Ring and Rotor Spinning of Recycled Fibers

The increasing importance of recycled fiber processing.

With barely one percent of garments being recycled and three quarters of the world's clothing ending up in landfill, the textile industry is actively seeking ways to make production patterns more sustainable and pay more attention to the entire life cycle of items of clothing. Rieter is offering solutions for the integration of recycled raw material into yarn production to help close the textile loop. The results of the latest study show that it is possible to spin not only rotor, but also ring yarns of different quality with a considerable amount of recycled raw material on a Rieter system.

In recent years, better use of raw materials has become very important in the textile sector due to growing environmental awareness, legal requirements for more sustainability, and the cost of raw materials. As a result, more research and development is being carried out in the various areas of textile recycling.

Coordination and cooperation between the different industrial sectors, from the procurement of raw materials through to the new final product, will be vital. Only then will it be possible to expand and optimize the entire recycling process to help it grow into a larger market. In the next few years, the realistic market potential for the staple fiber industry for recycled raw materials amounts to around 7.6 million tons annually if the current trend continues.

Classify the raw material

To help spinners in the area of recycled fibers, Rieter has established a classification system for the typical recycled raw material quality available on the market (Fig. 1). The Rieter Recycling Classification makes it easier for spinners to estimate what targets can be reached depending on the material.

Rieter Recycling Classification
Fiber key parameters for recycling

Classification	Short-Fiber Content	Mean Fiber Length	5% Fiber Length
Very good	45%	17 mm	31 mm
Good	55%	14 mm	29 mm
Medium	60%	13 mm	28 mm
Poor	78%	10 mm	22 mm
Cotton as a reference	24%	21 mm	34 mm

Fig. 1: The Rieter Recycling Classification allows a very good estimation of processability and yarn quality of the used material.

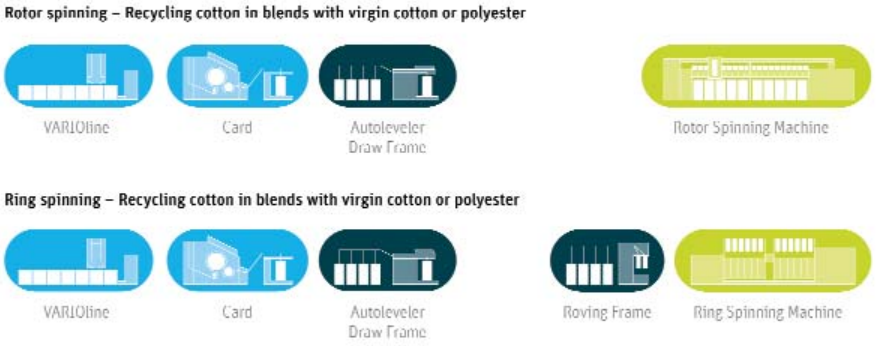

Fig. 2: Process sequences for recycled materials.

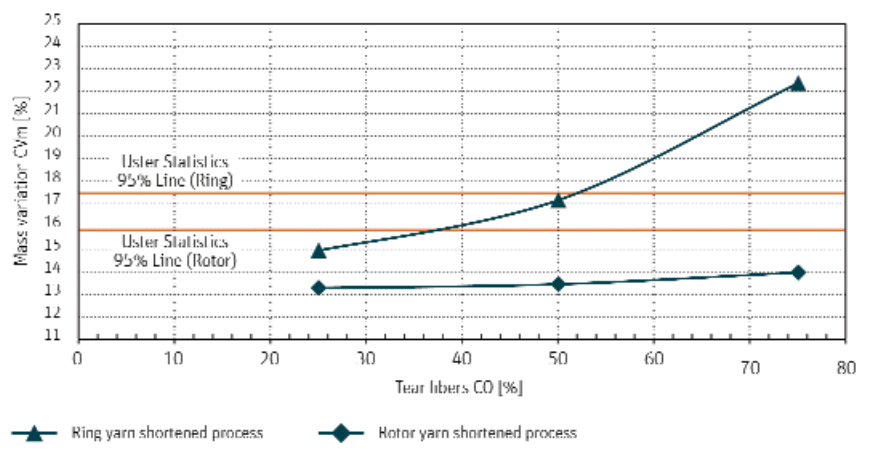

Fig. 3: The rotor spinning machine is well suited for processing fibers with a high short-fiber content, which is reflected in better evenness.

The short-fiber content, the mean fiber length and the 5% fiber length are important parameters after the tearing process because they help to determine which subsequent spinning process (ring or rotor) should be used and which quality (uniformity) and maximum spinning fineness (yarn count) can be achieved in this context.

Defining the optimal spinning process for recycled materials

A very interesting recycling example is the re-spinning of used cotton clothes, e.g. T-shirts. Typically, the recycled raw material is blended with virgin cotton. This application was also used in the Rieter trial to determine the optimum spinning process. Both the requirements for raw-material preparation and the best machine configuration for spinning staple fibers were considered. The raw material in the trial was a blend of virgin cotton from Chad and bleached cotton recycled fibers which were mixed in varying proportions. The graph shows the process sequences within the spinning process (Fig. 2).

