EXECUTIVE SUMMARY

0.1 INTRODUCTION

0.1.1 The process of post-twisting of staple-fibre yarns or of continuous filament yarns, sometimes, is necessary as the existing simpler yarns may not satisfy the requirements of many different end use applications.

0.1.2 Traditionally, ring twisters were used for ply-twisting spun yarns and up twisters were used for twisting filament yarns. Now-a-days, two-for-one twisters are gaining worldwide acceptance in both the sectors mainly because of their inherent advantages like (a) production of long lengths of knotfree yarn which facilitates better performance in subsequent processes, (b) higher productivity per spindle, sometimes more than double as compared to traditional twisters, (c) reduction in the number of pre and post-twisting operations, and (d) low manpower requirements. However, it has some limitations like high capital cost and high energy requirements.

0.1.3 The concepts of TFO twisting were first mentioned in a British patent in 1855. The practical exploitation came much later, in 1935, for filament yarns and in 1950, for spun yarns mainly because there was no pressure from the market to abandon proven technology. In India the TFO entered the spun yarn industry during 1970s.

0.1.4 At present, TFO are available to satisfy various application requirements, with speeds upto 15,000 rpm for spun yarns and 18,000 rpm for filament yarns and with simplified operations, handling aids, partial automation, integrated subsequent operations like waxing, singeing etc.

0.2 STRUCTURE AND STATUS OF INDIAN INDUSTRY

0.2.1 There are 12 TFO manufacturing units in India, 4 for spun yarns and 8 for filament yarns, out of which 4 units, 1 for spun yarn and 3 for filament yarns have technical collaborations and 2 units, one each for spun and filament yarns receive technical assistance from foreign manufacturers while the remaining 6 have developed and incorporated indigenous technology.

0.2.2 The total licensed capacity, installed capacity as on March, 91 and production in the year 1990-91 were 273+, 448, and 300 machines respectively for spun yarns and 890+, 570+, and 70+ machines respectively for filament yarn. (+sign indicates that the actual number is more than the mentioned value and this is because the data of some units are not available for reasons such as licence not required, installed capacity provided for a range of machineries, data not provided etc.)

0.2.3 The overall capacity utilization is about 67% for spun yarn TFO manufacturing units and less than 20% for filament yarn TFO manufacturing units.

0.2.4 The details of individual units for the year 1990-91 are given in the following table. Information on production for the year 1991-92 for five TFO manufacturers are given in an Annexure - VI.

A. FOR SPUN YARNS

S. No.	Name of the Unit	Source of Technology	No. of machines per annum (1990-91)			Capacity Utilisation %
			Capacity (Number)		Actual Production (Number)	
			Licensed	Installed		
1.	Prerna Textile Industries Pvt. Ltd. Daman	Technical assistance from Leewha Industries Co. Ltd. R. of Korea	93	96	45	47
2.	Star-Volkmann Ltd. Dharwad	Collaboration with Volkmann GmbH Germany	180	100	96	96
3.	United Machinery Works (P) Ltd., Coimbatore	Indigenous	NA	12	5	42
4.	Veejay Lakshmi Engg. works (P) Ltd., Coimbatore	Indigenous	NA	240	154	64
	Total		**273+**	**448**	**300**	**67**

B. FOR FILAMENT YARNS

S. No.	Name of the Unit	Source of Technology	No. of machines per annum (1990-91)			Capacity Utilisation %
			Capacity (Number)		Actual Production (Number)	
			Licensed	Installed		
1.	Ceepeem Engg. Co. (P) Ltd., Surat	Indigenous	NA	120	11	9
2.	Garden Engg., Surat	Collaboration with Tsudokoma corporation, Japan	180	80	8	10
3.	Himson Textile Engg. Industries Ltd., Surat	Indigenous	180	180	3	2
4.	Krislon Engg. Industries (P) Ltd., Pune	Indigenous	NA	NA	7	NA
5.	Kosheto Engg. (P) Ltd., Bombay	Indigenous	10	10	NA	NA
6.	Lohia Machinery Manufacturers Ltd., Kanpur	Collaboration with ICBT International France	400	120	31	26
7.	Marchon Textile Industries Pvt. Ltd., Bombay	Technical assistance from Davide Giudici and Figli S.n.C., Italy	NA	NA	3	NA
8.	Peass Industrial Engineers Pvt. Ltd., Navsari	Collaboration with RPR Officine Meccaniche Riva S.R.L., Italy	120	60	7	12
	Total		**890+**	**570+**	**70+**	**NA**

0.2.5 Most of the manufacturing units are equipped with conventional machines. Some units which have sophisticated machineries like CNC machines, Jig borig machine etc., use them mainly for their other activities as their scale of operations in TFO manufacturing are very low.

