TXL 520
REVIEW OF YARN SPINNING
Review on the Ring Spinning System
Overview of Short-Staple Spinning Processes
INTRODUCTION

• Ring spinning is the final operation before the strand is converted into a yarn of the required fineness.
• The technology is conventional as the machine was invented way back in 1826 by an American company.
• Currently, more than 80% of the world’s spun yarns are made from the ring spinning method despite the emergence of new spinning methods such as the rotor spinning, friction spinning, air-jet spinning, wrap spinning, etc.
Overview of the Ring Spinning System

• In the more than 175 years that have passed, the ring spinning system is still the most popular machine for staple yarn manufacturing.

• Ring spinning produces the best staple or ideal yarn quality and has been the standard/benchmark for all other yarns produced from different spinning methods.
RING SPINNING (conventional)

• Main objectives:
  – To attenuate the roving strand, through drafting, until the required fineness is achieved
  – To give strength to the fibre strand by inserting the required amount of twist, and
  – To wind up the resulting yarn into a package (cops) suitable for storage, transportation and the next processes
Ring Spinning
Operating Principle of Ring Spinning

Fig. 1
Typical Machine Specifications

• Draft : up to 40
• Type of roller drafting : 3-over-3
• Twist : 300 – 3500 tpm
• Spindle speed : up to 30,000 rpm
• Delivery speed : 30 m/min
• Spindle gauge : 70 - 75 cm
• Yarn count range : 5 tex – 100 tex
• Spindles/machine : 300 - 1488
• Production rate : 3 – 60 g/spindle hr
Process Descriptions

1. ROVING BOBBIN
2. ROVING STRAND
3. BOBBIN HOLDER
4. GUIDE RAIL
5. ROLLER DRAFTING ARRANGEMENT
6. FINE FIBRE STRAND
7. YARN GUIDE
8. SPINDLE
9. TRAVELLER
10. RING AND RING RAIL
• Roving bobbins are placed and secured on the bobbin creel on top of the spindle units.

• The strands are then guided through guides into the drafting arrangement.

• The input strand size is reduced by the drafting rollers, similar to the ones in the roving machines except that the draft is higher.
• After coming out from the front rollers, the yarn is subjected to some amount of tension before they are wound on the cop.

• Twist is therefore inserted to the yarn as it rotates around the cop guided by the traveler.

• The twisting is done by the spindle and the traveler
• The spindle, which carries the bobbin or cop, revolves at a fairly high speed (12,000rpm – 30,000 rpm) and carries the yarn end with it.

• The yarn, which is threaded through the traveler, will revolve at almost the same speed (lagging speed) as the spindle on the circular track of the ring.
RING

COP

TRAVELLER

*Ring and traveller.*
• The bobbin can only hold a limited length (weight) of yarn because the bobbin mass must be rotated as the twist is inserted. Doffing is therefore done very frequently by removing the full bobbin (doffing) and replacing it with an empty bobbin.

• In a process called winding, yarn from these bobbins will be rewound onto a larger package, and in the process, knots and yarn faults can be detected and removed to form a longer continuous yarn.
Spinning Triangle

• The fibres in the drafting zone is presented in a broad form. After exiting from the delivery roller, they have to be bundled together to form the yarn.

• Therefore, a triangle will be formed because the fibres have to be diverted inwards at the point of twist insertion to form the yarn.
Spinning Triangle

• Since there is no twist in this triangle, it is the weakest place along the yarn strand.

• Most of the end-breaks in spinning occur due to this triangle.

• 2 types of spinning triangle:
  – Short spinning triangle
  – Long spinning triangle

• Depends on twist level and inclination of drafting arrangement
COMMON PROBLEMS DURING THE RING SPINNING OPERATION
3 main problems in spinning operation:

• END-BREAKS

• FLY OR FLUFF LIBERATION

• ROLLER LAPPING
Factors for end-breaks during spinning:

- Long spinning triangle
- Yarn twist too low
- Yarn twist too high
- Worn out or burnt traveller
Factors for fly or fluff liberation during spinning

- Processing cotton fibre
- End-breaks – free ends results in fibre liberation
- Atmosphere too dry
- Worn out traveler and ring – higher frictional contact
Factors for roller lapping

• End-breaks – almost all lappings occur after an end-break
• Humidity too high
• Worn out rubber cots of soft rubber cots of top rollers – more surface contact
• Low pneumafil suction
• Fine fibres – fine fibres or thin fibres has more tendency to follow the roller profile
• Top roller pressure too high
AUTOMATION IN RING SPINNING

DEFINITION:

• OPERATIONAL TERMS
  AUTOMATION IS THE REPLACEMENT OF HUMAN ACTIVITY BY MECHANIZATION AND/OR ELECTRONIC CONTROL

• ECONOMIC TERMS
  AS A SUBSTITUTION CAPITAL FOR WAGE COSTS
AUTOMATION IS NECESSARY WHEN:

• THERE IS A GREAT DEAL OF MANUAL WORK

• THE MANUAL WORK IS ECONOMICALLY UNFAVOURABLE

• THERE IS A SHORTAGE OF PERSONNEL

• THE HUMAN OPERATOR REPRESENTS A SOURCE OF ERROR THAT MUST BE ELIMINATED
Some of the automation or features that have become available in modern ring spinning machines:

