Selection of suitable machine gauge by considering the GSM, shrinkage and spirality of single jersey knit fabric

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Abstract:

The work deals with the analysis of spirality, shrinkage properties and fabric GSM range for different machine gauge in case of single jersey circular knit fabric. As there are different combinations of machine gauge with stitch length and yarn counts are practiced, this work is done upon the most practiced combination found in the local knitting factories. Spirality and shrinkage percentages are tested for the finished fabric and GSM is measured both for the grey fabric and finished fabric. It is found that 24 gauge machines have the most significant importance as it can cover a wide range of GSM. Not only that, the spirality and shrinkage properties of the finished fabrics had been found very much acceptable in case of 24 gauge machine rather than other gauges.

Keywords: Gauge, GSM, Spiral, Shrinkage.

1. Introduction:

Knitting is the fabric manufacturing process which construction elastic and porous fabric. Knitted fabrics can be made much more easily and quickly than woven fabrics at comparatively less cost. Knitted fabrics are generally comfortable in wear even during travel but yet require little care to keep their neat appearance. The tendency of knits to resist wrinkling is another factor to boost up their popularity. Machine gauge is the number of needles in an inch which has a great influence in fabric structure. Not all the yarn counts can be used in same gauge of machine. Usually yarn needs to be fine with the increase of machine gauge. Knitting machines come in various gauges to accommodate the wide range of yarns available today. According to gauge of the machine the pattern of stitches in a fabric is changed. Same thickness of yarn will produce different stitch length due to the variation of gauge. And again GSM will also change if the same yarn is used by different gauge. Generally for handspun and bulkier weight yarns or heavy worsted weight lower needle gauge is practiced. Mid-Gauge is used for sport weight to light worsted yarns. Standard gauge is used for sock weight, fingering weight and baby weight yarns. Fine Gauges are used for lace weight to fingering weight yarns.

Several researchers worked with spirality, shrinkage and GSM of knitted fabrics according to count, twist, machine setting and other related parameters. Kothari VK et al.[2] discussed about spirality of cotton plain knitted fabric with respect to variation in yarn and machine parameters [1] and showed very significant relation among the machine parameters, spirality and variation in yarn count. The knit fabric tightness factor, fabric relaxation and finishing processes also have considerable influence on the extent of spirality. Rate of feeding also influences the spirality, width, stitch length, GSM for different counts.[3]
Black[4] suggested that many of the difficulties caused by excessive shrinkage could be alleviated by knitting fabrics as strain free as possible by careful adjustment of the knitting machine settings. Celik O[5] analyzed the spirality by image analysis specially by using logarithmic spectrum, 10 different sample were tested and analyzed successfully.

Various experimental studies [6-10] have explored the different contributory factors on spirality. Some are machine related like use of multiple feeders and gauge, whereas some are associated with constituent yarns like twist liveliness and linear density. Essentially in almost all citations, it has been clearly demonstrated that is the relaxation of torsional stresses which causes the dimensional distortions and instability in the knitted loop construction. This leads to the appearance of spirality on the knit fabrics.

2. Experimental details:

For production, the machine settings like needle arrangement, cam arrangement, yarn feeder timing to needle, take down tension, spreader width are also very important. For all the experiments every machine settings was set in same parameters where those were worked with the knitting parameters.

2.1 Material and sample preparation

Six types of combed yarn are procured which differs to each other in Count. Different important properties of these yarns are tested and the results are shown in table 1.

<table>
<thead>
<tr>
<th>Properties</th>
<th>Yarn count (Ne)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Twist factor [tex] ^{(1/2) \times tpc}</td>
<td>36.8 36.1 36.4 35.3 36.2 36.4</td>
</tr>
<tr>
<td>Tenacity mN/tex</td>
<td>165 154 158 151 158 162</td>
</tr>
<tr>
<td>Elongation at break %</td>
<td>4.7 4.6 4.4 4.3 4.2 4.1</td>
</tr>
<tr>
<td>Unevenness, U%</td>
<td>11 11 11 10 9 9</td>
</tr>
<tr>
<td>Thick Place/1000m (+50%)</td>
<td>19 20 21 24 25 27</td>
</tr>
<tr>
<td>Thin Place/1000m(-50%)</td>
<td>0 0 0 1 1 1</td>
</tr>
<tr>
<td>Neps/1000m (+200%)</td>
<td>40 42 45 51 52 55</td>
</tr>
</tbody>
</table>

Table 1: Constructional parameters and other specifications of the yarns used

The selected yarns were knitted in a single jersey circular knitting machine having 30 inch in diameter. Cylinders of 20, 24 and 28 gauge (needles per inch) were used and the yarns are knitted in nine manner (popularly used in factory) mentioned in the table 2, figure 1 and figure 2. The stitch lengths were also differ by changing the cam settings & positive feed device in the machine.