0.2.6 The manufacturing activities of most of the plants consist of assembling of components. Most of the components are procured from local vendors and/or imported and only a few are manufactured within the plant. The break-up of value of various components in a machine as percentage of the sales value of the machine of different manufacturers are given in the following table :

<table>
<tr><th>Unit</th><th>Components manufactured within plant Value addition, Miscellaneous</th><th>Components Procured from Ancillary Units</th><th>Imported Components</th></tr>
<tr><td>Prerna</td><td>40</td><td>25</td><td>35</td></tr>
<tr><td>SVL</td><td>43-49</td><td>18-22</td><td>28-35</td></tr>
<tr><td>UMW</td><td>55</td><td>45</td><td>NIL</td></tr>
<tr><td>VJL</td><td>80</td><td colspan="2">20</td></tr>
<tr><td>Garden</td><td>26</td><td>40</td><td>34</td></tr>
<tr><td>Himson</td><td>35</td><td>40</td><td>25</td></tr>
<tr><td>Kosheto</td><td>60</td><td>40</td><td>NIL</td></tr>
<tr><td>Krislon</td><td colspan="2">71</td><td>29</td></tr>
<tr><td>Lohia</td><td colspan="2">65-72</td><td>28-35</td></tr>
<tr><td>Marchon</td><td>20</td><td>40</td><td>40</td></tr>
<tr><td>Peass</td><td>31</td><td>36</td><td>33</td></tr>
</table>

Information on break-up of machine cost as on 31st March, 1992 are available five TFO manufacturers and are given in the Annexure - VI.

0.2.7 The major imported items are spindle assembly/spindle assembly sub-components like spindle, spindle inserts, tension capsules, protection pot; ceramic guides, some bearings, spindle driving belt, traverse cam, etc. Spindle assembly is a crucial component from the view point of machine performance and also the cost of the machine. At present about 35 to 40% of the machine cost is attributed to the spindle assembly. However efforts are being made by the industry to develop and commercialised the spindle.

0.2.8 Some of the indigenously procured components are spindle and spindle inserts, protection pot, balloon limiter, balloon guide eyelet, yarn sensors, traverse guide, winding drum, cradle, ceramic components, plastic components, gears, bearings, belts, motors, etc.

0.2.9 The major raw-materials are aluminium casting, cast iron, steel alloys, plastics, ceramics, bakelite etc.

0.2.10 The major manufacturing problems faced by the manufacturers are the lack of smooth supply of raw materials, inferior raw material quality, etc. Some of these problems are related to the small scale operations.

0.2.11 Performance of the Industry

For spun yarn twisting, there has been a steady growth in demand for TFO in the last three years. The total number of installed TFO is estimated to be about 1,20,000 spindles. The financial year 1990-91 itself accounted for 284 machines i.e. about 34,000 spindles.

For filament yarn twisting, the market acceptance is not encouraging and the sales in 1990-91 and 1991-92 is stagnant at about 80 machines per year i.e. about 20,000 spindles per year. The estimated number of spindles already working in the industry are about 1,30,000.

0.2.12 TFO manufactured indigenously are exported, albeit in very few numbers, to developing countries like Indonesia, Philippines, Malaysia, Nepal, Nigeria, Kenya, etc. So far, about 9 machines for filament yarns and 50 machines for spun yarns have been exported. Information on number of TFO machines exported in the period April, 1991 to March, 1992 by five TFO manufacturers is given in the Annexure - VI.

0.2.13 The estimated annual demand for the next 5 years in the domestic market is about 33,700 spindles (about 280 machines) for spun yarns and about 16,750 spindles (about 80 machines) for the filament yarn. The growth in demand may fall down after this as the market for substituting existing ring twisters/uptwisters will diminish and the demand will be mainly restricted to additional doubling requirements created by normal growth in the industry. However, possibilities of exporting the machines is to be considered.

