Relationship between Imperfection Count in Single and Ply Yarns

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The relationship between yarn unevenness of single and ply yarns is well known. In this paper, equations have been derived for relating thick places, thin places and neps in single and ply yarns.

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Doubling of yarns is employed as a means of improving certain desirable yarn and fabric characteristics. In regard to yarn it includes, besides other characteristics, the evenness of yarn and its imperfections. To quantify such an improvement some theoretical or empirical relationships between single and ply yarn characteristics should be of help. One can then easily work out the specifications needed in single yarns so as to meet those stipulated for the ply yarn.

There is a well-known relationship between single and ply yarn unevenness. According to this, if \( C_p \) and \( C_s \) represent the \( CV\% \) of ply and single yarns respectively, the relationship can be expressed as follows:

\[
C_p = \frac{C_s}{N^{1/2}} \quad \ldots (1)
\]

where \( N \) is the number of plies in the double yarn. However, there seems to be very little information in the literature concerning the effect of doubling on the reduction in the number of yarn imperfections. In one such study it was stated that the total number of imperfections in the double yarn (2-ply) was nearly one-sixth of those in the single yarn. It was also found that thin places of up to 100 in single yarn disappeared on doubling. The present work was taken up essentially to explore the nature of relationships between the number of imperfections in the single and ply yarns.

Cotton yarns of four different counts, viz. 10s, 20s, 40s and 60s, were procured from a local textile mill. These Z-twisted single yarns were ply-twisted in the S direction on a ring twister using appropriate twist multipliers. The single and ply yarns were tested for unevenness and imperfections on an Uster evenness tester at a speed of 50 m/min. The sensitivity levels were \(-50\%\), 3 and 3 for thin places, thick places and neps respectively. Each reading was taken over a 5
min duration. Thirty-two readings were taken for each yarn sample.

The testing of ply yarns on the Uster evenness tester may introduce a slight error because the cross-sectional shape of the ply yarns deviates from the circular shape of single yarns. This fact was kept in mind while interpreting some minor differences in the Uster values. The yarn unevenness (CV%) and imperfections are given in Table 1. The table shows a large reduction in the values of these characteristics in the ply yarns. The extent of reduction increases as the number of plies, i.e., number of single yarns in the ply yarn, increases. Fig. 1 shows that there is a curvilinear relationship between CV% of single and ply yarns. Fig. 2 shows the scatter when the observed CV% values were plotted against the calculated ones (using Eq. 1) for 2-, 3- and 4-ply yarns. The solid straight line in the figure shows the expected plot when there is complete agreement between the observed and the expected values. The deviation of the points from this line is not much. Hence Eq. (1) could be expected to predict the yarn unevenness of ply yarns quite accurately. Similarly, when the number of imperfections is plotted against the number of plies one gets curves (Figs 3, 4 and 5), which look similar to those in Fig. 1, though the latter ones show a steeper fall. One can therefore expect the relationship for imperfections quite similar to that used for unevenness (Eq. 1) except that the exponent of N may be higher. The relationship can be expressed in a general form as:

\[ I_p = \frac{I_s}{N^z} \]

where \( I_p \) and \( I_s \) are the imperfections in ply and single yarns respectively and \( N \) is the number of plies.

The data presented in Table 1 or Figs 3-5 can be used to find out the value of \( Z \) for each type of imperfection, viz. thick places, thin places and neps. Using the least square method of curve fitting the values of \( Z \)
converge to that of the original problem, \( f(X) \) in were calculated for each yarn count. The calculated values of \( Z \) are given in Table 2. The values seem to be around 2 for thick places and nepes and 5 for thin places. Depending on the count they range from 1.93 to 2.22 for thick places, 1.76 to 2.23 for nepes and 4.96 to 7.39 for thin places. This indicates that on ply-ing, the reduction in thin places is much higher than in thick places and nepes. The reduction in thick places and nepes seems to be of the same order. It is interesting to observe that the values of \( Z \) are lower for fine counts wherein the level of imperfections is higher. We cannot comment as to whether this fall is due to the lower linear density of yarn or the higher level of imperfections as these factors are interrelated in the present range of samples. To isolate the effect of each of these factors, a more detailed study needs to be carried out wherein one can also select mixings representing all types of fibres and blends.

**References**