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TEXTILE TOPICS

INTERNATIONAL CENTER FOR TEXTILE RESEARCH AND DEVELOPMENT
TEXAS TECH UNIVERSITY / LUBBOCK, TEXAS / U. S. A.

Volume XVI, No. 11 July 1988

CAUSES OF SUGAR ON COTTON Cotton that sticks to processing machinery during carding and spinning is a problem that textile manufacturers declare is occurring all too often. As one plant manager recently said, "If it happens once, that is too often."

It has been known for some time that cottons coming from certain countries, and certain areas within countries, often give this problem during processing. While cotton from some areas seems to contain a sticky substance almost every year, that coming from other locations will sometimes unexpectedly be a problem after a number of years during which stickiness is not detected at all. This was the case with the 1987 cottons coming from at least two locations in the United States.

Numerous causes of stickiness have been suggested. Almost every change in cotton production practices has been mentioned as a source of the problem. Oil from spindle harvesting equipment, agricultural chemicals, insects, weather, stripper harvesting, bacteria, fungi, cotton varietal differences, ginning practices and even soil types have been suggested. While there are sometimes isolated cases where grease, oil, gums or creosote cause cotton to stick during carding and spinning, for the most part the problem comes from sugar on the fiber. Today we recognize there are at least four separate sources of sugar that may be involved. These are nectar-secreted, cellulose precursor, insect-secreted, and microbiologically-generated sugars.

The transport form of sugar from the site of photosynthesis to the nectar glands and cotton fibers is sucrose. In cotton fiber growth, sucrose is enzymatically converted to one part glucose and one part fructose. The fructose is then converted to glucose and two molecules of glucose are reacted to form cellobiose. Cellobiose is then polymerized into cellulose.

Sucrose is secreted into shallow disk-shaped receptacles called nectar glands (nectaries) located on both the leaves and in the cotton bloom. A portion of the sucrose is hydrolyzed, again giving both glucose and fructose. When sucrose, glucose, or fructose is detected on a sample of cotton, it is likely impossible to determine whether the origin was nectar-secreted or cellulose precursor.

The situation is different for insect-secreted sugars. Plant lice (aphids), whiteflies and other insects feed on plant saps. Plant saps including nectars are extremely low in nitrogenous material such as amino acids and protein. Insects which feed exclusively on plant saps ingest large amounts to satisfy their protein requirements. The carbohydrate intake from the sugar in the sap is far in excess of their dietary requirements and the excess sugars which are ingested are excreted as honeydew. Honeydew is defined by entomologists as the sweet secretion from aphids and scale insects. On occasion there has been some confusion with the terms nectar and honeydew. The distinguishing feature about honeydew is the appearance of sugars other than the sucrose-glucose-fructose group normally present in plants. In some cases the principle sugar ingested is sucrose, which is a disaccharide formed from glucose and fructose. The principle sugar excreted can be turanose, which is also a disaccharide formed between glucose and fructose, but with a different linkage. These so-called higher sugars are more common in honeydew than in nectar.

Many entomologists are slow to recommend insecticide control measures for aphids or whiteflies, although significant amounts of honeydew may be generated in a short period of time. These insects do not significantly reduce lint yield, and any reduction in the use of insecticides simply means a lower production cost for the farmer and possible benefits to environmental preservation. However, some areas with impractical agricultural pesticide restrictions may inadvertently produce sticky cotton on a continuing basis when honeydew-producing insects are not controlled.

The fourth category of sugars includes the microorganisms living on the carbon and nitrogen sources excreted by nectaries, other glands, and insects. The colonies of microorganisms flourishing on the plant (usually greater than one million per gram of fiber) are present in the cotton lint, and as one might imagine, complications from this microscopic world can be quite confusing.

Some efforts have been made to correlate sticky cotton with certain chemical tests such as the Molisch

color reactor, which is observable with honeydew. A positive test will probably mean sticky cotton, although a negative test is no absolute assurance that the cotton will not stick during processing. Reliability of this test is similar to others in that the sporadic nature of the occurrence of sugar can result in large sampling errors.

