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RELATIONSHIP OF FIBER STRENGTH TO YARN STRENGTH Every individual who has ever been responsible for converting textile fibers into yarns has attempted getting the most from the fiber to give the highest quality yarn. Many fiber characteristics influence spinning performance and yarn strength, and in the case of cotton they seem to work together in transmitting qualities of the fiber into the yarn.

We have known for years that such characteristics as length, length uniformity, fineness and strength of cotton contribute to spinning efficiency, yarn strength and general quality. Before the rotor spinning era, most manufacturers were concerned with fiber length, the character of the cotton and its cleanliness. With the advent of open-end spinning, however, they had to begin looking at different parameters. It was realized early that rotor-spun yarns would be influenced greatly by the number of fibers in the cross section of the yarn. Therefore, it was recognized that finer fibers would give better spinning and stronger yarn than coarse ones and an effort was begun to obtain strong, mature, but fine fibers for rotor spinning.

All of this created a new understanding of the type of cotton necessary for producing rotor-spun yarns. Not many years ago low micronaire cotton was considered inferior; today it is much sought after, especially if the low micronaire is accompanied by good strength and a degree of maturity.

In the infancy of open-end spinning it was soon learned that yarns from this process were 15% to 20% weaker than ring yarns from the same cotton spun into the same number. In an attempt to regain part or all of the lost strength, research studies were initiated to determine which cottons were most satisfactory for rotor spinning. This research has continued to the present time, and apparently some of the results have been helpful. Today rotor-spun yarns appear to be entirely satisfactory in many woven and knitted fabrics, and the trend in spinning seems to be toward greater open-end production.

As we have had to look more closely at the fiber characteristics for rotor spinning, questions have arisen that were not even considered twenty years ago. Probably the most frequently asked question has concerned the transmission of fiber strength to yarn strength. Just about everyone these days is looking for high strength cotton for rotor spinning, and at least one company in the U.S. has been specifying that cotton purchased for one end product must have an average of 28 grams/tex. Although breeders and geneticists are working as rapidly as possible to develop commercial varieties that will have strengths around 28 to 30 g/tex, it is difficult for large users of cotton to meet all their needs for such high values. Therefore, we are looking at ways to retain more of the fiber strength in the yarn.

We have mentioned before that certain fiber properties are known to be beneficial in producing good quality yarns at high efficiency. Generally, most rotor spinners are looking for a medium length cotton with good length uniformity, medium to high strength, and micronaire values of 3.0 to 3.4 with a satisfactory degree of maturity. We realize there is a close relationship between micronaire and maturity in American Upland cottons and, as a rule, when extremely low micronaire cottons are used we are dealing with immature fibers. This may be satisfactory for some end products, but it is totally unsatisfactory for others.

Frequently, the spinner is also looking for cotton that will give a strong yarn while at the same time resulting in high spinning efficiency. We know that stronger fibers give stronger yarns, but one aspect many are not aware of is the percentage of fiber strength that is transferred to yarn strength. In this issue of *Topics* we would like to give information on this subject that we have accumulated over several years.

We have stated in previous research reports that there is a close relationship between fiber strength and yarn strength as measured by a 120-yard skein. This is a practical way of measuring yarn strength in many parts of the world where the skein is used for determining yarn number, strength and count-strength-product (CSP). However, we occasionally receive inquiries about the relationship between fiber strength and single-strand yarn strength. Some areas of the world deal only with single-strand strength, and as just about everyone will point out, the yarn after spinning is almost always used in single-strand form. This is true when winding, knitting, warping and weaving. Therefore, it is interesting to note the relationship between fiber strength and single-strand strength.

The table below illustrates this relationship. We have selected cottons from past reports that have approximately the same fiber properties, since it would be difficult to find many cottons with identical measurements. We have chosen lengths of 31/32 to 1-1/32 inches and micronaires generally at a level that would be of interest to rotor spinning companies, although a few shown are above the 3.4 discount level. No attempt was made to find cottons of any specific strength, except for the last entry. This long, high micronaire and strong cotton was included intentionally to make a comparison with the cottons that are generally purchased for rotor spinning. All examples are excerpted from past Texas cotton quality studies performed at the Textile Research Center for the Natural Fibers & Food Protein Commission of Texas.