Rotor yarn has the best unevenness

In essence, the rotor spinning machine is well suited for processing fibers with a high short-fiber content (>30%), which is reflected in better evenness (Fig. 3). This is due to better fiber feeding of the opened fibers in the closed fiber feed channel and the doubling of the individual fibers in the rotor groove. For acceptable yarn quality and operational reliability, a blend containing up to 75% recycled content is possible in this raw material configuration.

Ring yarn has the highest tenacity

Ring yarn, by contrast, has the highest yarn tenacity on account of more intensive fiber integration (Fig. 4). This opens a wider range of applications, namely the increased use of these yarns in weaving mills. It is important to note that tenacity reduces as the recycled and short-fiber content increases.

Is it economical to produce yarn from recycled fibers?

The economic efficiency depends on the proportion of recycled material in the yarn, as this has an influence on the yarn conversion costs and the yarn sale price. In the Rieter trial a yarn count between Ne 12 and Ne 20 was used and the yarn conversion costs were calculated for ring yarns and rotor yarns in Turkey. (Fig. 5).

The economic analysis assumes a slightly cheaper recycled raw material price compared to a medium-quality virgin cotton. The calculation is also based on the realistic view that trade will accept a higher price for yarn made of recycled fibers. Depending on the amount of recycled fibers there is little loss of yarn or fabric quality, but raw material resources are better utilized and meet the need of many companies to become more sustainable. A blend containing 25 to 50% recycled raw material should therefore achieve a yarn sales price which is at least 0.1 to 0.2 cents per kg higher than that of virgin cotton raw material, depending on the end-spinning process and yarn count. Graph 5 shows that the Return on Investment (ROI) is best for blends containing 25% to 50% recycled material.

There will be greater or lesser scope for the economic viability of the staple-fiber yarn production process depending on whether it is a case of yarn trading or a fully integrated process. In any case, the economic analysis shows interesting opportunities for processing recycled cotton raw materials using staple-fiber yarn production.

Detailed information on spinning recycled fibers can be found here: https://www.rieter.com/products/spinning-systems/recycling-spinning-system◆

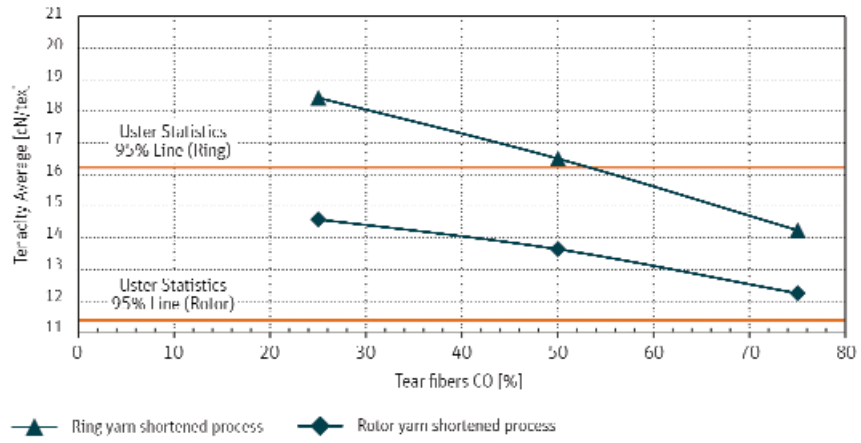

Fig. 4: The ring spinning process achieves significantly higher yarn tenacities than rotor spinning.

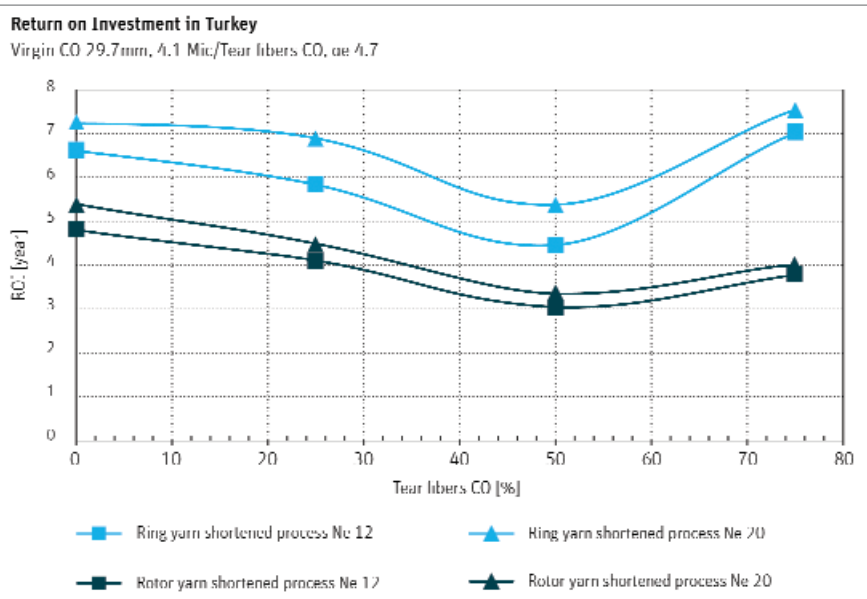

Fig. 5: The Return on Investment (ROI) is best for blends containing 25% to 50% recycled material.