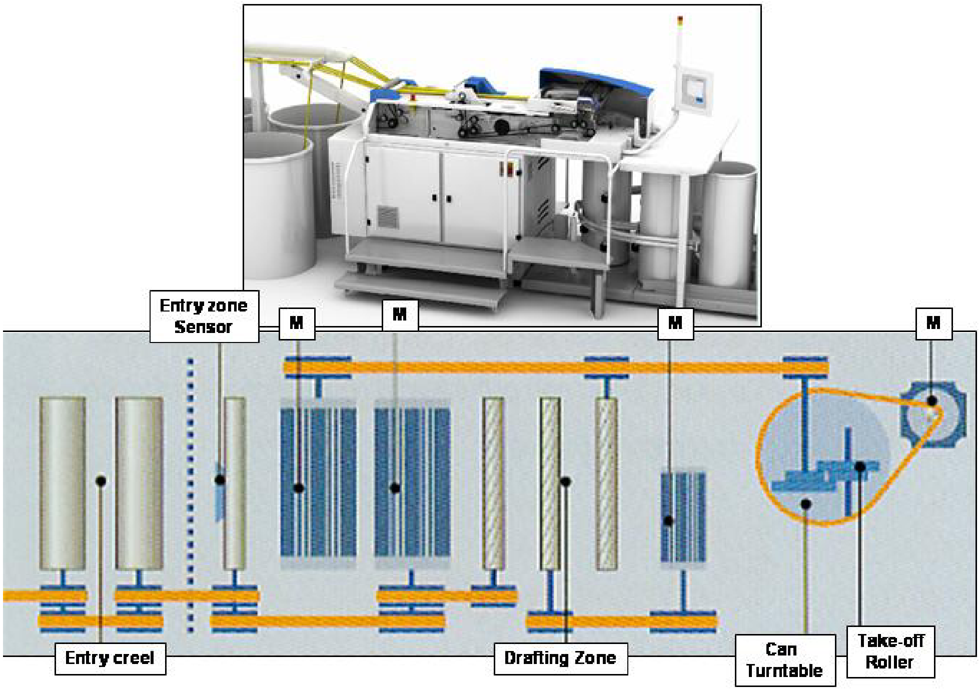

Figure 12. Trutzschler draw Frame TD 03.

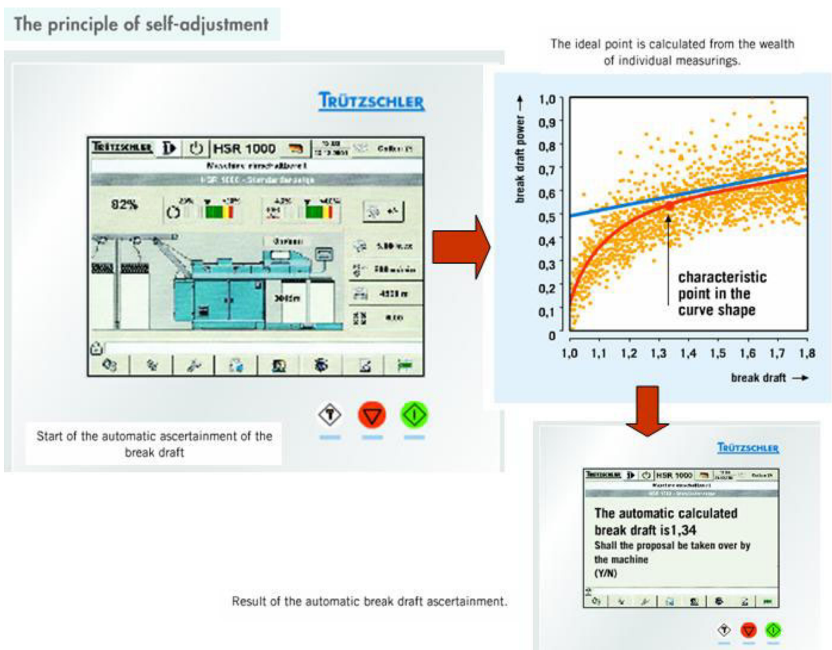

Figure 13. Trutzschler draw Frame TD 03 AUTODRAFT System.

The RSB-D 35 represents the latest development of draw frames by Rieter. It is largely an extension of the RSB drawframe series. The main features of this frame is high speed (up to 1,000 m/min) at high sliver quality (lowest CV%), increased dynamics of servo drive at maximum speed, consistent long-term count stability through precise scanning, effective dust removal by an improved suction system, and a new Rieter Quality Monitor for detecting thick places.

