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High Speed Spinning of Polyester and Its Blends with Viscose

A Practical Guide

S. Y. NANAL

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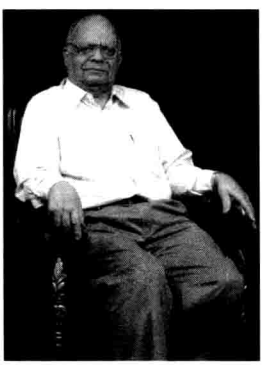
About the Author



Mr. Sharachchandra Yeshavant Nanal was born in Pune on 16th December 1932. His father, Y.M. Nanal, was the Principal of Maratha High School in Karachi. Therefore, Mr. S.Y. Nanal's schooling was in Karachi. After partition, the Nanal family shifted to Thane, near Mumbai. Mr. Nanal completed his B. Text, in First Class in 1955 from the Bombay University. He did his M. Text also from Bombay University in 1958. The subject of his Master's thesis was fibre friction.

His career has been in four areas in textiles: teaching and research, quality control and management in mills, technical services for polyester fibres, and consultation.

He spent first 11 years in the academic field as a Lecturer and Assistant Professor at the V.J. Technical Institute, and in BTRA (Bombay Textile Research Association).

The next 11 years saw him in textile mills. He worked as Head (Central Quality Control) in Mafatlal Group doing inter mill comparisons on technical subjects. Here, he developed a Point Rating System to quantify all fabric defects jointly with Mr. S. Maruthi. He presented a paper on this subject at the world's first international conference on Quality Control (ICQC 1969) in Tokyo in October 1969. Thereafter, he worked as a Mill Manager at Afprint Nigeria Ltd in Lagos, Nigeria.

The next 22 years were spent in Polyester Staple Fibre Industry as Technical Service Manager at Indian Organic Chemicals Ltd, Chennai; Swadeshi Polytex

Ltd at Ghaziabad; Reliance Industries Ltd, Mumbai and P.T. Polysindo Eka Perksa in Jakarta, Indonesia.

At the age of 67—in 1999—Mr. Nanal started to work as a free lance consultant in polyester fibre and blend spinning. He also marketed speciality polyester staple fibres from Saehan Industries Inc, Seoul, Korea. During these consultancies, he worked with Priyadarshini Spinning Mills to run their ring frames on 60s grey PV at 24 500 rpm and with Raymond Ltd, Chhindwara to run 33s and 50s fibre dyed PV at 22 000 rpm.

Mr. Nanal was awarded the fellowship of the Textile Institute, Manchester (FTI) in 1973; and in 1983, The Textile Association India honored him with an Honorary Fellowship of the Textile Association India. Mr. Nanal had written several technical articles and had presented numerous papers at conferences and seminars.

S.Y. Nanal died 17 days before the book release function and he couldn't see his book in print. He expired due to severe heart attack on 3rd December, 2008, just 13 days before his 76th birth day.

Foreword

India has always been known for its high productivity in spinning. When synthetic fibre spinning started a few decades back, the spindle speeds used to be low when compared with spindle speeds in cotton spinning. But the productivity of ring frames on synthetics was much higher than those of ring frames working on cotton on any count due to the lower twist multiplier used for synthetic spinning.

Of course, there were apprehensions that high spindle speeds could spoil the yarn quality. We cannot say that these fears were totally baseless. At the same time, just because the twist multiplier is low with synthetic spinning, it does not mean that these ring frames have to be run at low speeds.

When the ring frame is run at high spindle speed, there are certain factors which play an important role and help in determining the optimum speed. Machine condition, quality of spindles, rings and travelers; and breakage rate, increase in power consumption, etc are important factors. Of course, these factors vary from mill to mill and so whatever speed is achieved in one mill, may not be possible in other mills.

We at Priyadarshini believe in high speed spinning of polyester blends. So in the year 2000, we went in for 14 Lakshmi's LR 6 ring frames which are designed to run at a maximum spindle speed of 25 000 rpm. After we placed the order with LMW, I told my people that we are buying these high speed ring frames and I want them to be run as near to 25 000 rpm as is practically possible. I knew they had problems and I agreed with them to invite Mr. Nanal, the author of this book for help. I was happy when in 2001, all the 14 LR 6 ring frames ran at a maximum speed of 24 500 on 60s and

76s PV blends. I was really thrilled when Mr. Nanal told me that we were running these ring frames at the highest spindle speed in the whole world. And at that time—in 2001—most blend spinning mills could not imagine spindle speeds higher than 18000 rpm even in the wildest of their dreams.

We are convinced that high speed spinning of polyester blends is technically feasible and commercially viable. This will enable the managements of spinning mills to reduce the conversion cost to the lowest level and to be able to survive the worst market conditions—as they happen to be at present. The LR 6 ring frames are quite sturdy and we have had no breakdowns with them in the last 7 years, even when running them continuously at 24500 rpm. I compliment my people for running these ring frames at these super high speeds with steady working for the last 7 years. I am aware of the daily checks and observations they carry out religiously day in and day out. We are running not only the LR 6 ring frames at high speeds, we are also running Chinese and other local ring frames at 22000–23000 rpm. We have achieved high values of grammes per spindle shift. In 30s 100% polyester, we get 300 g/ss; in 40s PV we obtain 200 g/ss. We have established since several years a culture of high speed spinning in our mills.