Commercially available cottons from major production areas of Texas are evaluated each year at the International Center for Textile Research and Development. Information derived from this evaluation is available to cotton producers as well as marketing firms and manufacturing companies. While evaluating the 1987 Texas crop, it was decided to determine the sugar content of the eighteen cottons included in the study. An interesting observation was that a nectarless cotton variety that has become commercially popular in Texas was among those being evaluated, and this was determined to have a sugar content of 0.19%. However, one of the nectarous cottons was found to have a sugar level of 0.20%, which is also quite low. These two cottons had the lowest amounts of sugar, while the highest measured 0.75%. The average content for the eighteen cottons was 0.41%. A level above 0.60% would usually be expected to stick during textile processing. It has been generally concluded that a sugar content greater than 0.30% can be considered a potential problem, but none of the cottons in the study conducted here at the Center was found to stick, even in the slightest way.

As we have investigated this problem, we have realized that mill conditions (machinery speeds, settings, roll pressures and humidity levels) likely are influential on levels of sticking somewhere between severe to no sticking at all. We have observed that cottons with relatively high sugar contents (0.60% to 1.0%) have caused problems during processing at spinning plants in the Southeastern part of the United States where humidity is normally high. At the same time, cottons with the same sugar levels have not stuck when processed in West Texas where the humidity is usually very low. (Conditions in the Lubbock area for afternoon high-temperature periods normally have relative humidity levels of 0% to 20%.) It is necessary, of course, to have sufficient humidity in the card room to prevent static build-up, but the conditioning of the cotton prior to entering the mill seems to have a good bit of influence on whether it will stick.

In one case where we were experimenting with an additive that was applied to determine its ability to eliminate stickiness, we used a specially selected bale of cotton that had a sugar content of 1.30%. This, of course, is considered very high. However, the cotton would not stick to any of the equipment in our card room. We finally placed the opened bale in a laboratory where the relative humidity was 80% and left it there for three days in order to get it to stick during processing. Once this was accomplished, we then applied the additive to determine its ability to eliminate stickiness. The additive showed promise in improving processing performance. Results from this test are to be confirmed in an additional study.

This review of sugar on cotton and the problem resulting from it has been prepared with assistance from Dr. James E. Reynolds, Dr. Dick Crill and B. G. Wyatt, staff members of the International Center for Textile Research and Development. This is not intended to be an all-encompassing report on the subject, but rather a review of the causes of stickiness that we have identified in our studies. We are aware that others have done extensive research on the causes and possible cures for sticky cotton. We would like to recognize three who have prepared a number of publications on the subject. They are:

- Justin Gutknecht, Director, Division of Technology, Institut de Recherches du Coton et des Textiles Exotiques (IRCT), Montpellier, France;
- Henry Perkins, United States Department of Agriculture, Agricultural Research Service, Clemson, South Carolina; and
- O. Elsner, Textile Chemistry Department, Shenkar — The College of Textile Technology and Fashion, Ramat Gan, Israel.

We are grateful for the contributions these men have made that may eventually lead to the successful management and possible elimination of this problem.

We hope this article is of interest to the recipients of *Textile Topics*. We will appreciate hearing from anyone who has additional information that would be helpful to a better understanding of this subject.

REYNOLDS JOINS ICTRD STAFF Dr. James E. Reynolds has recently joined the staff of the International Center for Textile Research and Development as Coordinator of Chemical Processes. In this position he will supervise and coordinate the activities of the Center's chemical research and processing laboratories and the many programs conducted in them.

Reynolds has been involved in agricultural-related research and development work for many years,

both in the United States and abroad. From 1982 until 1986 he lived in Adana, Turkey, where his work involved developing a seed corn business for Basagene Inc., a New York corporation. The Turkish company, Bereket Tohum Sanayii, was the first wholly foreign-owned agricultural corporation to be chartered in Turkey. Previously, Reynolds spent four years in Cairo, Egypt as manager of Middle East Operations for Pioneer Overseas Corporation. While there he initiated a sorghum seed business in Sudan for Pioneer Hi-Bred International.

