CHAPTER 14

SUMMARY AND CONCLUSION

Weft-knitted fabrics find application in outerwear field, and single and double jersey fabric are typical and useful examples of this class. During the past 27 years, say from 1970, objective evaluation of these fabrics was carried out by many research workers utilising their own equipment and many useful contributions on their mechanical properties have been made. No less important are their dimensional properties, and in this area, many notable contributions have also been made. These studies, doubtless, have improved our understanding of the potential of these fabrics. An excellent study has been reported on the dimensional properties of interlock fabrics made from cotton, and the results of this study have been found to be valuable to the consumers. It is an undeniable fact that all these studies were directed ultimately to find out their suitability for garment production. It is also noticed from literature that a great deal of studies on the mechanical properties of woven fabrics have been made, and these were subsequently extended to weft-knitted fabrics.

With the advent of the Kawabata Evaluation System, which was developed earlier for woven fabrics, it will be interesting to investigate the mechanical properties of weft-knitted fabrics with some suitable modifications. It should be pointed out that Kawabata Evaluation System, besides giving total hand and appearance values, can also be used for measuring the mechanical properties. Hence, in this study, an attempt has been made to unearth some of the peculiarities existing in single and double jersey fabrics. Spirality of weft-knitted fabrics has been investigated from
1934 onwards, and during the past 63 years, a considerable body of knowledge has been developed.

There have been many previous studies concerning spirality of weft-knitted fabrics. There are excellent reviews available which provide fairly complete bibliographies of the field. The indications obtained from this study were that the structural variables of greatest importance to fabric spirality included type of yarn, namely ring, rotor or air jet, blend composition, twist, direction of twist and yarn treatment. The importance of yarn relaxation, both in its modification to yarn structure and its effect on the spirality was emphasized. A detailed inspection of the literature concerning these special subjects revealed only a partial understanding.

Still, a survey of literature on this subject has shown the absence of certain aspects such as carded and combed yarns, yarn treatment in a different manner, and use of combinations of ring and rotor spun yarns on fabric spirality. Thus new data on this subject have been provided to develop an understanding of the role of fibre and yarn types on this important area.

Handle and bagginess of knitted fabrics have been measured by simple and reproducible techniques and thus constitute highlights of the study. Assessment of commercial interlock fabrics has been made in the light of some current work done in this area, and the results provide prima facie evidence of their usefulness to the designers, consumers and producers. Neural network has been used for the prediction of the mechanical properties of a series of weft-knitted fabrics, motivated by the application and potential of this technique in many areas.

In view of the rather scanty data available on areas such as bagginess and pad batch method of dyeing, an attempt was made to
establish the later work on a sound experimental platform by carrying out detailed studies.

Pad batch method was traditionally popular for dyeing of woven fabrics using reactive dyes, and in this study an attempt has been made to accomplish this method for dyeing of knitted fabrics. The effects of pretreatment on the dyeing of knitted fabrics have been examined.

The major conclusions from this study are summarized below in point form.

1. Fine count Rotor spun yarns produced from cotton, polyester cotton blend and polyester show poor performance in strength but are more even and contain less imperfections than those of ring spun yarns.

2. Carded cotton yarns show inferior performance compared to combed cotton yarns.

3. Spirality in weft-knitted fabrics produced from SS/Z combinations of feed, treated yarn and a combination of ring and rotor cotton yarn has been found to be low.

4. There appears to be an improvement in spirality of fabric produced from combed cotton yarns compared to carded cotton yarns.

5. Most of the mechanical properties of the fabrics produced from different directions of yarn twist and feeding arrangements are found to be similar. There is no evidence to show that the direction of yarn twist has any pronounced effect.
6. In the case of knitted fabrics produced with different tightness factors, it is noticed that the extensibility of plain knitted fabrics is related to its tightness of construction (or tightness factor), the tighter the fabric, the less extensible it will be.

7. Bending parameters, namely, bending rigidity and hysteresis show an increase with increase in tightness factor, due to lack of freedom of movement.

8. Shear rigidity and hysteresis increase with increase in tightness factor; this result may be explained by the restriction on yarn movement in fabrics.

9. Course way extensibility decreases with an increase in tightness factor.

10. There is not much difference in the mechanical properties of knitted fabrics dyed with two different types of dyes.

11. Dyeing of fabrics did not affect their extensibility.

12. Fabrics made from carded yarns were more extensible than those made from combed yarns.

13. Weight of a plain knitted fabric is related to its tightness of construction (or Tightness factor)-the tighter the fabric, the heavier it will be.

14. Type of dye used does not have any effect on fabric weight.

15. Extensibility of fabric in course (width) direction is about double the extensibility in the wale (length direction).
16. **Extension** - load characteristic of fabric in the course (width) direction is almost linear.