The author of this book was associated with synthetic fibres and synthetic yarn spinning industry for several decades and had extensively toured many countries. He was quite conversant with the intricacies of synthetic fibre spinning. The author, with his long experience, had dealt with many issues in high speed spinning technology. I am quite sure that the information and the recommendations given in this book will help the synthetic yarn manufacturers in a big way to achieve the best productivity in their mills. This book will go a long way to make the synthetic spinning mills in our country more competitive in the international market. I wish that all the synthetic spinning mills in India take full advantage of this book.

C. K. Rao
Priyadarshini Spinning Mills,
Hyderabad
November 2008

Preface

Early in 2000 AD, the two major manufacturers of ring frames in India—viz. Lakshmi Machine Works and Kirloskar Toyota Textile Machinery Manufacturers Ltd—offered their latest ring frames—LR6 and RXI 240 respectively to the Indian spinning industry. Both these ring frames are designed to run at spindle speeds of 25 000 rpm.

It was in 2001, that I got involved with high speed spinning of polyester blends when I worked with the technical team of Priyadarshini Spinning Mills, Hyderabad to run their 14 Lakshmi's LR 6 ring frames at a maximum speed of 24 500 rpm. Since then, I have worked with other mills to speed up their LR 6 ring frames.

Since then, several spinning mills have installed these ring frames. But currently most of them run these ring frames at the speed of 16 000–18 000 rpm under utilising them. Spinners, who use these ring frames, have several fears—that at speeds above 18 000 rpm, the traveler temperature could reach 290 °C—well above the melting point of polyester which is 260 °C; and could lead to fusion of protruding fibres creating dark spots in fabric on dyeing; that hairiness will be so high that it will be difficult to weave these yarns especially on an air jet loom; and that power cost will go up too high which will make spinning uneconomic.

However, some of the adventurous spinners, whose number may be about 8 or 10, are running these ring frames at spindle speeds ranging from 20 500 to 24 500 rpm on both grey and dyed fibre spinning. They have found—to their relief—that the fears expressed by other spinners were not true. No fusing of fibres was found while hairiness increased only marginally. The

power cost did go up, but not as high as they feared. Making a success of high speed spinning involves several factors—right from selecting bales to be fed to the blow room to controlling U% and CV% of wrapping at finisher drawing, to ensuring almost zero breaks at roving. I have been personally involved in helping a few mills to run their ring frames at 22000–24500 rpm and so have built up a knowledge base on how to go about making a success of high speed spinning. This practical knowledge has a strong theoretical basis, Hence it can be applied successfully under varying industrial conditions. Therefore, I felt the urge to write this book as a practical guide to the spinners, not only of polyester viscose blends, but also of other fibres at the mechanically designed maximum spindle speed at ring frames.

This book includes four live case studies of spinning mills in India (Chapter 7) that are running their ring frames successfully on both grey and dyed fibre spinning at speeds varying from 20500 rpm to 24500 rpm. The book concludes by saluting the pioneers (Chapter 8) of 'High Speed Spinning of Polyester Blends', who had vision and took great risks to run their ring frames at real high speeds.

Since high speed spinning of polyester blends (Chapter1) is mostly an Indian phenomenon (Chapter 2), it is apposite that this book is written by an Indian and is produced in India. However, it charts out a path that a spinning mill any where in the world could take to run their ring frames at super high speeds. Right from blowroom till winding, one needs to ensure quality in such a way that at high ring frame speeds, end breaks at ring frame, vital yarn properties, and winding cuts remain more or less at the same level (Chapters 3 and 4) as obtained at slower ring frame speeds. The book examines economics of high-speed spinning (Chapter 5) and ends up predicting the future of high speed spinning technology (Chapter 6). The book would prove eminently useful to spinning mills, which buy modern high-speed ring frames, to run them successfully at speeds 20 500–24 500 rpm depending upon the count spun. By doing so, the spinning mill will ensure that their conversion cost is lowered substantially and the 'bottom line' is improved considerably.

It must be clarified here that this book could also be useful to all those mills that run their ring frames at speeds lower than the designed highest mechanical spindle speed, irrespective of the fibre material they process. To give an example: a spinning mill with Laksmi's G 5/1 ring frames runs them at say 16000 rpm for a PC blend or for 100% cotton in the range of 30–40s. This machine is designed to run at a maximum speed of 20000 rpm. If this spinning mill wants to speed up their G 5/1 frame to 20000 rpm, it will find ways to do so in this book. Of course, the norms of quality given in this book, which apply only to polyester and its blends with viscose, would need to be adapted to the material being processed. In fact, the financial returns from high speed spinning are so high that it is worth replacing the spindles,

rings and the drive motors by high speed versions to raise the mechanically achievable upper limit of spindle speed. (Appendix 1)

The ideas given in this book can definitely be applied to high speed spinning of other fibre/blends such as polyester/cotton, viscose, cotton and others.

