

# COMPARATIVE STUDY OF MECHANICAL PROPERTIES, TPI, HAIRINESS AND EVENNESS OF CONVENTIONAL RING AND MODERN ROTOR SPUN YARN

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## Abstract

This work presents a comparative study of the properties of yarns manufactured from identical raw material (100% cotton fiber), of 16 Ne & 20 Ne in conventional ring and modern rotor spinning frame. Mechanical properties e.g. tenacity, elongation%, TPI, hairiness and evenness e.g. unevenness, Thin/km, Thick/km, Neps/km, hairiness, CV of mass of both types of yarns were tested and compared. Ring yarns exhibit higher tenacity; where as rotor yarns expose better result in rest of the tests. Experimentally, most of the yarn characteristics are superior in rotor yarn, except tenacity; tensile strength of ring yarn is 36.36% higher than rotor yarn.

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**Keywords:** Coefficient of variation of Mass, Unevenness of Mass, Thin/km, Thick/km, Neps/km, tenacity, Elongation

## Introduction

Three major yarn production systems are ring, rotor, and vortex spinning. But the most popular spinning methods for cotton - ring spinning [Klein,1995] and rotor spinning [(Frey & Toggweiler),(Brunk & Trommer)]. Ring spinning is a continuous spinning system in which twist is inserted into a yarn by a tiny circulating traveler. Yarn twist insertion and winding take

place simultaneously. Ring yarn structure generally accepted as the basic structure in spun yarn technology. In rotor spinning, fibers bundle from the sliver feed stock are separated into individual fibers with an opening roller in an air stream and separated fibers are re-collected in the rotor groove.

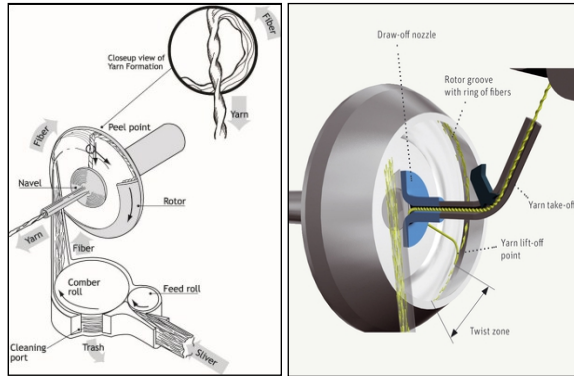


Figure 1: Rotor Spinning [Klein,1995]

Many open-end spinning methods have been invented, but none have been successful than rotor spinning. In rotor spinning the production rate are up to 200 m/min [Klein,1995], this can be achieved for yarn counts up to 20 Tex [Grover Elliot & Hambay,1993]. Two of the important differences are the degree of fibre hookiness and fibre migration, which later exit to a much lesser extent in rotor yarns than in the ring yarns. Some of the properties of rotor yarns are very different from those of ring yarns. In some respect rotor yarns are indisputably better and in other they are inferior. The mean strength of rotor yarn is normally less than that of corresponding ring yarn. So that on the face of it, rotor yarns are inferior. The rotor yarns are more regular; there is less variation in average strength, which tends to reflect in the fabric produced.

## Material & Methods

### Materials

Cotton fibers from same country of origin such as USA, IND & MALI, blend in a precisely homogenized way. The pre-processes up to drawing frame for both yarns were identical while, ring yarn prepared in Toyota RX 240 and rotor in Rotor frame at The Delta Spinning Mills Ltd.

Table 1. Raw cotton test result

HVI test		AFIS test	
Parameters	Value	Parameters	Value
Micronaire Value	4.59	Nep [Cnt/g]	227
Maturity	0.92	Nep [um]	714
SCI	115	SCN [Cnt/g]	15
Len	27.3	SCN [um]	1257
Amt	635	L (w) [um]	25.5

Unf	82.2	L (w) %CV	30.6
SFI	8.8	SFC (w) %<12.7	4.9
Strength	27.4	UQL (w) [mm]	30.0
Elongation	5.7	L (n) [mm]	21.9
Moist	6.8	L (n) %CV	40.5
Rd	76.4	SFC (n) %<12.7	15.2
+b	10.0	5.0% [mm]	34.2
Color Grade	21-4	Fine M Tex	153
		IFC [%]	11.3
		Mat Ratio	0.79

**Methods**

Table 2. Name of instruments which are used for testing the yarns

Test name	Testing instrument
Fiber parameter test	HVI & AFIS
Strength	USTER Tensijet
TPI	Single yarn twist tester
Elongation	USTER Tensojet
Hairiness	USTER evenness tester
Unevenness & Imperfection	USTER evenness Tester