PERCENTAGE OF FIBER STRENGTH TRANSMITTED TO YARN STRENGTH

Fiber Properties			Rotor Spun Yarns						Ring Spun Yarns			
			10/1 N_e		22/1 N_e		30/1 N_e		22/1 N_e		30/1 N_e	
Length (in)	Mic	Strength (g/tex)	Tenacity (g/tex)	% of Fiber Strength	Tenacity (g/tex)	% of Fiber Strength	Tenacity (g/tex)	% of Fiber Strength	Tenacity (g/tex)	% of Fiber Strength	Tenacity (g/tex)	% of Fiber Strength
0.97	3.1	23.4	14.2	61	12.4	53	10.9	47	14.1	60	13.4	57
1.00	3.1	21.7	13.8	64	12.3	57	12.3	57	14.0	65	14.1	65
1.01	3.0	23.3	13.6	58	12.8	55	12.5	54	13.6	58	13.8	59
0.96	3.6	23.3	13.7	59	12.7	55	12.4	53	13.8	59	13.2	57
1.03	3.6	26.9	15.8	59	14.9	55	14.2	53	16.6	62	16.6	62
1.02	3.0	24.1	14.7	61	13.5	56	12.0	50	14.5	60	13.8	57
1.03	3.8	26.4	15.6	59	14.3	54	13.5	51	15.3	58	15.3	58
0.98	3.6	25.4	14.4	57	13.4	53	12.1	48	14.4	57	13.0	51
0.96	3.6	21.7	13.6	63	12.3	57	11.8	54	12.5	58	11.7	54
1.02	3.9	21.3	12.1	57	11.6	54	10.3	48	11.9	56	11.3	53
1.04	2.8	25.8	14.6	57	13.2	51	13.1	51	14.7	57	14.9	58
1.02	3.5	23.3	13.0	56	11.8	51	10.5	45	12.8	55	13.0	56
1.04	3.0	24.7	13.5	55	12.5	51	11.7	47	13.9	56	13.2	53
1.00	3.3	23.2	13.0	56	11.6	50	11.2	48	13.3	57	12.1	52
0.99	3.7	23.2	13.1	56	12.1	52	11.0	47	13.2	57	12.2	53
1.05	2.9	23.8	13.8	58	12.9	54	12.1	51	14.7	62	13.4	56
				Avg. = 59		Avg. = 54		Avg. = 50		Avg. = 59		Avg. = 56
1.16	4.6	29.4	17.2	59	16.2	55	N.A.	N.A.	19.0	65	18.3	62

We want to mention at this point that we are aware the amount of twist inserted has a direct influence on yarn strength. Also, there are certain mechanical features of spinning machines that will affect yarn strength. The more obvious ones for rotor spinning are rotor speed, diameter and profile, the surface roughness of the navel or doffing tube, and opening roller speed and type. We have kept these constant during our spinning tests in an attempt to eliminate as many variables as possible. If anyone is interested, we will send complete details of spinning both types of yarn. The yarns reported here were spun with a twist multiplier of 4.80 for the rotor yarns and 4.0 for the ring yarns. There were minor variations in both TMs due to mechanical features of the machines.

The rotor-spun yarns were produced on a Rieter m1/1 machine, and the ring yarns were spun on a standard 240-spindle Saco Lowell machine. We have included spinning results from three different rotor yarns, N_e 10/1, 22/1 and 30/1. Two of the same numbers are presented from ring spinning so a comparison can be made between the two systems. We have not attempted to establish a correiation between the fiber and yarn strengths, but are showing the percentage of fiber strength that is transmitted to yarn strength. It will be seen that a higher percentage occurs in the coarse yarns, which have a greater number of fibers per cross section. This is true mostly for the rotor-spun yarns. As the rotor yarn size changed from 10/1 to 30/1, the average percentage of fiber strength going to yarn strength declined in what appears to be very nearly a straight line. However, there seems to be a different relationship when using these same cottons to spin ring yarns. It has been observed that the deterioration in strength as the yarn number goes up is less for ring yarns than rotor yarns because of the more ordered fiber orientation at ring spinning. Since ring-spun yarns are more variable, it is possible that occasional results will be obtained that show an apparent increase in yarn tenacity of a fine yarn over a coarser one.

