Abstract

Systematic scientific studies on double jersey knitting is very limited, moreover, those are mainly concerned with circular machines. Although scientific studies on dimensional properties of double jersey structures, particularly 1 x 1 rib fabric started long back along with the study of single jersey structures, relatively much lesser information is available on the same in the published literature. The configuration of the rib loop unit or structural knitted cell (SKC) is completely different to that of the plain loop. From the limited information available in the literature it is understood that double jersey structures also demonstrate the similar trend and behaviour in many respects like single jersey structure. Moreover, one of the most important tools in the scientific study of knitted fabric structural parameters is to develop the model of the loop unit (SKC) and the other important aspect is the statistical tool for analysis of data, particularly by using computer.

In the present research work attempt has been made to investigate as well as to gain an insight on the loop forming process and dimensional properties of the knitted fabrics produced on a double jersey machine, particularly flat bed machine equipped with 1x1 rib gaiting. Along with this the dimensional constants of 1x1 rib knitted fabrics have been established by incorporating the new principle of ultrasonic wave for obtaining fully relaxed fabric.

The development of the geometry of the knitting zone is essential for making the loop model in the machine state. The loop model helps us to calculate the theoretical length of loop at any point inside knitting zone, particularly at the knitting point. Once the loop length is defined, it becomes easier to predict the dimensional parameters of the knitted fabric such as courses and wales per inch, stitch density, loop shape factor, tightness factor, weight per square metre etc.

The modelling of 1x1 rib loop unit (SKC) during its formation in a flat bed double jersey machine has been done to study the shape and configuration of the loop at different points inside the knitting zone (KZ) including the knitting point as well as to establish the theoretical length of loop at knitting points. For the purpose, the detail path of the needles under the control of various cam elements in both front and back beds has been established for a computerized power driven
flat bed double jersey knitting machine. The extents and angles of the individual components of cam systems were observed and measured for obtaining the exact nature of needle movement inside the knitting zone and the configuration of the loop arms. As the rib loop is formed in multiple planes due to positioning of the needles in the two beds in different planes as well as making different angles with the ground, the position of the two beds were brought in a single vertical plane in order to achieve a simplified view of the geometry of the knitting zone. Utilising the same, equations of the stitch cam profiles have been derived in terms of angles of the descending and ascending side of the front and back bed stitch cams, tuck height, needle spacing and some other parameters of KZ. The cam profile equations thus obtained help to determine the position of any needle for both front and back bed inside KZ.

In order to identify the various configurations of the loop arms, observation was carried out since the catching of the yarn by any particular needle till its reaching in the knitting point. It was found that loop arm configuration passes through five different stages. The loop formed at the knitting point for the front bed same can be considered to be made up of eight segments of which five are straight portions and remaining three are curves neglecting very small curvilinear portions at the contact points with the old loops. In case of the back bed knitting point, the loop is made up of nine segments of which six are straight portions and remaining three are curves. The individual length of each segment is calculated with the help of the knitting zone geometry for getting the total theoretical length of the 1x1 rib loop unit (SKC). Although the geometry of the knitting zone of a flat bed double jersey machine differs to some extent with that of the circular double jersey machine, there is very little difference of the stages of loop formation and configuration of loop arms in those two different types of machines.

Attempt was made to establish the phenomenon of occurrence of ‘robbing back’ in the flat bed double jersey knitting by measuring the marked loop length at the knitting point during knitting, theoretical loop length obtained from the model and actual loop length by unraveling the yarn from the knitted fabric.

In the present research work attempt has also been made to investigate as well as to gather information on the non-dimensional parameters such as Course Constant (Uc) Wale (Rib) Constant (Uw), Stitch Density Constant (Us) & Loop Shape Factor (Ur) of the knitted fabrics
produced on a double jersey flat bed machine equipped with 1x1 rib gaiting using acrylic yarn. Fabric samples were prepared by varying the stitch cam setting, take down load, yarn count etc. in a 5.5 gauge flat bed knitting machine and were subjected to relaxation treatment by using conventional technique as well as mechanical energy of ultrasonic waves for maximum shrinkage. It is observed that this new relaxation technique produces similar dimensional and non-dimensional parameters of the fabric as obtained with the conventional relaxation treatments. It is observed that the values of the four non-dimensional parameters such as \( U_c \), \( U_w \), \( U_s \) & \( U_r \) follow a specific trend and the values are comparable with the experimental values obtained by previous workers for fabrics knitted in circular knitting machine.

A detailed comparative study of the fifteen 1x1 rib samples on dimensional parameters at different stages of relaxation was carried out. The parameters like loop length, fabric shrinkage, courses per inch, wales (ribs) per inch, stitch density etc were measured under different states of relaxation and the dimensionless knitting constants were established. These findings were correlated with the shrinkage, i.e., change in dimension of knitted fabric. The knitting constant values are also compared with the findings of the earlier research works in the field of circular knitting and a similar trend was found. Analysis of Variance (ANOVA) of the constant values of the knitted fabric samples for different stages of relaxation treatments were carried out at 5% significance level. The p-values were found for indications of significant differences between the values at different stages of relaxation. To identify the significant differences between the different relaxation stages the least significant difference or critical difference (lsd or cd) value at 5% level of significance was also calculated. For the said comparison purpose, 't' test has been performed. The effect of loop length on courses and wales (ribs) per inch at different stages of relaxation were studied and best fitted linear regression equations between courses per inch / wales per inch and loop length at different stages of relaxation have been developed. The effect of stitch cam settings of both front and back bed and the take-down load on dimensional parameters of the fabric samples were also studied.

Similar to flat bed machine, a detailed comparative study of thirty 1x1 rib samples on dimensional parameters at different stages of relaxation was also carried out. The parameters like loop length, fabric shrinkage, courses per inch, wales per inch, stitch density etc were measured
under different states of relaxation and the dimensionless knitting constants were established. The constant values are also compared with the findings of the earlier research workers and a similar trend was found. Analysis of Variance (ANOVA) of the constant values of the knitted fabric samples for different stages of relaxation treatments were carried out at 5% significance level in a similar manner as in the case of flat bed samples. From the limited observations it is concluded that there is a good resemblance in the dimensional and non-dimensional parameters of the knitted fabrics for both circular and flat bed knitting machines.

The effect of loop length on courses and wales (ribs) per inch at different stages of relaxation were studied and best fitted linear regression equations between courses per inch / wales per inch and loop length at different stages of relaxation have been developed in the same way. The effect of cylinder stitch cam settings and the yarn tension on dimensional parameters of the fabric samples were studied. ANOVA at 5% level of significance considering two factor – without replication analysis have been done to justify the inference.