**Results and discussion**

**Mechanical properties**

**Tenacity**

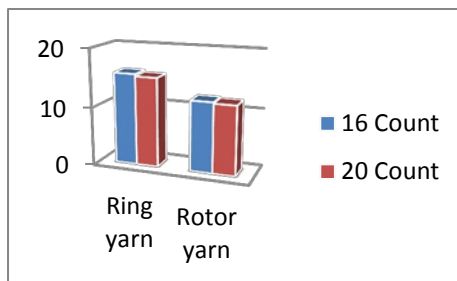


Figure 2: Value of tenacity of ring & rotor yarn

Ring-spun yarn contains envelope twist, twisting in the fibers from outside to inwards, whereas rotor-spun yarn in contrast has core twist, twisting in the fibers from the inside to outwards. Rotor spun yarn is therefore more voluminous, more open & rougher than ring spun yarn. The fibers in the envelope layer of a rotor-spun yarn can partly escape the twisting action during spinning & therefore take up turns of twist. They thus contribute relatively little to yarn strength & can more easily be rubbed together axially to form slubs, etc. Furthermore, the fibers in a rotor-spun yarn are less parallel than those in a ring-spun yarn. The core twist structure

& the lower degree of parallelism are the causes of lower strength of rotor-spun yarn.

### Elongation

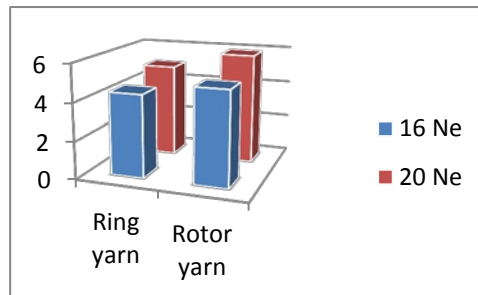


Figure 3: The diagram of Elongation test result

Rotor-spun yarn is superior to ring-spun yarn in terms of elongation at break (%), in contrast to yarn tenacity. Based on Uster Statistics it is apparent that the elongation at break of rotor-spun yarns is higher than that of comparable ring-spun yarns, albeit only marginally in some cases. This is especially positively noticeable in the working capacity of rotor-spun yarn, in that the differences relative to ring-spun yarn are smaller than for count-related yarn tenacity.

### TPI

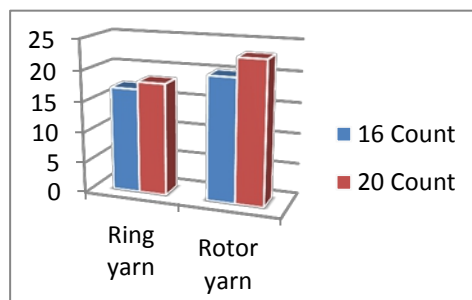


Figure 4: Value of TPI of ring vs rotor yarn

Twist [GREGORY,1995 & HEARLE,1958], spiral turns of fibers, is essential to keep the component fibers together in a yarn. Ring spun yarn is usually assumed to have an ideal cylindrical helical structure uniform specific volume and each helix having the same number of turns per unit length. The average helix angle of fibers in ring spun yarn was found to be 17.2. While noticing the configurations of tracer fibers of ring spun yarn, it was observed that the helix angle varies along the length of the fibers confirming the presence of definite fiber migration in the yarn structure. The rotor spun yarn shows a core of fibers this are aligned with the helix of the inserted twist and form the bulk of the yarn, than an outer zone of wrapper

fibers, which occurs irregularly along the core length. The average helix angle of fibers in rotor spun yarn is significantly higher than that of rings spun yarns. This is because, for same yarn count, rotor yarn demands more TM than the ring yarn to keep the end breakage rate at a lower level.

**Hairiness**

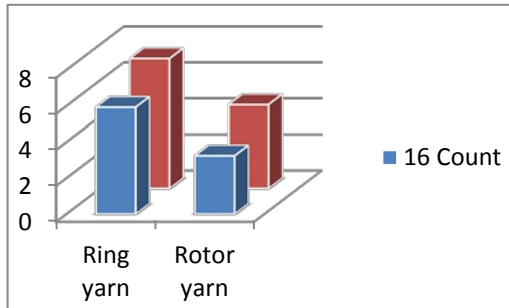


Figure 4: comparison of Hairiness of ring & rotor yarn

The hairiness index  $H$  corresponds to the total length of protruding fibers within the measurement field of 1cm length of the yarn. From the above work we found that, Rotor-spun yarns display significantly lower hairiness [Booth,1996] than comparable ring-spun yarns. The reason is that the fiber ends facing away from the yarn take-off direction point toward the interior of the yarn and the number of free fiber ends is therefore about half in ring-spun yarns. Furthermore, the wrapper fibers wound crosswise around the yarn help to ‘bind-in’ loose fiber ends. The clinging tendency, fiber abrasion and fiber fly of rotor yarns in downstream processing are less critical than for comparable ring-spun yarns. Simply, the higher hairiness of ring-spun yarns is caused by the uncontrolled passage of edge fibers in cylinder drawframes and in the wide spinning triangle [Klein,1993] at the ring frame delivery end.