Carding-Drawframe Integration Concepts

The concept of compacting and shortening the spinning preparation process has been one of the major concerns among all machine makers. The condensed and effective opening and cleaning line that we see today was a result of a continuous strive by all machine makers to shorten the process, increase productivity, and maintain high quality at the same time. Over the years, machine makers have also attempted to link the carding process with the drawing process. Since doubling represents a key aspect of drawing to achieve better drawn sliver uniformity, one obvious choice would be to link several carding machines (many card slivers) with a single drawframe. This idea was implemented in the 1960s through feeding the card sliver directly by magazines and channel guides to the draw frame. However, the system was quite complex and vulnerable to possible malfunctions of single machines within the compound. In a latter development, the concept of a direct link between carding and drawframe producing a single drawn sliver from a single card sliver was introduced under the name “Sliver Machine”. This concept was commercially implemented for rotor spinning to make coarse rotor spun yarns for carpets and other products. Other approaches implemented were based on using only a simple one-zone-drafting system, which is merely used for reduction of sliver size or handling waste material of excessive short fibers to slightly improve processing behavior.

In recent years, Trutzschler introduced the so-called “Integrated Draw Frame, IDF” concept for the purpose of shortening the spinning preparation process at acceptable sliver quality levels. At ITMA 2003, Trutzschler continued to pursue the IDF concept using its new TD 03 drawframe and in conjunction with its square sliver can approach, particularly for direct spinning of rotor-spun yarns. One of the obvious challenges facing the direct card-drawframe linking is the need for coarser card slivers. Typically, coarse card slivers come from a thicker fiber web on the main card cylinder. However, a very thick fiber web in the carding zone will reduce the cleaning and nep removal efficiency of the carding machine. Fortunately, the introduction of Trutzschler’s "WEBFEED" 3-licker-in system can assist in meeting this challenge because of its capability of introducing a thoroughly pre-opened homogenous fiber web to the card cylinder. Accordingly, fibers can be intensively carded with finer clothing, smaller cylinder/flat settings, and at higher speeds.

The second challenge is achieving a quality drawn sliver (appropriate drafting, straightening, and parallelization of fibers) from a direct card-drawframe linking. This challenge is largely overcome through proper adjustments of drafting levels and optimization of drafting zone widths. Experimental studies [S. Schilchter, and S. Peter, 2002] were conducted in which tests were carried out to determine the dependence of the fiber length and yarn strength on the draw frame draft. In these tests, different drafts in one or two successive drawing passages were inspected, starting with an un-drafted card sliver and producing rotor-spun yarn of Ne 24 from 100% cotton fibers. These trials revealed that the drafts of normally 1.25, realized in cards by conventional one-zone drafting systems, are not enough to reach the results of a drawing passage. Only when arriving at a drafting level of 2, a quality level sets in which clearly lies above the values of the card sliver. Hence, the quality improvements of the sliver regarding alignment and parallelization, which are necessary to substitute a draw frame, can therefore only be achieved with a drafting system, which allows for drafts in the range of two- to threefold. In this drafting range, however, a transition from one to two drafting zones is necessary, analogous to the experiences with high performance draw frames.

Perhaps, the utmost challenge associated with developing a card/drawframe direct linkage is sliver evenness. In an integrated process, it is important to achieve a highly dynamic leveling system to accomplish high sliver evenness, particularly in short-term areas. Trutzschler accomplished that by turning away from conventional control mechanisms of low dynamic and facing modern, mass reduced drive concepts with high-dynamic servo-driving axles.

The integration of the processes of carding and drafting into one machine further requires that both machines be adjusted to each other, with regard to productivity and efficiency. Since the efficiencies in a compound system are multiplied by each other, it was necessary to place extreme requirements on both components with respect to operation safety at high production rates. The almost break-free carding of the sliver on the high production card DK 903 and TD 03 was therefore a prerequisite to accomplish a successful combination-solution card/ draw frame. According to Trutzschler, obstruction of efficiency of the card is avoided by placing the sliver, which has been drafted by the integrated draw frame, at high delivery speeds into the cans without quality loss. Thus, the complete sliver guidance in the drafting system and in the can deposit have to meet the high demands on geometry and surface. Moreover, this resulted in positioning the drafting system directly above the can deposit at the delivery side of the card. This ensures that the drafted sliver is fed directly into the can deposit and no longer has to be transported at high speeds over sliver guides.

IDF Components

In the Trutzschler IDF system, a compact drawing unit is installed on the can changer of the card, into which the sliver passes vertically and is fed directly to the sliver deposit (Fig. 14). The unit consisting of a can coiler, can changer, and IDF, is normally placed central in front of the card. The core of this unit is the 3-over-3 two-zone leveling drafting system with pneumatic top-roll load and integrated suction of the operation parts. The leveling principle of the IDF consists of a sliver-measuring funnel, which scans the mass of the card sliver fed to the drafting system. The signal of this measuring funnel influences the main draft, while the break draft remains constant. Thus, a servo-motor is coupled with the two break draft rolls on the drive side, while the other servo-motor drives the third pair of rolls of the drafting system, as well as the delivery rolls and the coiler. A sliver-measuring funnel at the delivery side of the drafting system is also used to provide continuous monitoring of the sliver produced and the required quality data to the main quality data recording system. Accordingly, the IDF works with a constant delivery speed because of this, while the speed of the feed-roll pairs (similar to the draw frame) is changed. The setting of the drafting system is largely variable and enables the processing of short staple regenerates, 100 % cotton, typical blends as well as 100 % man-made fibers up to a maximal staple length of 50 mm.