0.2.14 Interaction with User Industry

The mills using TFO are spread all over India. The spinning mills, mainly the synthetic (Polyester, Polyester-Viscose blends) spinning mills, have readily accepted the technology. However the composite mills, majority of which are concentrated in Ahmedabad and Bombay, have been slow in switching over to TFO from conventional ring doublers. The filament yarn twisting units using TFO are concentrated in the western region (near Surat and Bombay). However, switching over from uptwisters to TFO is very slow.

The users opinion regarding the quality of the end product, the performance of the machine, simplicity in operation and maintenance, etc., in most of the cases, are favourable to this technology.

Most of the users (spun yarns) preferred TFO for coarse and medium count ranges in preference to ring doublers in case of expansion of doubling capacity. However, they are dissatisfied about the high capital cost and high energy requirements of TFO.

0.3 R & D EFFORTS, TECHNOLOGY ABSORPTION AND GAPS

0.3.1 Testing Facilities

Most of the manufacturers have in-house testing facilities. The facilities available are limited to simple measuring instruments like gauges, callipers, hardness testers, stroboscope, balancing machine etc. Sophisticated equipments like CAD, vibration analyser, metallurgical testing instruments, thickness/uniformity of surface coating testing instruments etc. are very rarely used.

Some of these sophisticated testing facilities are available with few governmental and few non-governmental laboratories, spread all over the country. There are no well equipped central testing laboratories in proximity to and serving mainly the textile machinery manufacturers.

0.3.2 Thrust Areas

The thrust areas, as identified by the individual manufacturers differ depending on their requirements. In general, the major thrust areas of R & D activities are :

- Development of indigenous technology of Two-For-One twisting.
- Modification of the design to suit the Indian environment.
- Indigenisation of components i.e. import substitution.
- Minimization of cost by value engineering analysis.
- Quality control.
- Development of ancillary units.
- Studies on energy requirements and energy saving.

0.3.3 Achievements

There are already six manufacturers who have developed TFO without any technical assistance or collaboration with foreign manufacturers.

Technology absorption efforts made by the manufacturers has led to indigenisation of most of the components. The noticeable achievements are as follows :

Spindle assembly consists of many subcomponents like spindles, spindle inserts, tension capsules, protection pots etc. Most of the manufacturers have indigenised some parts e.g. protection pots. Also few manufacturers have developed indigenous spindles and spindle inserts, which consequently has brought down their machine costs considerably. However these indigenous spindles are reported to be lacking in some aspects like smooth running at high speeds, and to be giving greater wear and tear.

One reputed spindle manufacturer has recently developed one type of spindle suitable for filament yarn TFO. However this spindle can only be used on limited models of TFO.

Also, the same manufacturer has developed reserve disc and deflector plate suitable for one model of spun yarn TFO of a leading manufacturer and the same is supplied to the users as replacement alternative.

- Some ancillary units are doing plasma coating on some vital components of spindle assembly which come in contact with running yarn.

- Ceramic components are indigenously available but the quality, as felt by users, is not satisfactory.

- With sufficient power consumption studies, some manufacturers are able to guide the customers in selecting right kind of machinery/motor horse power for optimum power consumption.

0.3.4 Technology Gaps

Based on the information given by the international suppliers during this study and on literature survey, there are no technological gaps as far as product ranges and speeds of production are concerned. However, some gaps like ease in operations, automation, etc. exist in the indigenously manufactured machines. Some of these developments like bobbin conveyers, use of robots etc. are not required considering the present local conditions in India. Some developments like pneumatic threading, package conveyer belts on some models meant for coarse yarn twisting etc., which ease the work of the TFO operator are not provided on Indian machines.

0.3.5 R & D Efforts in National Laboratories/Institutions

There are many research associations and institutions in India devoted to the development of textile industry. Some of these are ATIRA, BTRA, NITRA, SITRA, MANTRA, IIT DELHI etc. The role of these organisation in the development of user industries is commendable but, is very limited in the field of textile machinery manufacturing. In the field of TFO manufacturing industry SITRA had active collaboration with Veejay Lakshmi Engineering Works in the development of indigenous TFO in the initial years of manufacturing. However, ATIRA has built up expertise in design and development of textile machines. Some examples are : multiphase loom, high speed loom. etc. ATIRA's developments viz. yarn length measuring device, twist indicators, etc. can be adapted to TFO. Also ATIRA has undertaken some studies on spindle-to-spindle twist variation in TFO twisted yarns.

