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Clemson University

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THE

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In keeping with our past policy of featuring a central theme for our magazine, the 1958-1959 staff of the Bobbin and Beaker brings to you the student, and to you who are in industry, reports and articles from some of the leading textile schools in the United States.

Our features tell a story of the activities centered in and around these institutions which supply the textile industry with the management material and information so vitally needed at the present time.

Statistics, words, and pictures are blended together to show that "Textiles . . . the Field is Unlimited."

—Wayne Freed, Editor
Textiles -- The Field Is Unlimited

Sal Castorina. Ch.E. ’60
Georgia Institute of Technology

Reprinted through the Courtesy of the “Georgia Tech Engineer,” February 1958 Issue.

Claiming to be the 3rd oldest school on the Georgia Tech campus, the A.French Textile School was established in 1889. This date gives it the right to claim the title of being the first textile school south of the Mason-Dixon line. But textiles, as well as the school, have come a long way in the past 69 years. The textile industry has grown from a southern necessity to a nationwide institution. Textile corporations now take their place in industry side by side with the automotive and railroading giants. More and more high school students are becoming interested in textiles. Some in textile engineering, some in the chemistry of textiles. New techniques, advanced methods, and finer products demand better quarters to insure better textile specialists. As the textile industry grew the A. French Textile School began making plans to move. In 1949 the $1.5 million Harrison Hightower building was ready for occupancy. Included in this “little red schoolhouse,” besides its many mill rooms, are eight classrooms, a student lounge, ten offices, a conference room, a library, an auditorium and an exhibition gallery. This massive building does not stand as a teaching aid for a decadent or a dying industry. The applications for admission into the textile school are increasing from year to year. There must be a reason. Actually there are many reasons.

Today’s high school student is a well-informed person concerning careers and vocation. Heavy stress is placed on the future. Vocational classes are conducted. Guest speakers laud the particular merits of their chosen field. As these students were told, the textile field has much to offer. For those in search of a field of satisfying work, as well as the many desiring to choose a career in a profitable as well as secure industry, textile work carries a loud cry.

An entering freshman in the textile school has three branches of textile work of which he may choose his preference. Degrees offered in the undergraduate school are Bachelor of Textile Engineering and Bachelor of Science in Textiles. The latter is further broken into two options, the manufacturing option and the Chemistry and Dyeing option. As a freshman the curriculum of all three branches is primarily the same. The basic courses of Math, Chemistry, English, Engineering Drawing and Modern Language or Social Science are taken by all. But in his sophomore year specializations begin. Perhaps we had better pause here and clarify one item. The idea may have been given that textile work is strictly for men. The masculine pronoun is used solely for convenience. The number of women studying Textile Engineering and Textile Chemistry is growing yearly.

In his sophomore year the textile engineer begins studying in his department with Fabric Design and Fabric Analysis along with the basic sophomore courses of Calculus, Physics and English. Surprisingly enough, in his junior year he takes only two courses in his department, Yarn Manufacturing and Weaving. The remainder of his curriculum is filled with courses in other schools. Thermodynamics and Industrial Marketing are two of these subjects designed to give this engineer the background necessary for a successful career in today’s complex industry. But in his senior year nine different courses are scheduled in his department along with a number of other courses, such as Technical Writing and Industrial Psychology.

The program for a B.S. in Textiles in the Chemistry and Dyeing Option is different in the amount of courses taken in the School of Chemistry. Analytical, Organic, and Physical Chemistry constitute a portion of a Sophomore and Junior’s interest in Chemistry. Along with his chemical courses, then and also when he is a Senior, come many classes in bleaching and dyeing. These are supplemented by courses similar to the extras of the Textile Engineering program, Technical Writing and Industrial Psychology.

A student in the manufacturing option begins his specialization in his sophomore year with Yarn Manufacturing. Highlighting his junior year are such courses as Organic Chemistry, Weaving, Industrial Marketing. These are followed the coming year with Cotton Classing, Physical Textile Testing and other allied subjects.