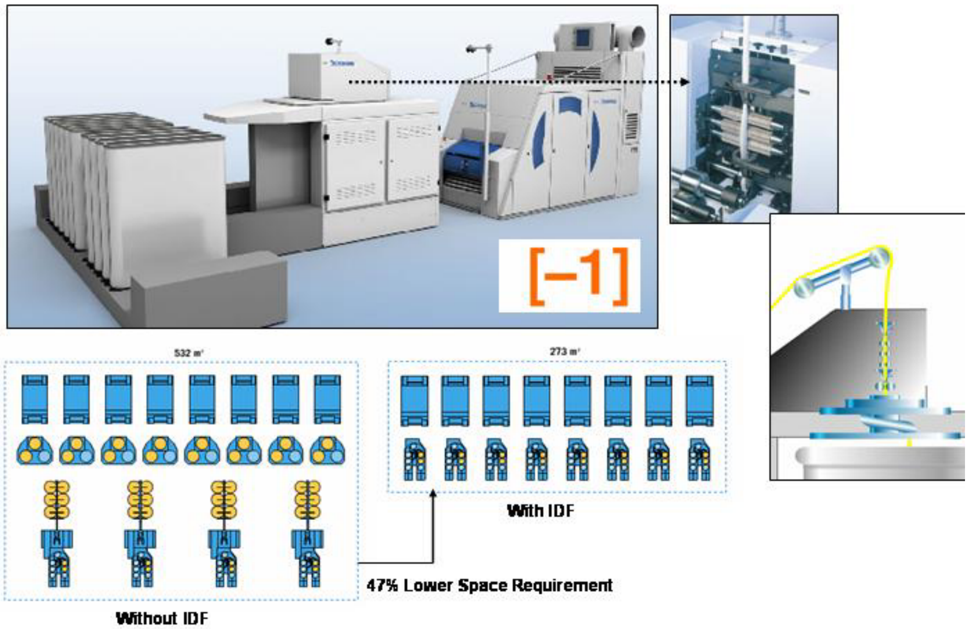

Figure 14. Trutzschler IDF System.

The IDF drive takes place via three independent, frequency-controlled AC-servo-motors and maintenance-free tooth belt drives. Besides the two drive axles in the drafting system, a drive is also carried out separately for the can plate by an individual motor. Maintenance-intensive and wear-and-tear-intensive drives are therefore not used for the IDF. The direct-drive technique with small mass moments of inertia and the high frequency scanning result in an excellent control dynamic. According to Trutzschler, the slivers produced with this unit are very comparable to those of a leveling draw frame of the second passage, with regard to long and short-term sliver deviations. The IDF sliver is delivered to cans in regular round-can format for feeding to a final drawing passage or to direct spinning.

According to Trutzschler, the IDF is designed for delivery speeds up to 500 m/min and for a main-draft up to 3.0 fold. The operation of the IDF takes place centrally, via the card control and the card display. The drafting system can be easily opened for maintenance work and threading of the sliver. The pneumatic load of all rolls ensures a reproducible operation of the drafting system at any time. The coupling of the card to the IDF is done with the help of regulated sliver-loop storage. This storage guarantees that the leveling deviations of the IDF do not influence the card, and thus the carding quality.

Trutzschler uses an interesting characterization of the IDF concept depending on the machine layout in a spinning mill. When the IDF is used to replace the breaker draw frame in a two-pass drafting operation, the IDF concept is labeled “Minus 1”. This is typically suitable for rotor spinning operations. By comparison, a “Minus 2” system implies direct spinning straight from the IDF without any further drawing passes. Some of the test results pertaining to the performance of the IDF system and carried out by Trutzschler in typical spinning mills are shown in Figures 15 and 16. In general, these results indicate positive results in favor of the IDF system.