17. Since measurement of bending rigidity by cantilever bending test, shear by bias extension and elongation values from Instron tensile tester constitute simple methods of testing, and since they are correlated to the mechanical properties measured by Kawabata Evaluations System, their usefulness in assessment of fabrics is obvious.

18. A very good correlation exists between the elongation determined by KESF (Kawabata Evaluation System) and Instron tensile tester. Also, the elongation values obtained in bias direction for a series of weft-knitted fabrics show that they lie inbetween wale and course-way values. Also, unlike woven fabrics, extension values in bias direction are the least.

19. Knitted fabric produced from carded yarn displays a better handle when compared to the one produced from combed yarns.

20. Surface roughness of single jersey fabrics shows that the course way values are significantly higher than those in wale-way.

21. The ratio of course way extensibility to wale-way values for double jersey is of a high magnitude compared to single jersey fabrics.

22. Surface roughness of a series of double jersey fabrics shows that in course-way the values are about six times greater than those in wale-way. These differences can aid in discriminating double jersey fabrics from single jersey fabrics.
23. RT (tensile resilience) shows a significantly higher value for double jersey fabrics produced from cotton and Lycra.

24. Fabric weight and thickness have a pronounced effect on bending and shear rigidities.

25. Surface layer thickness values for weft knitted fabrics vary between 0.381 mm to 0.568 mm. There appears to be no correlation between surface layer thickness and total hand value.

26. Percent compression values of the fabrics and compression resilience show no relationship. RC values show somewhat higher values in respect of fabrics knitted from cotton and Lycra.

27. Technical face side of the fabrics shows a higher value of handle force compared to the technical back side.

28. Most of the mechanical properties determined by KES and simple instruments are correlated to the specific handle force.

29. Bagginess values of fabrics containing Lycra are low.

30. Tensile properties, which are obtained from bagginess tester, are more accurate in view of the fact that a single parameter is provided.

31. Values of RT and WT determined from the bagginess tester are well correlated to the values determined by Kawabata System.

32. Values of WT (tensile energy) show a progressive increase with increase in the specimen diameter.
33. It is possible to assess the dimensional properties and weight per unit area of interlock fabrics before manufacturing them.

34. Fabric samples knitted from different direction of yarn twist and different combinations of feed display much better WD values as their proximity to the standard value is good.

35. Use of carded yarn in the fabric has led to a better WD value than the combed yarn knitted fabric.

It is possible to predict the mechanical properties by an artificial-neural net model with much less error.

Pretreatment of knitted fabrics with alkali at room temperature and subsequent dyeing by pad-batch method has resulted in a higher dye uptake.

14.1 PRACTICAL IMPLICATIONS

This work has concentrated on many areas such as spirality, handle, bagginess, prediction of mechanical properties by neural network, assessment of commercial interlock fabrics and dyeing by pad batch method. Each one of these has commercial relevance and the findings of the present study can be applied to advantage to many areas in knitting sector. The results can be profitably used for reducing spirality which will aid in a reduction in rejects during garment making.

The work on the use of different twist direction and combinations of employing them will be of immediate interest to fabric producers, as SS/Z combination has resulted in a marked decrease in spirality. Knitted fabric manufacturers and garment makers particularly for exports can apply these techniques.
The new method for permanently reducing or eliminating spirality in single jersey fabrics made from ring spun yarns, which involves aqueous swelling of them in hot water at 75° to 80°C for two hours, has a lot of potential, and the manufacturers of these fabrics can adopt them. Whereas this treatment can reduce the incidence of spirality, the strength of the yarn is reduced to a small extent.

The working of the knitting machines improved with this type of yarn and fly was much less. It is hoped that the slightly increased thickness of the yarns, which can probably be attributed to the more open yarn structure, makes the surface of the knitted fabric smoother.

There are a number of advantages in this process which are detailed below:

1. Permanent reduction, and in certain cases, even the elimination of skewing in single jersey fabric made from single ring spun yarn.

2. More light weight knitted fabrics compared to knitted fabrics made from two ply yarn.

3. The fabric has a better surface structure.

4. Less waste in making-up and

5. There is no need to carry out a separate steaming process on the knitted fabrics.

Since knitted fabric made from carded yarn has exhibited a better handle, its use can be explored. Its elongation is greater than that of the fabric made from combed yarn which is again a desirable property.
Surface roughness of 1x1, 2x2 and interlock fabrics can provide information on their structure.

As regards interlock fabrics, it is possible to design them without producing the fabric on the machine. It should be possible with a computer to programme the production and quality of these fabrics and to monitor them on a day to day basis.

The handle tester and bagginess tester can be used to advantage by the knitting mills.

This work has also discussed the dyeing of weft-knitted fabrics by pad batch method, and the results, which have been achieved, should prove useful to the dyer. In these days of escalating costs, it is imperative to explore the possibility of dyeing fabrics in bulk so as to realise the benefits.