But all of this textile student’s education is not learned in the classroom. Many hours are spent in the lab or mill rooms. Practical work constitutes a very important phase of a textile student’s education. Work with actual looms, yarn and knitting machines is necessary for three options. Supplementing these labs are frequent field trips to nearby textile mills.

(Continued on page 20)
It's Your Future--Choose It Wisely

By

Alan Bell, TE ’60
Clemson College

You are approaching the final phase of preparation for your life's work. As you look toward a college education, you must make decisions that will determine your entire future—be realistic—consider the facts—do not be swayed by impractical dreams or influenced by passing fads.

Would you like to be part of an industry which employs more than two-thirds of all the manufacturing personnel in South Carolina, provides more than two-thirds of the manufacturing payroll in the state, gives employment to over 130,000 South Carolinians earning in excess of $400,000,000 annually? The 325 plants in South Carolina are valued at fifteen percent of the state's total assessed property. Of course this is the textile industry, the industry which produces 63 percent of this state's gross annual manufactured products which amounted to more than $1,700,000,000 last year.

South Carolina accounts for more than 34 percent of the active textile spindle hours in the United States, and at the same time consumes more than 28 percent of all the cotton used by textile mills. In addition to the mills in South Carolina there are textile mills located in 40 of the 48 states. The total number of textile mills in the United States is approximately 8,000. These plants employ some 1,000,000 persons who earn approximately $3,300,000,000 annually.

In 1957 the textile industry ranked sixth in size by employment, ninth by assets, and ninth by sales. These figures prove that the textile industry is not only basic to our state economy but also to our national economy. Taken together with the garment and allied industries it ranks first in industrial employment.

The textile industry is located chiefly in the heart of the south-lands. Three states, North Carolina, South Carolina, and Georgia have the majority of the mills with other southern states giving them help. Why this location in the south? Here trained labor is available, cheap power is available, there is room for expansion and reasonable taxes are some of the answers.

Opportunity for rapid advancement is exceptional for trained personnel. In few industries will you find as many young men holding key positions as in the textile industry. Starting salaries in the textile industry are high. Textile executives seem to get to the top sooner, to stay there longer, and to be paid better than those in most other industries.

The number of Textile graduates is small in comparison to the number needed by the textile industry. A textile graduate has a wide and varied choice of jobs. In the past several years, almost every Clemson Textile Graduate has had from 5 to 10 job offers. A recent survey shows that about five times as many textile graduates will be needed in the next ten years as present enrollment indicates will be available.

Many textile plants offer training programs to college graduates which may consist of several months of actual training in the mill before any definite assignment is made. Few other industries offer training this valuable to new employees.

Those entering the textile field are not restricted to one phase of the industry, but are usually tried in several departments to determine where they will best fit into the organization. This may include: yarn manufacturing (cotton, wool, silk blends), synthetic fiber manufacturing, textile machinery manufacturing, dyeing, finishing, costing, research, design, quality control, sales, personnel, textile chemicals and supplies, advertising, writing, teaching, textile specialties and many others.

The textile industry has problems—all industries do. That is one of the reasons why top level executives are interested in college and technically trained men. They need them to keep their plants ahead.
To an industry that has duplicated the work of the silk worm, the wool of the sheep and developed new and unheard of fibers, very few things are impossible if college graduates, trained in methods of research and development are available. Most mills have their own research departments now, where new methods and processes are developed.

Yesterday was the day of the technician in the textile industry — the mechanic who developed new ways of spinning. Today is the day of the research worker and the chemist. These are the laboratory workers who discover new ways to do new things and who open new horizons to designers, manufacturers, and retailers.