The dyeing of the knitted fabrics was carried out at an industry with normal industrial parameters. The procedure detailed by fully automatic winch dyeing machine. The fabric samples were stitched end to end and all fabric samples were processed in the same dye bath. The recipe of dyeing was- Remasol Yellow RR- 0.0015%, Remasol Red RR- 0.002%, Common salt- 20g/L, Soda ash- 5 g/L at 60˚C for 1 hour with a material-liquor ratio of 1:8. After dyeing, they were cold washed two times followed by a hot wash at 60˚C, a neutral wash with 0.5 g/L acetic acid and a detergent wash at last. Afterward, each fabric sample was independently set in compaction machine. The regular procedure to finish the fabrics which is appropriate for single jersey knitted fabrics was followed to achieve the nominal finishing targets. Then drying was done by an open width dryer.

2.2 Technique and methods

2.2.1 GSM measuring technique
When finishing is done these samples are conditioned for 24 hours in a standard atmosphere of 27±2°C and 65±2% RH. The method for measuring GSM was simply following the steps. Firstly, to take the conditioned fabric for test on the GSM cutter pad so that no crease or crinkle is formed. Secondly, to cut the fabric with GSM cutter (cut area was 100 square cm). Thirdly, to take the weight of the fabric by an electric balance. Fourthly, multiply the weight of the cut sample by 100. The result is the GSM of the fabric. Both the grey GSM and finished GSM were calculated for all the nine fabric samples and the results are shown in table 2 and figure 1.

<table>
<thead>
<tr>
<th>Machine diameter</th>
<th>Machine gauge</th>
<th>Yarn count in Ne</th>
<th>Stitch length in mm</th>
<th>Grey fabric GSM</th>
<th>Finished fabric GSM</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>20</td>
<td>20</td>
<td>3.06</td>
<td>161</td>
<td>200</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>18</td>
<td>3.05</td>
<td>167</td>
<td>200</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>18</td>
<td>3.10</td>
<td>178</td>
<td>210</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
<td>24</td>
<td>2.84</td>
<td>156</td>
<td>175</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
<td>28</td>
<td>2.72</td>
<td>134</td>
<td>150</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
<td>30</td>
<td>2.74</td>
<td>125</td>
<td>134</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
<td>30</td>
<td>2.78</td>
<td>129</td>
<td>141</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
<td>32</td>
<td>2.57</td>
<td>108</td>
<td>126</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
<td>32</td>
<td>2.64</td>
<td>116</td>
<td>130</td>
</tr>
</tbody>
</table>

Table 2: GSM variation of grey and finished fabric according to machine gauge

![Figure 1: Variation of GSM against the machine specification](image)

2.2.2 Shrinkage % measuring technique

For calculating the shrinkage percentage samples were cut into 20 cm × 20 cm, then a rectangular area was marked 15 cm × 15 cm on each. Then the fabric is treated with 0.5% owf wetting agent for 2 hours at 30 to 35°C with a liquor ratio of 1:50. Then after drying the fabric the distance of the mark length and width are measured and shrinkage percentage is calculated by the formula. Shrinkage % = \[100 \times \frac{(a-b)}{a}\] where, a = Distance between two ends before treatment b = Distance between two ends after treatment.

In this way both the lengthwise and widthwise shrinkage percentage is calculated and they are shown in the table 3 and figure 2.
<table>
<thead>
<tr>
<th>Machine diameter</th>
<th>Machine gauge</th>
<th>Yarn count in Ne</th>
<th>Stitch length in mm</th>
<th>Lengthwise shrinkage%</th>
<th>Widthwise shrinkage%</th>
</tr>
</thead>
<tbody>
<tr>
<td>30</td>
<td>20</td>
<td>20</td>
<td>3.06</td>
<td>-5.85%</td>
<td>-5.71%</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>18</td>
<td>3.51</td>
<td>-7.14%</td>
<td>-2.57%</td>
</tr>
<tr>
<td>30</td>
<td>20</td>
<td>18</td>
<td>3.05</td>
<td>-4.85%</td>
<td>-4.85%</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
<td>24</td>
<td>2.84</td>
<td>-2.70%</td>
<td>-2.85%</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
<td>28</td>
<td>2.72</td>
<td>-3.85%</td>
<td>-2.85%</td>
</tr>
<tr>
<td>30</td>
<td>24</td>
<td>30</td>
<td>2.74</td>
<td>-3.70%</td>
<td>-3.85%</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
<td>30</td>
<td>2.78</td>
<td>-7.14%</td>
<td>-3.42%</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
<td>32</td>
<td>2.64</td>
<td>-4.85%</td>
<td>-5.71%</td>
</tr>
<tr>
<td>30</td>
<td>28</td>
<td>32</td>
<td>2.57</td>
<td>-7.14%</td>
<td>-5.71%</td>
</tr>
</tbody>
</table>