14.2 OBSERVATIONS ON THE MECHANICAL PROPERTIES OBTAINED FROM KES-F INSTRUMENTS

The measurement of bending, shear, tensile and compression parameters does not show any differences in the parameters between woven and knitted fabrics as some minor modifications in the mode of testing have been effected. For example, for knitted fabric a maximum tensile force of 0.5 N/cm width is applied in contrast to a woven fabric where a tensile force of 5 N/cm width is applied. Similarly, in shear, the maximum shear angle of 3° is used. All these changes are made due to the highest extension of knitted fabrics.

The most important aspect is the measurement of the surface roughness of single and double jersey fabrics. The geometric - roughness probe is sufficiently sensitive to respond to surface rugosities due to differences in yarn and fabric structure, especially with relatively 'hard'
yarns and fabrics. It does not, however, respond to differences in fabric hairiness or prickle. Surface hairs are flattened under the 10-g load applied to the 0.5mm diameter piano - wire probe. Due to the structures of 1 x 1 rib and interlock in which cords are running along the length of the fabric the surface roughness along courses shows an exceptionally high value. Thus it appears that the mode of testing of surface roughness in respect of 1 x 1 rib and interlock structures needs some revision. Either the probe has to be changed in the surface roughness tester, or the diameter of the wire needs to be replaced. The measuring methods of surface mechanical properties in KES-F system seem to be too rough to detect subtle differences existing in knitted fabrics.

As a result of the abnormally high values of surface roughness in 1 x 1 rib and interlock fabrics how far the THV computed from the various mechanical properties reflects the handle of fabrics is a moot point. Since surface roughness is dependent on fabric thickness, and since knitted fabrics are somewhat thicker than the woven fabrics, it is to be expected that the surface roughness of the former will be greater than that of the latter.

14.3 SUGGESTIONS FOR FURTHER RESEARCH

1. This study has concentrated on majority of single jersey fabrics which have been knitted from yarns varying in direction of twist and structure. It will be interesting to knit the same yarn on four or five different gauges of machines, and to study the spirality.

2. It would be interesting to extend the investigation by subjecting the knitting yarns, whether they are of ring or rotor type, to aqueous treatment for different duration, and to study the spirality or handle of fabrics. This can do away with wet processing treatments that are applied on fabrics following knitting and can result in considerable cost savings.
3. It would be very interesting to study the effect of relative humidity on the mechanical properties of weft-knitted fabrics utilising KESF system. Also the effect of relative humidity on the bagginess of fabrics can also be investigated.

4. Another suggestion that may be given to reduce or completely remove spirality is to take the yarn and to steam it. A slight twist is put into the steamed yarn in the opposite direction to the original twist. If the original yarn twists in the Z direction and the slight twist applied after steaming is in the S direction, the yarn then has pure Z-twist and may be taken up for knitting. This can result in a considerable reduction in spirality and rejection of fabrics.

5. Yarns, which are being spun in Ring frame for purposes of knitting, may be wetted on the Ring frame by allowing water to trickle down on the front roller. This yarn may be directly wound onto the cone, and may be taken up for knitting on the machine. Special types of ring frames may be developed for this purpose. This may be tried for different directions of twist.

6. It would be desirable to develop packages for producing single and double jersey fabrics for designing them using computer. Product development is an area where a great deal of work is necessary on knitted fabrics.

7. An interlaboratory trials on the mechanical properties of 1 x 1 Rib, 2 x 2 Rib and Interlock can be carried out with the aid of several laboratories using Kawabata Evaluation System.

8. Production of knitted fabrics from doubled yarns may be undertaken. Also, knitted fabrics may be produced from fine count
Rotor yarns, and various aspects of knitting performance such as fly liberation may be studied.

9. Assessment of commercial interlock fabrics, which are used as outerwear should be made by using Kawabata system so as to find the variation existing among them. Such a study has not been made in the present work due to lack of time.

10. Gratings to measure spirality of weft-knitted fabrics can be prepared so that this property can be measured simultaneously for several wales at a time.

11. Evaluation of mechanical properties of knitted fabrics dyed by pad batch method is necessary to have a complete understanding of the fabrics and to compare these with those obtained by exhaust method. Several pretreatments can be attempted, and their effect on the mechanical properties may be investigated.

12. Study of mechanical properties of double jersey fabrics with the aid of Kawabata Evaluation System is warranted. It may be mentioned that a great deal of work on this was carried out by Hamilton and Postle.

13. Since compressional properties, obtained with the compression tester, which forms a package in Kawabata Evaluation test, are found to be unsatisfactory, it would be necessary to carry out work at very low pressures and very high pressures; this would necessitate the development of a new instrument.

14. Since among the mechanical properties, only bending and shear properties have been found to be significantly affected by fibre, yarn structure and fabric structural parameters, it will suffice if attention is paid to these for characterising the knitted fabrics. This does not mean that the other properties can be ignored.