• Roving break detector

• Yarn break detector

• Fully automatic doffing
Some of the automation or features that have become available in modern ring spinning machines:

- A fully automatic link between the ring spinning and winding machine

- Transfer of autodoffed roving bobbins directly to ringframe creel area

- A facility to have a slower speed on the first few layers to reduce the incidence of end-breaks
MACHINE MONITORING

MONITORING CAN BE IN SCREEN DISPLAY AND/OR PRINT-OUT REPORTS

PURPOSES OF MONITORING:
• TO DETECT AND INDICATE ENDS DOWN
• TO DETECT AND DEALS WITH ENDS DOWN
• TO DETECT AND REGISTER ENDS DOWN
MACHINE MONITORING

• TO DETECT ENDS DOWN AND EVALUATE ACCORDING TO NUMBER, PERIOD FOR WHICH THREAD IS BROKEN, FAULTY SPINNING POSITIONS, ETC

• TO DETERMINE MACHINE DOWNTIME

• TO DETERMINE QUANTITY PRODUCED

• TO DETERMINE EFFICIENCY

• TO INITIATE ROVING STOP AFTER AN END BREAK
EXAMPLE OF DATA THAT CAN BE REPORTED ON THE
SCREEN DISPLAY OR PRINT-OUT REPORT:

• MACHINE NO.
• DATE, TIME
• SHIFT NO.
• PRODUCTION PERIOD
• SPINDLE SPEED
• YARN TWIST
• PRODUCTION OUTPUT PER HOUR

• PRODUCTION IN GRAMS PER SPINDLE HOUR
• EFFICIENCY
• DOWNTIME ON INDIVIDUAL SPINDLE
• DOFFTIMES
• NO. OF ENDS DOWN
• LENGTH/COP, ETC
DEVELOPMENTS IN RING SPINNING
• The spindle speed (has not changed much): from 20,000rpm in ITMA 1987 to around 30,000 in ITMA 1999.

• Spindles per machine: max. at 1488 spindles in ITMA 1999

• Ring diameters: 36mm – 58mm in ITMA 1999
• Machine automation

• Machine monitoring

• Compact spinning - Presenting the fibres in narrow form and providing an air-suction at the delivery roller so as to reduce the effect spinning triangle. This effect will increase the yarn quality: reduce end breaks, reduce yarn hairiness, decrease fly liberation, increase yarn strength, etc
• Ceramic ring and travelers- Increase traveler life and wear and high traveler speed

• ‘Super-traveller’ - Traveller rotating by a rolling effect rather than friction around the ring. Permits higher rotational speed and increase in traveler life, thus saving in production cost and time
Limitations and disadvantages of the Ring Spinning Machines:

- Limited traveler speed due to the generation of heat (around 40 m/s). This results in:
  - Limited delivery speed of around 30m/min
  - Limited spindle speed of below 30,000rpm
  - Limited production output of between 3-60g/spindle hour

- Generation of heat at the traveler and the ring has been measured as high as 649°C
Traveller limitation

• As the traveler travels around the ring flange, there is a frictional drag due to the frictional contact which causes wear at the areas where the ring and traveler are together.

• The frictional drag is necessary to induce enough tension in yarn to control:
  – Balloon diameter
  – Avoid balloon collapse, and
  – Produce a firm and stable package
Frictional drag occurs here.
Delivery Speed

• Delivery speed gives the amount (length) of yarn produced per unit time

• Delivery speed (m/min)
  \[ \text{Delivery speed} = \frac{\text{Spindle speed (rpm)}}{\text{Yarn twist (tpm)}} \]

• Delivery speed = Front roller surface speed

• Traveller speed (m/s)
  \[ \text{Traveller speed} = \text{Spindle speed (rpm)} \times \pi \times \text{X Ring dia. (mm)} \]
Draft

• Draft is the amount of attenuation or reduction in mass per unit length of a textile strand

1. Draft = ?

2. Draft = ?

3. Draft = ?
Limitations and disadvantages of the Ring Spinning Machines

• Difficulty in machine automation
• Labour intensive machinery
• Limited package mass in the form of cops
• High spinning production costs (about 60%)
• Prone to several problems in production such as end-breaks, fly liberation and roller lapping which limits the production output
Ring spun yarn structure

• Ring spun yarns are considered as ideal yarns in which all other yarns from new spinning systems are compared with.

• The advantage of Ring Spun Yarns lies in the yarn structure.
• The fibres in a ring spun yarn are intermingled throughout the yarn structure (fibre migration) and therefore have good locking together of fibres and inter-fibre frictional contact.

• The yarns also have better fibre extent giving straight and uniformly paralleled fibres.
• The better fibre extent results in high fibre length utilization and, consequently fibre strength utilization.
Major Spinning Machine Manufacturers

• Rieter Machine Works, Switzerland
• Zinser GMBH, Germany
• Howa Machinery, Ltd, Japan
• John D. Hollingsworth on Wheels, Inc, USA
• Fratelli Marzoli & C. Spa, Italy
• Toyota Automatic Loom Works, Ltd., Japan