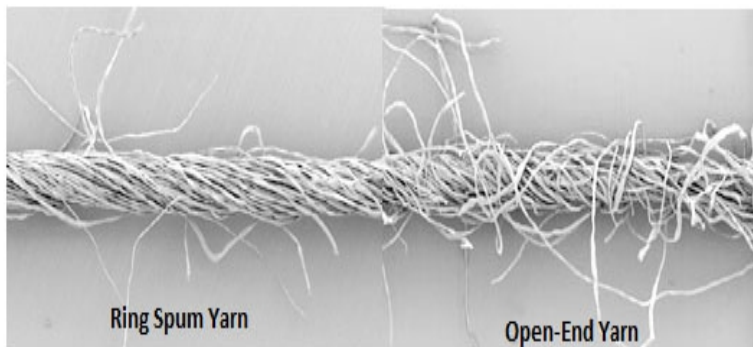


Figure 5: Ring and rotor yarn

**Evenness [BARELLA, 1996]**

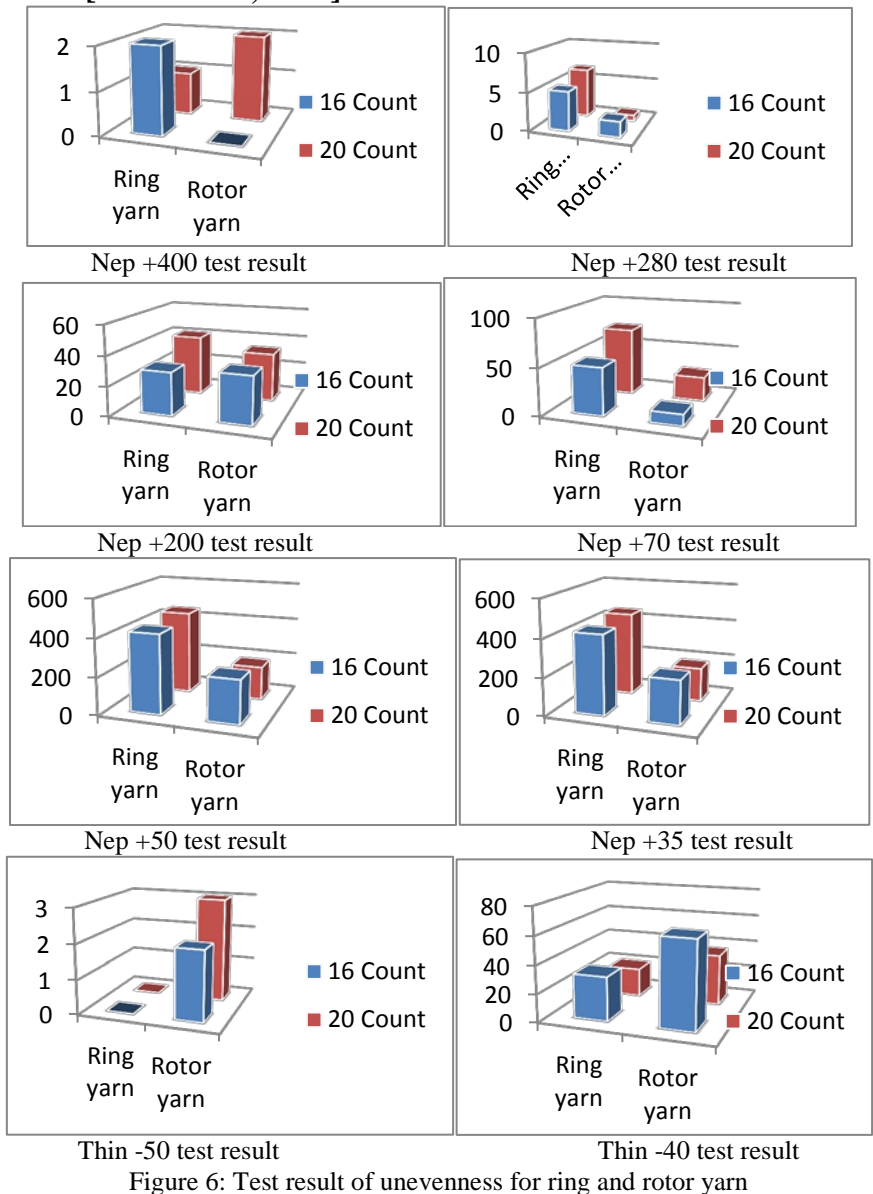


Figure 6: Test result of unevenness for ring and rotor yarn

From bar diagram it is found that the neps are originated more in ring yarn than rotor yarn. According to the latest Uster Statistics, the number of thick places and neps per 1000 m of yarn are up to 60% and 80% lower in rotor-spun yarn than in ring-spun yarn. However, if the number of imperfections rises above the usual level, this can be attributable to both raw material and machine-related causes. For example, immature cottons are very predisposed to produce neps during processing. However, thick places and neps also occur when spinning elements or other fiber-guiding machine

components are worn or damaged. Bent, broken or notched clothing teeth on the opening roller in particular can cause steep increases in the numbers of neps and thick places. Wear or deposits in the fiber guide channel also result in fibers accumulating at these points and being fed uncontrolled to the rotor as larger or smaller clumps of fiber. Depending on their mass, these clumps result either in ends down or if spun in defects in the yarn and the final fabric.

According to the above discussion it can be stated that, rotor yarn has less imperfection than ring yarn.

### Imperfection Index

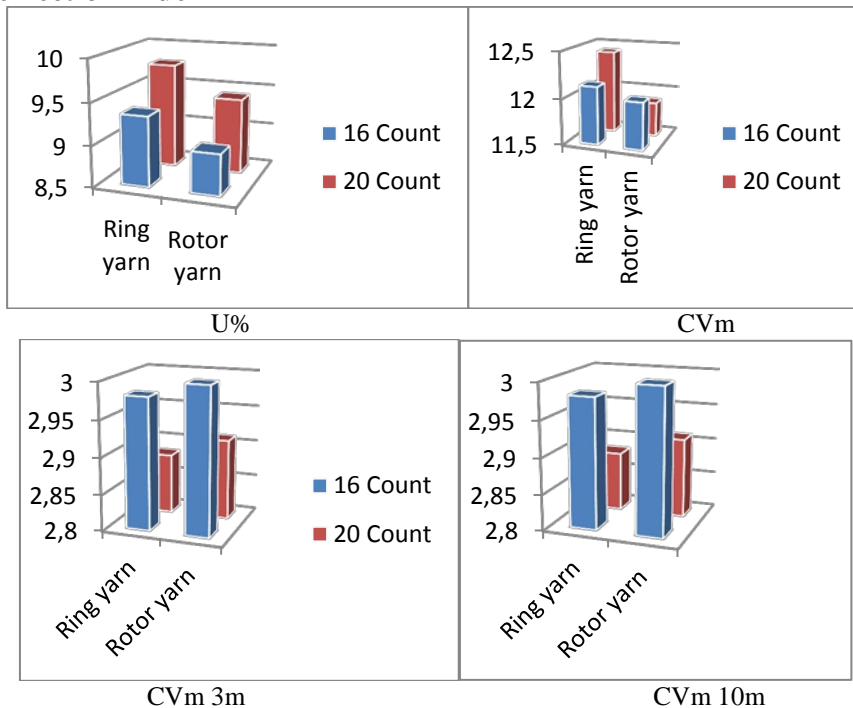


Figure 7: Imperfection index of ring yarn vs rotor yarn

