Correlation of Yarn Properties with Knitted Fabric Properties

Source: Textile Review

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Correlation of Yarn Properties with Knitted Fabric Properties

By: B. B. Jambagi, R. N. Narkhedkar & Pankaj Gangane

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The air permeability value for knitted fabric produced from carded yarn is higher than other two fabrics irrespective of yarn count. Yarn U%, IPI, and total faults adversely influence the bursting strength of the knitted fabric. The correlation between U% & appearance is very much significant. The faults like long thick and long thin also hamper the appearance of knitted fabric. The negative value of correlation coefficient clearly indicates that increase in thick, thin places, neps, long thick, thin and A,B,C,D,E yarn faults decreases the knitted fabric appearance. The total hand value have shown the trend that the fabric from combed yarns have better hand value as compared to the fabric made from carded yarns.

Global demand for knitwear is growing at faster rate as that of woven fabrics. Currently about 45% of the clothing needs in the developing countries is met by the knit goods. In the production of knitted fabric the yarn parameters plays dominant role with about 60-70% of the fabric cost. Any error in the selection of the raw material can not be rectified or repaired after production of the knit fabric. The yarn faults plays very important role on the properties of knitted fabric. The number of faults in the fabric depends on the type of yarn manufacturing process, the type of raw material, process parameters, and the effectiveness of yarn clearer.

Yarn Faults	**Knit Fabric Faults**
Spin-in colored filament	Hole
Foreign matter	Stain contamination
Short thick place	Fly
Long thick place	Missed stitch, Double stitch
Thin ring	Tear-off
Thin ring	Needle break
Short thin place	Transfer stitch
Knot/ Splice	Rings(mixed yarn)
Unevenness	Dropped stitch
Periodic variation	Additives
Requirement profiles of cotton yarn for knit wear	
100 Mt count CV%	<1.8%
10MtcountCV%	<2.5%
Breaking tenacity	> 10 cN/tex
Variation of breaking force	<10%
Elongation at break	>5%
Elongation at break CV	>10%
Yarn twist(a m value)	Ring spun yarn 94-110
Surface friction value	Ideal around 0.15μ
Hairiness	< 50% value of uster statistic
Between bobbin hairiness CV%	<7%
Yarn irregularity	<25%
Total imperfections	<25%
Really occurring thick & thin places	A3/B3/C2/D2/D1
Classimat faults	More sensitive
Remaining yarn faults	A3+B3+C2+D2= <5/100000m

1. **Count variation:**
   Higher count CV% results in ring-in effect in knitted fabric as well as dark light strips in the fabric.

2. **Mass variation (U %):**
   Due to higher U% the knitted fabric have a cloudy appearance.

3. **Thick Place:**
   A short thick place not only affects the appearance of the fabric but also gives damage to the needles of the knitting machine during processing.

4. **Breaking tenacity of yarn:**
   Improvement in the breaking tenacity of the yarn improves the strength of the knitted fabric.

5. **Elongation at break:**
   In knitting process sudden forces are acting on the yarn, so yarn must withstand these tensions. For that purpose yarn must have higher elongation at break.

6. **Yarn twist:**
   Yarn twist plays very important role in knitting process. In case of filament yarns if twist is less, then the filaments can scatter from the bundle and static charges can be generated which will disturb the knitting process. The luster and handle of the fabric can be affected by the amount of twist and twist direction. High twisted yarn possesses problem of snarling in knitting.

   The study of Jiang Tao, R.C. Dhingra stated that due to the dimensional instability of knitted loop construction, single jersey knitting fabrics suffers from various types of dimensional distortion. The fabric distortion is araised by the use of twist lively yarns. Higher twist lively yarns gives lower tightness factor. According to the study of Ruppenicker & Lofton yarn hairiness is reduced by increasing twist factor and which results in to less generation of fly lint during knitting.

7. **Coefficient of friction:**
   It should be low and uniform. Small increase in friction leads to more end breaks during knitting process and gives variation in loop length. It should not exceed 0.17.

8. **Hairiness:**
   During knitting many of the hairy fibre ends are either pulled or sheared from the yarn and accumulate around the knitting elements. This fibre accumulation may be picked up by the running yarn and blocks or breaks the needles.

Material and methods

Three different types of yarns i.e. Carded, Semi-combed, Combed with two different counts like 24s Ne & 32s Ne are taken for the study. The raw material is processed in same mill under standard conditions. These yarns were cleared by common clearer with standard settings.

The yarns are then tested for their important characteristics like U%, Count CV%, Single yarn strength, Appearance grade, Reflectance, Handle value & knitting performance. Then by checking the properties of knitted fabric the correlation has been made with all properties of the yarn.

Knitting machine details:

Modern circular knitting machine with positive feeders to produce single Jersey fabric were used. The m/c details are given in following table,

Description	Parameters
Type	Weft circular
Make	FXC-Z/3S
Diameter	30 inch.
Speed	30rpm
Gauge	28
Stitch length	2.75mm
Weight/sq. mtr.	130
Course/inch	4S
Wales/inch	28
No. of feeders	90
Tightness factor	15
Yarn tension	4 gm.

Result and discussions: The average values of yarn test results are as given below,

Count	24s Ne			32sNe		
	CRD	SCb	Cb	CRD	SCb	Cb
U%	11.8	9.6	9.1	13.8	10.9	10.4
T(-30)	1680	750	544	1972	1099	516
T(-40)	135	25	17	405	139	98
T(-50)	27	2	0	43	4	2
T(-60)	2	0	0	2	0	0
Th (+35)	1025	380	200	1030	700	406
Th (+50)	256	48	18	303	89	38
Th(+70)	48	5	0	64	7	0
Th (1 00)	2	0	0	2	0	0
N (+140)	1540	560	325	1833	1184	563
N(+200)	530	88	39	688	182	64
N (+280)	32	8	2	84	24	6
N(+400)	3	1	0	7	2	0
RKM	12.1	13.5	15	11.3	13.2	13.9
ELONG.	4.1	4.95	5.0	3.4	4.4	4.4
A	411	64.2	41	522	85	54
B	32.4	10.1	4.1	49.3	17.7	15.9
C	9.6	2.2	0.7	10.3	4.6	3.7
D	0.3	1.1	0.6	1.8	1.2	0.5
E	1.2	0.7	0.7	1.2	0	0
L Thick	18.6	13.9	2.3	18.7	0.8	0.3
L Thin	135	2.9	0.4	248	7.3	1.8
ABCDE	455	78.3	47	594	108	74
TOTAL	609	95	50	762	117	76.3

Where: T - Thin Places, TH - Thick Places, N - Neps.

Fabric properties of three types of yarns

	C	SC	Cb	C	SC	Cb
B.S(Kg/cm2)	7.3	8.5	9.2	6.4	7.5	8.5
A.Pm3/m2/m	19	21	23	22	24	28
Appearance	1	3	5	2	4	6
Reflectance%	56	66	76	57	68	79
Handle	2.1	2.4	2.9	2.3	2.5	3.0
Performance	19	6.0	2.0	22	8.0	4.0

Where: B.S - Thin Places, A.P – Air Permeability

1. Correlation coefficient between yarn properties & fab. Air permeability-

In this knitted fabric the air permeability varies from 28.4 to 18.7 cub.mtr/sq.mtr/min. In the yarn if hairiness is higher, greater will be the resistance to air flow. The correlation coefficient for hairiness is negative which indicates that if yarn hairiness increases the air permeability reduces.

Thick faults and imperfections increase the air space in the yarn due to lower compactness and thereby increase the air permeability.

Neps and slubs result in missed stitch holes in the fabric hence gives more air permeability. TPM plays very important role in producing the fabric, if TPM is very high it will produce wire mesh type fabric structure which allows more air to pass through it i.e. air permeability will increase.