It takes all kinds of men to fill the needs of the textile industry, there is a place for every man. There is a place in textiles for the man who likes machines, there is a place for the person who likes people or mathematics or research. Others who do not like the technical end of textiles may find their place in the management of personnel fields. No matter what your interests, more than likely you can find a job to suit you in the diversified field of textiles. You can find opportunities to increase your education and prepare yourself for promotion.

There are excellent career opportunities for women in textiles. About 35% of the textile workers in the south are women. The pay rate is generally equal to that of men doing the same work. Within a few months women may expect to be earning higher wages than in any other industry with equal training. Many women are holding key positions with textile firms.

The field of chemistry offers a good chance in laboratory work and research. A woman with some artistic inclination may go far as a designer. Personnel work is a wide open field for women, but few girls go very far in the supervisory fields of production.

Women with formal textile training and a knowledge of shorthand and typing can have their pick of the choice secretarial jobs.

Why go far afield to some unproved occupation when the textile industry is here at home? Consider the opportunities offered by this industry before making a final decision. The need for office supervisory workers has advanced greatly. White collar workers are about as numerous as blue collar workers. This trend emphasizes the need for trained personnel with increased income.

There are ten schools in the United States that offer textiles as a major course of study. Technological advances make the college trained man more desirable and the one with a textile background even more so.

There are about 8,000 Textile Plants plus many related fields competing for the services of these graduates. With a decreasing supply and an increasing de-

mand, where are your executives and production men to come from?

Clemson College has one of the finest textile schools in the world for you. Clemson at present has three curricula in textiles which cover almost every phase of cloth manufacture from the processing of the raw materials to the completion of the finished product. Within the scope of Textile Manufacturing, Textile Science, or Textile Chemistry you will find the training to prepare you for many phases which may interest you.

Each of the three curricula offered combines detailed technical training with sound liberal education to give you a broad background for a successful career. The day of the narrow specialist is gone. If you are to serve in any phase of textiles, you must become more than a skilled technician. You must have an overall view of the whole field. Upon this philosophy textile education at Clemson is based. A brief description of the three major Textile curricula offered at Clemson follow:

TEXTILE MANUFACTURING

Textile manufacturing prepares you to enter the production and management phases of the textile industry. In this curriculum you learn the general methods of preparing raw materials, spinning them into yarns and weaving these yarns into cloth. You are taught the fundamentals of textile machinery (Continued on page 21)
Introduction

During the past ten years Textile Research Institute has conducted a broad program in cotton research aimed at providing for the American cotton industry fundamental knowledge of cotton. Since Textile Research Institute is a research and educational institution, supported by dues from a group of firms within the textile industry and its allied branches, the cotton research program at TRI must be considered as a portion of the cotton industry's investment in fundamental research. Certain aspects of the work have been and are currently being conducted under contract with the U. S. Department of Agriculture. In order that the research program be pertinent to the problems of the cotton industry at all times, over-all guidance is in the hands of the TRI Cotton Research Advisory Committee. This Committee is composed of technical representatives from the sponsoring firms, the U. S. Department of Agriculture, and the National Cotton Council of America. The Committee meets semi-annually with the TRI technical staff in order to discuss the results of past work and to advise in the formulation of the future program. Clearly, the Committee fulfills the dual function of keeping the TRI staff aware of the industry's technical problems, as well as providing the sponsoring organizations with information on the progress of TRI research. The sponsoring organizations are also kept abreast of developments by frequent technical reports which are issued by the Institute. Finally, significant aspects of the work eventually find their way into scientific literature where they become available to the entire cotton industry.

Technology of the cotton industry constitutes a vast, complex structure utilizing the services of biologists, chemists, physicists and engineers. All these fields of science must be called upon to keep the cotton industry operating smoothly, efficiently and competitively. This underlying fact is a result of the technological developments which have taken place during the past two or three decades. These developments range from the spectacular advances of the cotton breeder, who has provided the industry with many new cotton types, to the evolution of a variety of textile finishing processes which produce many useful and interesting effects in the final fabrics. Thus, the term "technology of cotton" is an extremely broad designation and no single organization can possibly undertake to study all the many ramifications that the term includes.

While it has been stated that the broad objective of the TRI cotton research program is to provide fundamental knowledge of cotton, the program must of necessity be oriented to answer certain specific questions. What, then, are some of the phases of the research program which have been carried out in the past as well as those which are now under investigation?

Influence of Fiber Properties

If a student were asked to list the mechanical properties of single cotton fibers, he would be hard put to give a concise answer even for the frequently discussed values of breaking strength, breaking extension and elastic recovery. The inability to give such an answer would not be the result of poor studying habits on the part of the student, but would be due rather to the development of cotton fiber types possessing unique combinations of fiber properties. For example, cottons have been developed whose average single fiber breaking extension in tension is as low as 5%, while other cottons have been grown whose average single fiber breaking extension is as high as 15%. Similarly, average single
fiber breaking tenacity values may be made for practically all fiber characteristics. Cotton fiber properties are highly interrelated so that generally cottons with a low fiber extensibility are strong and stiff, whereas cottons with a high fiber extensibility are weak and pliable. While it has been possible for the breeders to develop these cottons with extreme values of certain fiber properties, the question as to the influence of these properties on the characteristics of yarns and fabrics remains to be answered conclusively.

One of the major phases of the TRI cotton research program is the establishment of the influence of cotton fiber properties on the characteristics of cotton textile end products. Experiments of this nature entail the judicious selection of several desirable cotton types and the careful evaluation of the single fiber mechanical properties of the chosen cottons; highly controlled processing of the experimental cottons into standard construction fabrics; and finally, the evaluation of the characteristics of the resultant fabrics. An example of the influence of single fiber breaking strength on the breaking strength of the corresponding fabrics is shown in Figure 1 for six experimental cotton types. It will be noted that the fabric strength increases with increasing fiber strength for five of the cottons, but that the sixth cotton has a lower fabric strength than would be expected on the basis of its single fiber breaking strength. This indicates that fiber strength, though an extremely important fiber characteristic, is not the only factor which determines fabric strength. Some other fiber property, which may or may not be related to fiber strength, plays an important role.

The establishment of this and other relationships between fiber properties and end-product characteristics is an important part of the TRI cotton research program. It is the aim of this portion of the program to provide information which will guide cotton breeders in developing superior fiber types.

Cotton Fiber Structure

Of considerable interest and importance to the textile scientist is a thorough knowledge of the chemical and physical structure of any given fiber and the relationship of the structure to the fiber mechanical properties. As is well known, the cotton fiber is a cellulose material, and is in fact the purest form of cellulose found in nature. Cellulose is a long chain polymeric carbohydrate material found in virtually all vegetable matter. It has been shown by many investigators that the manner in which the cellulose is arranged within the fiber has a distinct bearing on the chemical, physical and mechanical characteristics of the fiber. Investigations at TRI are constantly under way to establish more clearly and definitely the structure of cotton cellulose. Concurrently investigations are conducted to determine the relationship between certain of the structural parameters and cotton fiber mechanical properties. As an example, the degree of orientation of the cellulose molecules with respect to the fiber axis has been shown to relate to practically all fiber properties. The degree of orientation is most readily evaluated by a parameter known as the x-ray angle. The relationship between the x-ray angle and the fiber breaking extensibility for 16 experimental cotton types is illustrated in Figure 2. This relationship clearly indicates that a fiber mechanical property, such as the breaking extensibility, is a function of the physical structure of the cellulose comprising approximately 96% of the fiber. Similar relations could be shown for other fiber properties.

