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Knit Leggings Report

Background

This evaluation was carried out in order to compare the quality and performance parameters for different fabric types using a range of different knit leggings. My group analyzed black leggings from the brand RBX. The leggings are 88% Nylon 12% Spandex in fiber content, interlock knit structure, and is a 4-way stretch fabric. The fabric weight is 10.98 oz/yd^2 with a wale x course count of 44 courses and 61 wales. The leggings are made from a wicking fabric, flame resistance, not colorfast, and has flat lock seams. It also has greater stretch in the widthwise, or course, direction.

Procedure

For the fabric count and weight previously detailed, we used the ASTM D8007 Method for Wale and Course Count of Weft Knitted Fabrics and ASMT 3776 Test Method for Mass per Unit Area respectively.

In order to test the pilling, we used the Martindale Machine used to test abrasion resistance. For this test, we followed the procedures of ASTM D4970 except abraded the fabric against itself rather than against the wool abradant. We ran it for 10,000 cycles and then visually evaluated the textile using the pilling standards.

To test snagging resistance, we used the ASTM D3939 Method for a Mace Tester in the course direction and measured how often a spiked ball would catch on the fabric surface. Using two 6 x 12.5 inch samples cut from the knit leggings, one in the wale direction and on in the course direction, we covered the testing drums and positions the mace towards the back of the drum. We set the counter for 600 revolutions before starting the tester. After removing them, we examined the fabric surface for changes such as protrusions, distortions, snags, or color contrasts.

For air permeability, we used ASTM D737 Test Method for Air Permeability which measures the air flow through a fabric. Using a large section of our knit leggings, we clamped the fabric onto the Frazier Air Permeability Tested with the washer on top of the clamp. Using nozzle 4, we dialed the rheostat slowly until the oil level in the horizontal manometer reached 0.5 inches. We then recorded the level of oil in the vertical manometer on the right. We repeated this procedure twice more across different locations in the fabric.

We used the British Standard Method 7209 in order to test the water vapor permeability of our garment over a 24-hour period. This was accomplished by measuring the evaporation of a pan of water sealed beneath the fabric. We used circular cut specimen secured using a cover ring above 40mL of distilled water in a dish. The diameter of the test dish we used was 87mm. We weighed and calculated water vapor permeability.

Finally, in order to test stretch and recovery from stretch we used the ASTM 2594 Method, Stretch Properties of Knitted Fabrics Having Lower Power which measures the percentage stretch and degree of recovery for knit fabrics. Due to fabric constraints, we only tested in the wale direction and used a modified test method. It is important to note that our group did not have a big enough sample to cut the fabric to the instructed dimensions of 5 x 15 inches. Instead, we cut the swatch to 4.75 x 12.5 inches and used it to sew into a tube. Using this tube-shaped sample, we inserted two aluminum tube sections into the loop with pink cord through each. We then tied the top cord at the black dots and the bottom cord to the top of a hand weight, stretching the fabric. With a gage length of 5 inches, we measured the stretch under tension, the stretch after 1 minute, and the stretch after 1 hour.

Results

For the pilling test, our leggings sample had a mean pilling rating of K 4-5. Therefore, it would meet a brand standard rating of 4. After 600 snagging cycles for the snagging resistance test, the fabric had 21 small distortions and can be categorized as unnoticeable.

Compared to the other fabrics, ours had an about average air permeability with a score of 19.5 $ft^3/min/ft^2$ and other brands ranging from as high as 28.86 $ft^3/min/ft^2$ and as low as 11.66 $ft^3/min/ft^2$.

Our fabric had a lower water vapor permeability of 605.59g/m^2 as opposed to brands such as Calvin Klein and Danskinn which had results in the high 800s or 900s range. It is interesting to note that another pair of leggings also by RBX had a high score of 823g/m^2.

In terms of elongation, or stretch, we obtained a 55% stretch in the wale direction with a growth percentage of 4% after 1 minute and 2% after 1 hour. This is a low result compared to the other specimen, which values ranging between 39.4% to 80% for stretch in the wale direction, 2.5% to 10% growth after 1 minute, and 1.25% to 9.8% growth after 1 hour. Based on this result, we can also conclude that our fabric did demonstrate growth after both 1 minute and 1 hour, but it is very low. Therefore, we can conclude it has sufficient stretch recovery.

Conclusion

Based on our test results, this fabric met brand standards for pilling and snagging resistance. It had an average air permeability score, low water vapor permeability, high stretch, and good stretch recovery compared to other brands. Based on these qualifications, I would deem this fabric a good choice for athletic leggings.

While compared to other brands it had an average air permeability score, this is acceptable because leggings are used for activewear and low air permeability may be uncomfortable because of high perspiration. On the other hand, if the air permeability were too high, it would result in a low cover and leggings are meant to be worn by themselves.