Yarn Faults	24s Ne	32sNe
U%	0.67	0.69
Total thin	0.71	0.77
Total thick	0.74	0.72
Total neps	0.71	0.77
TotailPI	0.72	0.75
Hairiness	-0.74	-0.71
ABCDE	0.66	0.69
Longthick	0.63	0.66
Longthin	0.64	0.65
Total faults	0.64	0.67

2. Correlation coefficient between yarn properties & fab. Bursting strength-

From the results it is found that the bursting strength of the knitted fabric is directly correlated with the yarn properties like strength, toughness, and yarn quality index. The yarn irregularity, imperfections and c1assimat faults adversely influence the bursting strength which is due to the distorted loops.

Bursting strength of combed yarn knitted fabric is higher than the carded knitted fabric due to its higher RKM values, better elongation, lower unevenness and imperfections of the yarn.

It is found that the strength of coarser yarn is higher than the finer yarns so bursting strength of coarse yarn knitted fabric is higher than fabrics made up of finer yarns.

Yarn Faults	24s Ne	32sNe
U%	-0.78	-0.76
Total thin	-0.74	-0.73
Total thick	-0.76	-0.72
Total neps	-0.68	-0.71
Total IPI	-0.79	-0.81
RKM	0.76	0.73
Elongation	0.69	0.70
ABCDE	-0.74	-0.75
Long thick	-0.71	-0.68
Long thin	-0.75	-0.73
Total faults	-0.74	-0.70

3. Correlation coefficient between yarn properties & fab. Appearance –

The results of fabric shows that classimat faults A,B,C,D,E , imperfections as well as yarn hairiness significantly correlated with fabric appearance, higher number of above faults gives lower fabric appearance.

In case of imperfections the correlation value decreases with the increase in the length of faults. The correlation between appearance of the fabric and U% is negative and highly significant i.e. it hampers the fabric appearance.

Excessive yarn hairiness gives dim or cloudy appearance to the fabric which is due to the fact that, the fabric luster is blemished due to scattering of light on the surface of fabric.

Fabric produced from combed yarn gives higher appearance rank than that of carded yarn fabric.

Yarn Faults	24s Ne	32sNe
U%	-0.83	-0.87
Total thin	-0.70	-0.69
Total thick	-0.71	-0.73
Neps(+400)	-0.73	-0.7 4
TotailPI	-0.71	-0.72
Hairiness	-0.72	-0.67
ABCDE	-0.72	-0.71
Longthick	-0.72	-0.71
Longthin	-0.76	-0.79
Total faults	-0.74	-0.77

4. Correlation between yarn properties & fab. Handle properties-

In case of the combed yarn short fibre per cent is less and the fibres are arranged parallel to the axis of yarn and gives uniform yarn. In case of the combed yarn, there is improvement in the softness, elasticity and bending property of yarn which leads to better fabric handle.

Yarn Faults	24s Ne	32sNe
U%	-0.88	-0.82
Total thin	-0.87	-0.79
Total thick	-0.88	-0.82
Neps(+400)	-0.87	-0.85
TotallPl	-0.87	-0.82
Hairiness	-0.89	-0.81
ABCDE	-0.83	-0.76
Longthick	-0.79	-0.74
Longthin	-0.80	-0.74
Total faults	-0.83	-0.75
RKM	0.88	0.83
Elongation	0.80	0.71

In this correlation it confirms that higher the number of imperfections, hairiness, and faults lesser will be the total handle value of fabric.

Conclusions

1. The air permeability value for knitted fabric produced from carded yarn is higher than other two fabrics irrespective of yarn count.

2. Yarn U%, IPI, and total faults adversely influence the bursting strength of the knitted fabric.

3. The correlation between U% & appearance is very much significant. The faults like long thick and long thin also hamper the appearance of knitted fabric.

4. The negative value of correlation coefficient clearly indicates that increase in thick , thin places, neps, long thick, thin and A,B,C,D,E yarn faults decreases the knitted fabric appearance.

5. The total hand value have shown the trend that the fabric from combed yarns have better hand value as compared to the fabric made from carded yarns.

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