Table 3: Shrinkage variation% (Both lengthwise and widthwise) according to machine gauge

Figure 2: shrinkage % according to different machine gauge (G= gauge, L.S%= lengthwise shrinkage%, W.S%= widthwise shrinkage%)

2.2.3 Spirality % measuring technique:

Spirality or twisting in a garment is appeared after washing. As a result one of the side seams comes at front of the garment when wearer wears it. Spirality percentage depends on fabric torque and garment structure.

\[
\text{Spirality\%} = 100 \times \frac{B}{A}
\]

Where, B= displacement of side seam at bottom after wash (shown in figure 3)
A= side seam length (shown in figure 3)

The results obtained from this experiment are shown in Table 4 and figure 4.
Machine diameter | Machine gauge | Yarn count in Ne | Stitch length in mm | Spirality %
--- | --- | --- | --- | ---
30 | 20 | 20 | 3.06 | 4.14%
30 | 20 | 18 | 3.51 | 5.26%
30 | 20 | 18 | 3.05 | 4.98%
30 | 24 | 24 | 2.84 | 1.69%
30 | 24 | 28 | 2.72 | 3.48%
30 | 24 | 30 | 2.74 | 2.81%
30 | 28 | 30 | 2.78 | 4.14%
30 | 28 | 32 | 2.64 | 5.17%
30 | 28 | 32 | 2.57 | 6.20%

Table 4: Spirality% of knit fabrics according to machine gauge

3. Results and discussion:

3.1 GSM variation according machine gauge:

Table-2 and Figure-1 show that 20 gauge machine is suitable to produce those fabric which has GSM around 200 where the lower count (18-22 Ne) is preferable as well as 28 gauge machine is perfect for the lower GSM which covers the range 125-145 with higher range in count (28-32Ne). But 24 gauge shows wide range GSM from 135-175 with wide range of count 24-30 Ne. In short for GSM variations it is observed that for 24 gauge machine, it is possible to produce wide range of knit fabrics by using higher range of counts rather than 20 and 28 gauge.

3.2 Shrinkage variation% (Both lengthwise and widthwise) according to machine gauge:

As seen from Table-3 and figure-2, it is clear that both lengthwise and widthwise shrinkage variation% is in acceptable range from 24 gauge where the 20 gauge and 28 gauge fabrics have more shrinkage% sometimes more than -5% for either lengthwise or widthwise shrinkage. So, it can be noted that 24 gauge machine is preferable for low shrinkage variation% (both lengthwise and widthwise).

3.3 Spirality of knit fabric according to machine gauge:

From table-4 and figure-4 it is clear that spirality is less than 4% for 24 gauge whereas 20 gauge and 28 gauge machine has spirality more than 4% and lends it to 7-8%. It is also observed that best result in spirality (1.69%) was found for 24 gauge machine with 24 Ne yarn. As the acceptable range of...
spirality is less than 5%, it will be safe to produce knit fabrics on 24 gauge whose range is less than 4%.

Finally, from the above discussions it can be summarized as that fabric produced from 24 gauge machine has a great range of GSM, 20 gauge machines do not cover the lower GSM areas and 28 gauge machines cannot fill the requirement of high GSM. The best shrinkage value for both lengthwise and widthwise direction is obtained in case of 24 gauge machines. Greater the gauge, greater percentage of shrinkage and when the gauge is 20, it also increases the shrinkage percentage but not as high as 28. Spirality also found less in the cases of the fabric which has produced from 24 gauge machines.

4 Conclusion:

Product development is an important aspect for knit production. This is because knit structure is produced due to formation of loops. During subsequent process the loop shape and size changes substantially. In this experiment it is found that machine gauge show significant effect on properties and quality of knitted fabric. Wet processes like dyeing, finishing and washing also affect the properties of knitted fabric significantly. The study reported here will very helpful for experts who work in the area of circular weft knitting. However further work will be necessary to generate more clear conception about the above mentioned effects.

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References: