New Developments in Testing Methods

FibreShape System to Measure Fiber Widths

SaskFlax - Saskatchewan Flax Development Commission, www.saskflax.com

One of the most important properties of flax fiber and flax fiber bundles is the diameter or width of the fiber or bundle. In the textile world, this is often referred to as fiber "fineness". In general, the finer (thinner) the fiber, the stronger the yarn or the plastic composite that uses such fibers.

Intuitively this seems odd, since we usually think that when we put thick strong fibers together in a rope, a yarn or a plastic composite we must, indeed, get a very strong final "construction" or product. However, it turns out that most of the strength of a yarn or a rope comes from the friction between the surfaces of adjoining fibers and not from the strength of the fibers themselves. For a given weight of fiber thin fibers have much more surface areas than does the same weight of thick fibers, hence a stronger rope or year of a given diameter can be made from thin fibers than from thick fibers. Similarly in a plastic composite, most of the strength comes from the bond between the fibers and the resin and not from the strength of the fibers themselves. Since a given weight of fine fibers has more surface area than the same weight of coarse fibers, a plastic composite made with a given weight of fine fibers will have better strength properties than if it is made with the same weight of coarse fibers (all other things being equal). Hence, in may applications, the finer the fiber, the higher the value of the fiber.

Fiber diameters were traditionally measured under a microscope, one fiber at a time. Although such a method is very accurate, it is very slow, tedious and expensive. In addition, the results may not truly represent a whole bale or shipment of fiber since there are many millions of fibers in even a single bale of fiber. Over the years, the cotton, wool and synthetic fiber industries have developed several types of "air flow" systems as an alternative to relatively quickly and cheaply estimate the average fiber fineness of a sample of fiber. This system is based on the principle that the finer the average diameter of the fibers in the sample, the more resistance there will be to a constant (i.e. fixed or given) blast of air.

Air flow systems have been used for many years with cotton, wool and even synthetics and they work well with these fibers because these fibers are all single fibers. Unfortunately, flax is a bast or stem fiber (as is hemp, jute, kinaf and ramie) and the fibers get packed into tight bundles as the fibers mature inside the plants' stems. The more mature the bast fiber plant, the more tightly packed and thicker the fiber bundle. When the stems of bast fiber plants are retted, the microbes growing on the stems secrete enzymes which break down and dissolve the pectin that hold the fibers tightly together in the bundle and/or that hold the bundles to the rest of the stem. After retting, mechanical action in the form of scutching and/or decorticating and/or hammer-milling machines attempt to complete the breakdown of fibers bundles back into single fibers. Some methods are more successful than others but no system does the job perfectly. Hence, flax fiber samples always have some combination of individual fibers and different sizes of fiber bundles. When we try to use an airflow system to give us an estimate of the fiber fineness of such processed flax fibers, we can get easily tricked because there are many combinations of thick and thin fibers and bundles that could give the same air flow reading . As an alternative, some textile engineers have developed a laser based system (i.e., Lasercan) that can quickly measure thousands of fibers and then graph the results but system is quite expensive (i.e. more than $100,000).

<u>The FibreShape System to Measure Fiber Widths</u>

The hardware used in this system consists of a commonly-available high resolution slide scanner, a computer and software developed by Innovative Sintering Technologies Ltd. (IST) of Switzerland. Fibers to be measured are mounted on slides and inserted into the slide scanner where they are scanned and an optical image of the fibers is created. After being calibrated, the software then measures the widths of clearly separated sections of fiber and accumulates the results of thousands of such measurements. These measurements are then combined to create discrete and cumulative bar and line graphs that show the range of fiber diameters that are present in the test sample. In the past, such a test was almost never done because of the weeks of time and expense that would be involved in doing even one test.

The new “FibreShape” optical recognition and software system is much cheaper (about $15,000) than a laser based system, is very fast and can present the results in a graphical form and appears reasonably simple to operate. However, like many measuring systems, the protocols that are used to collect, prepare and present the material to be measured (in this case, fibers) can and do effect the accuracy and repeatability of the results. Recently the Flax and Linen sub-committee (D13.17) of the American Society for Testing and Materials (ASTM) have been working on standardizing the protocols and software settings that should be used with the FibreShape system to ensure accuracy and repeatability. When these draft protocols are tabulated and approved by the ASTM membership, there will be a new standardized optical recognition ASTM test method to measure the diameters f flax fibers with the tentative title of “Standard Test Method for Determining Fibers Width Using Image Analysis.” The results will show the percentage distribution of fibers that fall between many given ranges of micron values and will nominally be based on the optical analysis of many thousands of fibers in a sample. Such results are much more valuable to industry than are the single average “air flow” diameter estimates that are commonly used in the cotton, wool and synthetic fiber industries.