This pair of leggings performed well for the stretch and recovery test, with high stretch results. It also tested lower in stretch after time had passed compared to other brands, demonstrating its good stretch recovery. This is important because leggings are a fitted garment used for high activity, therefore it must stretch to fit the wearer and the wearers form as they move around. It also allows the leggings to retain dimensions with good stretch recovery which prevents the garment from becoming misshapen or loose.

The one attribute that may make it a bad choice would be its low water vapor permeability, because it would cause discomfort if the wearer sweats.

In order to get a more accurate idea, I would also like to test the leggings after washing, because a lot of times washing can demonstrate the wear of the garment.

Data

			3	5	6	4
Group members	**Danielle and Julia**	**Jieun Lee, Ashleigh Jang, Nicole Tansey**	**Melisa, Shivani, Quinn**	**Chloe Sarina Nikki, Nicole**	**Caitlyn, Hanna, & Anastasia**	**Georgia, Melissa, melanie**
Legging color	Turquoise	Dark Lavendar	Blue tie dyed	Black (star + dot)	Black (no markings)	Black Calvin Klein
Legging brand	Calvin Klein	RBX	Danskinn	RBX	Jockey	Calvin Klein
Fiber content	91% nylon, 9% spandex	75% polyester, 25% spandex	81% Polyester 19% spandex	88% nylon, 12% spandex	94% Cotton 6% Spandex	95% Cotton, 5% Spandex
Knit structure	Interlock	Rib	Interlock	interlock	Jersey	Rib
Wale x course count	44 Wales x 71 Courses	71 Courses X 62 Wale	48 courses x 71 Wales	44 courses 61 wales	68 Courses x 40 Wales	70 courses x 56 wales
Any finish, surface treatment, or special feature	4-way stretch,fade resistant, wicking	Compression, fade resistant, flat lock seams, 4 way stretch, wicking	Flat lock seams, 4-way stretch	wicking, 4 way stretch, flat lock seams, fade resistant (not colorfast), capri	None	4-way stretch, wicking, fade resistant
Fabric weight oz/yd2	9.73	7.82	7.7	10.98	8.17	13.716
Fabric weight g/m2	276	265.236	260.37	373.37	277.02	465.055
Mean pilling rating, 1- 5	K3 4-5	K3 4-5	K2 2-3	K 4-5	K1 3-4	4-5
Air permeability, ft3/min/ft2	28.86	11.663	25.90666667	19.5	25.97	22.823
Snagging rating, wale direction: no change,	0, no snags	Had only 1 noticeable protrusion	0, unnoticeable	21 small distortions unnoticeable	No noticeable protrusion or distortion	0, no noticeable snags. No visible color change

noticeabe, unwearable					snagging, but visible color contrast (difficult to tell the source of color change due to the yarn being black)	
WVP: Initial Weight	128.75	130.6	133.38	132.61	130.68	133.79
WVP: Final Weight (24 hours) grams	123.38	125.71	128.14	129.01	126.83	129.96
Water vapor permeability, g/m2/	903.33021	823.0016334	882.15	605.59	647.64	644.27
% Stretch, wale direction	60%	50	39.40%	55%	80%	72%
% growth after 1 minute	n/a	2.5	4.76%	4%	10%	12%
% growth after 1 hour	n/a	1.25	3.85%	2%	9.80%	10%
Which direction of your fabric stretches more, wale or course?	width wise	Width	Width Wise	width	Wales	wales

knit leggings test calculations

fabric weight

sample 1 : $\frac{45.72(0.2473g)}{1 in^2} = 11.3 oz/yd^2 \times 33.906 = 383.36 g/m^2$

sample 2 : $\frac{45.72(0.2467g)}{1 in^2} = 11.2 oz/yd^2 \times 33.906 = 383.4 g/m^2$

sample 3 : $\frac{45.72(0.2261g)}{1 in^2} = 10.3 oz/yd^2 \times 33.906 = 350.4 g/m^2$

mean in (g/m^2): $\frac{383.36 + 383.4 + 350.4}{3} = \boxed{372.67 g/m^2}$

mean in (oz/yd^2): $\frac{11.3 + 11.2 + 10.3}{3} = \boxed{10.98 oz/yd^2}$

air permeability

- used nozzle 4

4.4 → 22.84

2.7 → 17.65

2.8 → 18

water vapor permeability   initial = 132.61g   final = 129.01g

$WVP = \frac{24M}{At} = \frac{24(132.61g - 129.01g)}{(0.0059)(24hrs)} = \boxed{605.59 g/m^2}$

$A = \frac{\pi(87mm)^2}{4} \times 10^{-6} = 0.0059$

stretch / elongation / recovery   4.75" × 12.5"

(B) after 1 min : 5.2"   (A) gauge length : 5"