From the diagram it is seen that, ring yarn is more uneven than rotor yarn. In processing in the spinning mill, the unevenness of the product increases from stage to stage after drawframe. There are two reasons for this-

The number of fibres in the cross section steadily decreases. Uniform arrangement of the fibres becomes more difficult, the smaller their number.

Each drafting operation increases the unevenness. Each machine in the spinning process adds a certain amount to the irregularity of finished yarn. After draw frame rotor yarn is produced directly from rotor, but in terms of ring yarn it is passed a several process & draft is also imparted. That's why ring yarn is more uneven than rotor yarn.

## Conclusion

The results show that the tenacity of the ring yarns expresses greater value than rotor spun yarn and the elongation% of the ring yarns has a significantly lower value than that of rotor yarn. The hairiness tests revealed an essential difference between the ring and the rotor yarn. Rotor yarn is less hairy compared to the conventional ring yarn. Unevenness of mass (1%, 3%) & their corresponding co-efficient of variation are higher for ring yarn with count than that of rotor yarn. Moreover, Index of irregularity also shows the same trend. Though thick place/km (+35%, +70%, +140%, +280%), neps/km (+280%, +400%) are higher in ring yarn, thin place/km in ring yarn are less than that of rotor yarn. The results are valid only within the experimental regions. This paper will become a good ally for those who are going to start spinning factory with ring or rotor frame.

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