Dr. Reynolds received a B.S. (with honors) in General Agriculture from New Mexico State University in 1953. In 1963 he was awarded a Ph.D. in Plant Pathology with minors in chemistry and botany from Oregon State University.

Reynolds has moved to Lubbock with his wife, Barbara, from Coralville, Iowa. We are pleased to have him on our staff.

DONATION RECEIVED FROM TEXTUBE CORPORATION The Textube Corporation of Greer, South Carolina recently donated two large boxes of top value plastic cones to the International Center for Textile Research and Development. These are for use on our Schlafhorst Autocoro rotor-spinning machine and will be very helpful in both research and training programs.

We always appreciate contributions of this type, and we are grateful to the Textube Corporation for its generosity in making these cones available to us.

GROZ–BECKERT DONATES SUPPLIES We were very pleased to receive recently a generous supply of high quality knitting needles from Groz-Beckert U.S.A., Inc., of Charlotte, North Carolina. These are for knitting equipment that is used for educational and research programs here at the International Center.

Assistance of this nature is important to a non-profit institution, and we thank Groz-Beckert for making these needles available to us.

SHORT COURSE CONDUCTED FOR JOHNSON & JOHNSON The International Center for Textile Research and Development conducted an intensive short course in Textile Technology for Johnson & Johnson of Sherman, Texas July 5 through 8, 1988. Johnson & Johnson personnel participating and receiving certificates upon completion of the course were James Heintz, Vesna Novakovic Rafaty, Dan Casmey, Elizabeth Higdon, Stephen H. Murray, Jimmy L. Daniel and Howard G. Mays. Instructors were R. Russell Rhinehart, Chemical Engineering Department, Texas Tech University; and S. Rose Matic, Pauline Williams, Harvin R. Smith, Edwin R. Foster, John B. Price, William D. Cole and Richard N. Combs, staff members at the International Center.

We have offered short courses for Johnson & Johnson for several years, and it has been a pleasure working with them. Though such courses are not given by ICTRD on a regular basis, we are happy to design specialized courses for those who request them. If any of our readers desire more information about this, please contact the Center at the address given on the back page of *Topics*.

VISITORS Visitors at the International Center during July included T. Wayne Spraggins and B. W. Henry, Avondale Mills, Sylacauga, AL; S. R. Skaggs and Peter D. Shalek, Los Alamos National Laboratories, Los Alamos, NM; R. H. Pusch, Woven Structures, Compton, CA; Charles Elk, TU Electric, Dallas, TX; Erwin M. Claeys, Texas Research and Technology Foundation, San Antonio, TX; Adrian Hunnings, Cotton Council International, Washington DC; Joe W. Thomas and Bill M. Norman, Continental Eagle Corp., Prattville, AL; Trudy Moeller and W. J. Turner, Cardox, Dallas TX; Barbara Shaeffer, Motion Control Inc., Dallas, TX; T. C. Yang and H. C. Yu, Taiwan Cotton Spinners Association, Taipei, Taiwan; Chun-Kuei Chang and Wu Bing-Hang, Tai Yuen Textile Co., Ltd., Chupei, Hsinchu, Taiwan; Alec M. Ford, Wool Research Organization of New Zealand, Christchurch, New Zealand; and Jeong Chun Lee, Pung Han Textile Co., Ltd., Choong-Cheong Namdo, Korea.

In addition to those named above, Eugene King of I.C.I. Americas brought a group of twenty cotton farmers from Australia for a tour of the Center, and twenty-two participants in Texas Tech University's "Shake Hands With Your Future In Engineering" program came to the Center on July 21.

THANKS FOR YOUR HELP In the May 1988 issue of *Textile Topics*, we asked you to help us improve

our mailing list. Many of you did this, and we appreciate your cooperation.

We encourage others who know of a change that should be made to write and give us corrections in mailing addresses, changes in personnel, or other information that will lead to a more efficient distribution of *Topics*. Also, because we are interested in sending this publication to as many textile managers and executives as possible, we will be pleased to place additional names on our mailing list.

We thank you for your interest and assistance.