It is interesting to note that the difference in the percent of fiber strength going to yarn strength (rotor/ring) is 54/59 (0.915) for the 22/1 yarn, and 50/56 (0.893) for the 30/1. This shows that the 22/1 rotor yarn is about 8.5% weaker (100 minus 91.5) than the same ring-spun number, and the 30/1 rotor yarn is 10.7% weaker (100 minus 89.3) than its ring-spun counterpart. This is a measure of the progress that has been made in recovering some of the strength loss that was found in the early days of rotor spinning.

Another point worthy of note is an indication of the fiber strength that should be purchased for achieving a certain yarn strength. If yarn strength is an important criterion which must be achieved when spinning a 22/1 rotor yarn to replace the same number at ring spinning, one would need to buy a cotton about 9.3% stronger (59/54). For 30/1 yarn, purchasing a cotton 12.0% stronger (56/50) will be required. This is only a rough guide, but it might be useful. For example, in dealing with a N_e 30/1 yarn alone, increasing the cotton fiber strength from 22 to 25 g/tex should permit the equivalent of ring yarn strength to be achieved while spinning with appropriate twist on a modern rotor machine that is in top condition.

This report is not intended to be conclusive. We simply are attempting to pass along some observations made in our research. We hope this will be of interest to our readers, especially those who have inquired about the relationship between fiber strength and single-strand yarn strength.

SYMPOSIUM UPDATE In the previous issue of *Textile Topics* (Vol. XV, No. 11), we did not have the exact title of the presentation to be made by Mr. George Blomquist of Parkdale Mills, Lexington, North Carolina, during the November 18 session of the symposium on *Recent Developments in Cotton Fiber Testing and Spinning Technology*. We are now pleased to announce the title, which is "Testing and Blending Procedures for Spinning Cotton and Synthetics on Rotor Machines." This is a matter of considerable interest to many textile manufacturers. We believe Mr. Blomquist is well qualified to speak on this subject, as Parkdale Mills is a leader in yarn production from cotton/polyester blends.

We are pleased with the interest shown in this symposium and the number of persons who have already registered for it. While most of those indicating plans to attend are from the United States, we have received registrations from friends in Brazil, Switzerland, France and England. We are aware there will be attendees from other countries as well. We want to assist those planning to attend in any way we can, and hope anyone who desires additional information will contact us.

Please remember these details: Participants should make their own lodging arrangements directly with the Lubbock Plaza Hotel, where we have a block of rooms set aside. A hotel room reservation form is reproduced on the next page. Symposium registrations and fees should be sent to the attention of Harriet Boone at the Textile Research Center. As stated earlier, the $45.00 fee will be refunded to anyone who finds he cannot attend. Finally, please make checks payable to the **Textile Research Symposium**. Observing these details will greatly facilitate your registration.

VISITORS Visitors to the Textile Research Center during August included Carl Cox, Natural Fibers & Food Protein Commission of Texas, Dallas, TX; Lynn McDonald, Stoneville Pedigreed Seed Co., Stoneville, MS; Greg Boggs, Texas Department of Agriculture, Amarillo, TX; David Cross, Brown Associates, Austin, TX; Dean B. Turner, Cotton Incorporated, New York, NY; John Johnson and Noel Shepherd, Hercules Incorporated, Magna, UT; Roger Bolick, Allied Fibers, Hopewell, VA; Toni L. Basinger, Meister Publishing Co., Memphis, TN; and Jack Altman and Roger Hoffman, Brookshire Knitting Mills, Inc., Dallas, TX.

Others were Rais Ahmed, Pakistan Institute of Cotton Research & Technology, Karachi, Pakistan; and Chris Theron, Oranje Co-op, Upington, Republic of South Africa.

Groups visiting included twelve students from Austria who were participants in the Rotary International exchange program; forty 4-H members from Roosevelt County, New Mexico; and twenty-four students from Mukogawa Women's University, Kyoto, Japan, who were accompanied by MWU faculty members Billy Burke and Takeshi Yasuda.

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