(C) after 1 hour : 5.1"   (D) under tension : 7.75"

fabric stretch % = $100 \times \frac{[D-A]}{A}$ = 100[7.75-5]/5 = $\boxed{55\%}$

% growth (1 min) = 100 × [B-A]/(A) = 100 × [5.2-5]/5 = $\boxed{4\%}$

% growth (1 hour) = 100 × [C-A]/A = 100[5.1-5]/5 = $\boxed{2\%}$

Abraision/Pilling mean	4-5		
FABRIC WEIGHT 1X1"			
sample:	**weight (g)**	**g/m^2**	**oz/yd^2**
1	0.2473	383.3	11.3
2	0.2467	383.4	11.2
3	0.2261	350.4	10.3
mean		372.3666667	10.98
STRETCH AND RECOVERY		**SNAGGING RESISTANCE**	
recover after 1 min	5.2'	type	# of occurances
after 1 hour	5.1"	**protrusion**	no
under tensions	7.75"	**distortion**	21 ish
AIR PERMEABILITY		**color contrasts**	no
trail	reading (ft^3/min/ft^2)	**total #**	21
1	22.84	**rate**	
2	17.65	4.75" by 12.5"	
3	18	*our sample didnt have enough fabric to cut the length we're supposed to	
mean	19.49666667	**WATER VAPOR PERMEABILITY**	
*used nozzle 4		WVP=24M/At=	
FABRIC STRUCUTRE/CONTENT		weight after 1 hr (g)	132.61
88% nylon, 12% spandex. interlock. wicking, 4 way stretch, flat lock sems, fade resistant (not colorfast), capri		weight after 24 hrs (g)	129.01
thread count	44 courses 61 wales	test diameter: 87mm	

Discussion

Pilling

Pilling is the formation of balls of fiber on the surface of a fabric. This can occur due to fiber content and fiber tenacity. To elaborate, a fabric with two fibers differing in abrasion resistance will pill when the shorter, less-resistant fiber breaks off and becomes tangled, forming the little balls of fiber. Typically, pilling occurs in staple-fiber fabrics where the fiber breaks off and gets entangled more easily. Fabric structure also influences pilling: compact weaves and high yarn twist reduce pilling. Finishing can also be applied to reduce pilling. Fabrics with higher pilling resistance will be more comfortable because pills create texture which feel rough against the skin and may compromise the aesthetic of the garment.

Snagging

Snagging depends on fabric structure: higher density fabrics tend to have lower snagging because the friction is lower. Additionally, fabric structures with more texture tend to be snagged easier. For example, the longer the float in a fabric weave is, the easier it is for the yarn to be snagged, resulting in worse snagging resistance. Snagging is avoided because it can ruin the look and comfort of the garment for similar reasons as pill.

Air Permeability

The volume of empty voids in between warp and weft yarns in fabric causes air permeability. Thus, the air permeability of a fabric is influenced by the fabric structure, the number of yarns, the amount of twist in the yarns, and the size and type of yarn structure. To elaborate, denser and tighter fabric structures will have lower air permeability because there is less space for the air to travel through the fabric. In a similar fashion, having more yarns per unit will increase density and decrease air flow. The yarn structure also comes into play because textured filaments create more open space for air permeability. Higher air permeability per unit area of fabric provides less protection against the winds, whereas low air permeability may cause increased body perspiration. Therefore, the degree of air permeability for a qualified garment depends on its end use.

Water Vapor Permeability

Water vapor permeability is the ability of a fabric to allow moisture vapor to pass through the material. Therefore, much like air permeability, water permeability is affected by the fabric and yarn structures. Denser, tighter fabric structures and textured yarn structures will have lower water vapor permeability. Fabrics with higher thickness and weight will have lower water vapor permeability. Surface treatments can be added in order to manipulate water vapor permeability.

Stretch and Recovery from Stretch

Fabric stretch and recovery from stretch are influenced by a myriad of factors. For one, fibers with high crimp will increase the stretch of a fabric. The chemical composition and molecular arrangement of fibers can affect stretch. Highly oriented and crystalline fibers will not stretch easily but they recover from stretch more quickly. On the other hand, molecular chains which are amorphous and not oriented will have higher stretch. If fibers have poor elastic recovery, they tend to produce fabrics that stretch out of shape. A fiber with better elastic recovery is more likely to recover and maintain appearance after stretch. The fabric structure is also important. Typically, knits are much stretch than woven fabrics because in knit fabrics, there is no single straight line of yarn in any direction. However, some knit structures stretch more than others and some stretch in different directions.

Stretch and stretch recovery is important especially for fitting clothing such as leggings because it needs to stretch in order to be fitted against the wearer and then recover from stretch so that the garment does not become baggy or misshapen.

Citations

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