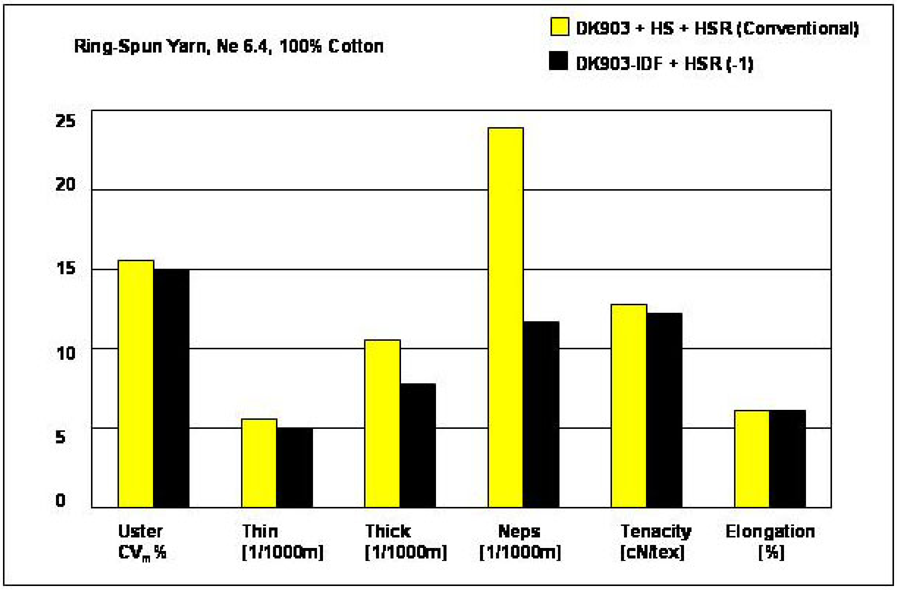

Figure 15. Effects of Different Card/drawframe Combinations on 100% Cotton Ring-Spun Yarn Characteristics [Trutzschler: S. Schilchter, and S. Peter, 2002].

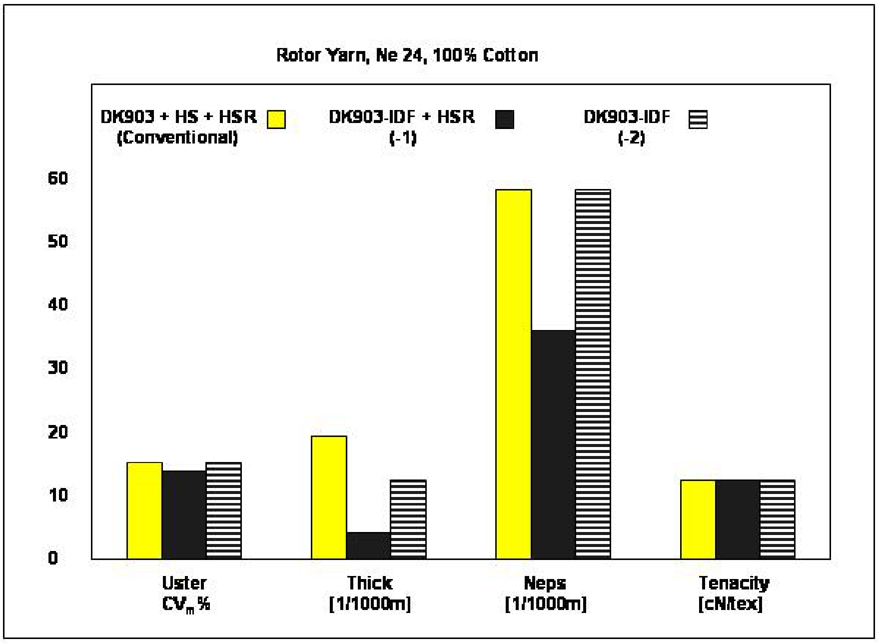

Figure 16. Effects of Different Card/Drawframe Combinations on 100% Cotton Rotor-Spun Yarn Characteristics [Trutschler: S. Schlichter, and S. Peter, 2002].

Closing Remarks

This review of short-staple fiber processing machinery clearly indicates that machine makers fully realize the global market and economical changes. The inevitable shift of textile manufacturing from Industrial countries to Less-Developed countries (LDC), imposed by obvious cost related factors, has resulted in a total revival of the development approach of textile machinery. From a development trend aiming at "speed, speed and speed" in the 80s and 90s, the trend now is "quality, quality and quality" with major efforts toward dealing with serious quality problems of many of cotton varieties around the globe that must be consumed to assist in cost reduction. When dealing with Less-Developed countries (LDC), the concept of utilizing information technology and process control should be also modified to accommodate the wide range of qualification. As a result, new information technology tools (e.g. displays of performance and adjustments, and fault information) should be represented in the simplest way possible (operator's skill-robust) to allow effective and easy implementation. In addition, cost will always be a primary issue for both the maker and the user of textile machinery. The over capacity of textile machinery in the world today drives a more innovative and creative approach toward attracting the buying power of machinery. In favor of textile machinery makers, more than 70% of the textile machinery used around the globe today is twelve years or older in service. However, unless low cost alternatives are presented the issue of over capacity will continue and this in turn will lead to technology regress. Technological trends such as process shortening and flexibility represent positive efforts in this regard.

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