This book should prove eminently useful to:

- The top management of spinning mills who should compare the highest spindle speed at their ring frames with those employed by high speed spinners, look closely at the economics given and then check if their ring frames can be speeded up so as to increase substantially their mill's profits. Also if the mill does not posses high speed ring frames, then top management should take inspiration from RSWM Ltd. which runs their Lakshmi's G 5/1 ring frames at 22000 rpm against the designed speed of 20000 rpm in a very cost effective way as given in Chapter 7, and supported in Appendix 1.
- Senior spinning technologists can check if they can speed up their ring frames and make a success of high speed spinning as suggested in this book, so as to add to their unit's profits.
- Quality control heads who would need to help the production personnel in taking trials to finally reach the goal of high speed spinning
- Maintenance personnel will know what mechanical conditions of the machines are expected to make a success of high speed spinning and could plan their activities accordingly.
- Teachers in textile institutes would find this book useful to explain to their students the inter relations of various actions starting from fibre properties to breakage rates in ring spinning and winding. The way in which knowledge gained as different subjects gets used in controlling the processes will become clear to the students. A good study of the ides in this book will prepare them to become better technicians when they join the industry.

I hope that my efforts of putting the ideas used in consultation in a book form become fruitful, and all these groups use this book on a large scale and benefit from it.

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9th October 2008
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S. Y. Nanal

Contents

1

Concept of High Speed Spinning of Polyester Blends

The highest spindle speed at which a modern ring frame can work is 25 000 rpm. This high value of the mechanical limit to spindle speed was achieved by machinery makers about 15 years ago; and several manufacturers have delivered such machines in several countries including India. The limiting cause for this stagnation in the highest achievable speed could be that the ring/traveler friction becomes excessive at higher speeds, or the ring frame tenter finds it extremely difficult to manage a satisfactory piecing. Several other factors which, a mill technologist would not be expected to know or to understand, may also be responsible for this upper limit not increasing continuously over the years. But is this upper limit really restricting the Indian spinners at present in their efforts to increase productivity to the maximum? Not really.

Is high speed spinning of polyester blends practicable?

Many spinners have expressed several fears for running ring frames at higher than 18 000 rpm. Important among them are as follows:

(a) Possible fusing of protruding ends of the polyester staple fibre (PSF) due to coming in contact with traveler. The temperature at the traveler can go as high as 290 °C at very high spindle speeds, and the melting point of polyester is 260 °C. So, the protruding ends would fuse. On

dyeing the fabric, the fused portions will take deeper colour leading to several dark spots in the fabric.

(b) The speed of yarn delivery from the front rollers would become so high that good piecing of ends after a break would become difficult; and the proportions of bad piecings will become too high for good working of the yarn in further processes like winding and weaving.

(c) The other worry is about the end breakage rate increasing steeply. At high levels of end breaks, the tenter would not be able to manage the higher workload and the frames under his care would get 'jammed' i.e. too many un-pieced ends leading to roller lapping and increase in suction clearer waste and consequent loss in productivity.

(d) Yarn hairiness would increase so much that weaving, particularly on air jet looms, would then be uneconomical due to very poor running efficiency of the looms.

(e) The traveler life would become as short as a few hours; apart from the increased costs, very frequent traveler changes would increase workload and would reduce the machine running time substantially.

(f) And finally, the power cost would go so high that spinning as a commercial operation would become uneconomic.

The combined effect of all these fears has been that no one wants to try out high speed spinning of polyester blends. But, are these fears real? Are they supported by technological logic or experiments?

Before we answer this question, we need to define 'high speed'. The Indian textile mills have grown gradually in the use of polyester fibres over the years starting from early 1960s, and the speeds have been gradually increasing from about 10 000–18 000 rpm by 2000 AD. Any number above which the spindle speed (in revolutions per minute) is to be considered as 'high speed' would, of necessity, be an arbitrary number. However, knowing that the maximum permissible speed is 25 000 rpm, that the spindle speed is kept somewhat lower at the beginning of a doff than at the middle of the doff, and that most mills in India run their frames at not more than 18 000 rpm as the maximum speed during the doff. We can consider any spindle speed above 20 000 rpm used for regular yarn production on ring frames as high speed.

Only when the maximum speed of a ring frame spinning polyester blended yarns is 20 000 rpm and above, only then should that spinning operation be termed as "*High Speed Spinning of Polyester Blends*". The average speed over the doff could be lower than 20 000 rpm in some cases of high speed spinning.

Fortunately, India manufactures two models of modern ring frames—LR6 made by Lakshmi Machine Works and RXI 240 produced by Kirloskar Toyota Textile Machinery Manufacturers Limited. Both these frames are