0.4 CONCLUSIONS

0.4.1 Two-for-one twisting is well proven and accepted technology worldwide because of its advantages like production of long lengths of knot-free yarn. higher productivity, low man-power requirements etc. as compared to the conventional systems of twisters. It has certain limitations like high energy requirements and high capital costs.

0.4.2 The range of TFO manufactured indigenously (in many cases with some imported components) is wide enough to meet the various requirements of both spun and filament yarn sectors.

0.4.3 The total installed capacity of TFO for filament yarns is about 620 machines per annum and for spun yarns is 448 machines per annum as on March 1991 and the production has been 70 + (70 plus means because data of some units are not available) and 300 machines respectively. The capacity utilization hence, is less than 20% for filament yarns and about 67% for spun yarn in 1990-91.

0.4.4 The number of manufacturers supplying TFO for filament yarns and for spun yarns are 8 and 4 respectively. Out of these 4 manufacturers of TFO for filament yarn and 2 manufacturers for spun yarns have foreign technical collaboration.

0.4.5 The total number of machines sold during 1990-91 was 70 + and 284 for filament and spun yarn twisting respectively as against 84+ and

246 + in the previous year (+ indicates that the actual number is more than the mentioned number).

0.4.6 TFO, manufactured indigenously are exported to developing countries like Indonesia, Malaysia, Nigeria, Kenya etc. in a limited number. So far about 9 TFO for the filament yarn twisting and about 50 TFO for spun yarn twisting have been sold in the international market.

0.4.7 The overall scenario for the TFO, specially with respect to filament yarn twisting is not encouraging, including the growth in demand for the machine because of the high cost of machinery, due to imported components, high energy requirements and no special preference of users for TFO twisted yarn except for those to the exported.

0.4.8 The estimated demand for TFO for the next five years is about 33,700 spindles (280 machines) per annum for spun yarns and about 16,750 spindles (80 machines) per annum for filament yarns.

0.4.9 The techno-economics of twisting using TFO twister as compared to Ringdoublers indicate unfavourable cost of production for TFO twisters. The incremmental cost of production including interest and depreciation on machinery ranges from Rs. 0.36 to Rs. 7.56 per kg of production, depending on the type of machinery, count and speeds. However, the inherent advantage of knotfree yarn and in some cases, premium on TFO twisted yarn partially offsets the higher cost of twisting.

0.4.10 The manufacturers are not equipped with sophisticated manufacturing set-up and testing equipments. The small scale operations also impedes providing/using these facilities.

0.4.11 The manufacturing activities of most of the suppliers are limited mainly to assembling of components. Most of the components are procured from local vendors or are imported. The two, together constitute about 60 to 70% of the value of the machine in many instances.

0.4.12 Most of TFO manufacturers develop many of their required components by providing specifications to ancilliary units and taking a follow up on manufacturing/quality control. These ancilliary units are normally small setups. Considerable efforts have been made be TFO manufacturers to develop their vendors.

0.4.13 The major import items are spindle & spindle inserts and complete spindle assembly, driving, belts, certain bearings, ceramic guides etc. Spindle assembly is a major cost item, which by itself constitutes 35 to 40% of the value of the machine.

0.4.14 The major problems with respect to production faced by the manufacturers are the lack of smooth supply of raw materials like alloys, steels, metal sheets, etc. This may be due to their meagre requirements because of small scale operations. Inferior raw material quality, in some cases, is another problem.

0.4.15 Technology absorption efforts are made by most of the manufacturers. This has led to indigenisation of most of the components. The noticeable developments are as follows :

(a) Spindle Assembly

Spindle assembly consists of many subcomponents like spindle inserts, tension capsules, protection pot etc. A few manufacturers are indigenously producing spindles and spindle inserts, which consequently has brought down their machine cost considerably. However these indigenous spindles are lacking in some aspects like smooth running at high speeds and as felt by users, high wear and tear.

One reputed spindle manufacturer has recently developed one type of spindle suitable for filament yarn TFO twister. However, this can only be used on limited models of TFO.

Protection pots in most of the cases are manufactured indigenously.

Tension capsules in many cases are imported.

(b) Ceramics

Ceramic components are now supplied by some Indian manufacturers. But, most of the TFO manufacturers felt that the quality is not at par with those imported.

0.4.16 Based on the information given by the international suppliers during this study and literature survey, there are no technological gaps as far as product ranges and speeds are concerned. However, some technological gaps like ease in operations, automation etc. exist in indigenously manufactured machines. Some of these developments like bobbin conveyers, use of robots etc, are not required considering the present local conditions. Some developments like pneumatic threading, package conveyer belts on some models meant for coarse yarn twisting, which aid the operator are not provided on Indian machines.

0.4.17 R & D activities, in many cases, are limited and confined to standardisation of parts, reducing failure rates and material substitution. With the exception of few manufacturers, R & D is not carried out for energy conservation, noise control, etc.

0.4.18 R & D activities are pursued independently and minor help is taken from outside agencies like research associations, spindle manufacturers, users etc.

0.4.19 Apart from the successful design of a prototype of TFO twister by the South India Textile Research Association (SITRA) in the late 70s, there have been no major contributions from the Indian textile research institutes in further development of this technology.

0.5 RECOMMENDATIONS

0.5.1 Efforts to develop low cost, high precision, energy efficient TFO spindle should be made.

One of the spindle manufacturers has developed one type of TFO spindle for filament yarn, but these efforts are to be given sufficient boost for perfection of technology as well as to manufacture TFO spindles of other types.

0.5.2 Indigenisation efforts for manufacturing spindle driving belts, ceramic guides, and certain bearings should be encouraged by providing sufficient assistance to or linkages with appropriate agencies.

0.5.3 A system should be developed to ensure continuous supply of special quality raw materials of desired specifications and quantity to TFO twister manufacturers. As most of the manufacturers are in the small scale sector, requiring only small quantities, channalisation or raw-material purchases through a central trading agency or through association of manufacturers will help in this regard.

0.5.4 Looking to the existing status of TFO manufacturers, it is desirable to set up a laboratory with sophisticated testing facilities such as vibration monitoring device, dynamic balancing unit, surface roughness tester, coating thickness tester, facilities for metallurgical analysis, plasma coating etc. at an appropriate location. Since, all small manufacturers (except UMW) having installed capacity of less than 100 are located in and around Bombay, Surat and Vadodara, Western India will be the appropriate choice for the Central Laboratory. Also, as several textile research associations/laboratories are located in Western India, any one association having infrastructure facilities can be developed further to cater to the textile machinery manufacturers. This can help TFO manufacturers and other textile machinery manufacturers in continuously upgrading their machines as well as in developing machine design where industry can produce small and medium size yarn packages, whose market is high in India and in few developing countries.

It may be noted that for many years. ATIRA is having a laboratory to test the accessories and machinery components of Spinnings and Weaving machinery. User mills and machinery/component manufacturers are utilising these facilities, regularly. Further development and augmentation of these facilities will help in extending the services of machinery manufacturers in a better way.

0.5.5 After carefully analysing cost benefit ratio the TFO manufacturers should be encouraged to use sophisticated manufacturing equipments like Computerised Numerically Controlled (CNC) machines suitably aided by CAD facilities. Also, retrofitting to CNC equipments should be encouraged. However, this should be implemented at a stage when these units have sufficient market demand for TFO machines. Linkages with Central Machine Tools Institute (CMTI), Bangalore can help.

0.5.6 Since TFO comprises of thousands of different types of parts which again vary slightly from manufacturer to manufacturer, standardisation of components and accessories wherever possible should be emphasized. One of the major components where urgent thrust should be given is the spindle assembly. Such standardisation will help ancilliary units to reach economies of scales of operation and thereby reduce its cost.

0.5.7 TFO twister manufacturers should undertake R & D programmes for reduction of power consumption, noise level, simple and useful add-on instrumentation, etc. Joint efforts by machinery manufacturers and national laboratories supported by the user industry and the government can be thought of.

0.5.8 A major gap between TFO manufactured by Indian and foreign companies is in the area of degree of automation. Though much automation may not be helpful in the Indian market, encouragement should be given to develop selected attachments which is desirable for boosting exports. Also development of some of the handling aids will prove useful for Indian market.

0.5.9 Efforts should be made on two fronts to increase the demand for the TFO. One is to increase the demand of TFO twisted yarns in domestic market as well as increasing plied yarn exports, while the other is to boost export of TFO to developing countries in Asia and Africa, with necessary quality improvement, automation, etc.