Effect of Processing

From the time that the lint is picked in the field to the time that it finds its way into a consumer product, cotton undergoes a wide range of processing operations. Some of these operations are purely mechanical, others purely chemical, and still others require a delicate balance between chemical and mechanical action. The study of the manner in which fiber properties are altered as a result of either mechanical or chemical action constitutes another phase of the TRI cotton research program. For example, it has been found that excessive heating prior to ginning induces certain weakness in the cotton fiber, and that upon subsequent mechanical processing the fibers have a tendency to break. The net result is that excessively heated cotton has a higher percentage of short fibers than a corresponding cotton which had not been subjected to excessive heat. The higher percentage of short fibers results in poorer processing efficiency and a lower end-product quality. The significance of fiber length distribution was thus indicated and, after suitable further verification by other examples, can now be considered as established.

Chemical Receptivity

With the current expansion in chemical finishing and modification of cotton it was thought advisable to initiate a study of the manner in which different cottons respond to chemical reactions. While this phase of the TRI cotton research program is only in initial stages, certain interesting observations have already been made. Foremost amongst these was the evaluation of the manner in which cottons respond to mercerization. This chemical treatment is by far the most common cotton finishing operation. It is carried out either on yarns or on fabrics by the action of concentrated sodium hydroxide solutions while the cotton material is held under sufficient tension to prevent shrinkage. The result of mercerization is
to increase strength and luster as well as to increase the ability of the material to absorb other chemicals such as dyes and crease-proofing agents. In laboratory experiments, where single cotton fibers were subjected to the conditions of mercerization, it was observed that different cottons did not respond in the same way to the treatment. One of the most pronounced effects of single fiber mercerization was an increase in the fiber stiffness. This property is measured by the fiber elastic modulus which can be defined as the resistance of the fiber to an initial extension. Cottons with an originally high elastic modulus to the same extent as did cottons with an originally low elastic modulus. Basically this observation indicates the levelling-out effect of mercerization, since the differences among untreated cottons are larger than corresponding differences among mercerized fibers. It should not be inferred that the differences among cottons are eliminated as a result of the mercerization treatment; such differences are still evident although considerably reduced.

Fiber Testing Techniques

Any research program which deals with the study of the mechanical and other properties of cotton fibers must concurrently and constantly strive to develop more efficient methods for evaluating these properties. At the same time the research program must devote a portion of its effort to finding means of testing fiber properties which have hitherto not been evaluated. An example of a fiber characteristic which has not been accorded its fully deserved attention is the fiber surface. Despite the fact that both light and electron microscopy have done a great deal to elucidate the surface structure of cotton and other fibers, many questions remain unanswered in this field. Particularly, one may inquire as to the nature of the fiber surface while the fiber is subjected to conditions such as it might encounter in carding, spinning and other processing operations. In order to shed some light on this seemingly important question, an instrument has been developed at TRI which gives a record of the fiber surface while the fiber is slowly drawn over a sensing element. The signal that is generated and eventually recorded when the fiber is passed over the sensing element comes about from the surface roughness of the fiber and is modified by the physical nature of the fiber. Thus, what is actually being recorded is a combination of the geometric configuration of the fiber surface and the pliability of the fiber. It is felt that this combination of fiber characteristics may be a particularly useful and significant one, since it appears plausible to say that this same combination of properties is brought into play in textile manufacturing operations such as carding, drawing and spinning. The instrument is at this time only in its experimental stage, but indications are that several important observations will be possible with this equipment.

Conclusion

It is impossible in this short space either to present all of the cotton research activities at TRI or to give detailed experimental observations and discussions upon which the conclusions are based. It is hoped, rather, that this article will indicate to the reader the nature of the work which constitutes the TRI cotton research program.
The New Government Spinning Laboratory At Clemson College

By
Harral Young, T.M. ’61

The National Cotton Council, an organization to improve the competitive position of cotton in the industrial and agricultural world, has instigated a movement to find the true market value. The Council is made up of farmers, ginners, crushers, merchants, warehousemen, and spinners.

In spinning experimentation up to the present, one of the big problems has been the fact that the experiments have been conducted on too small a scale to get really conclusive data. One of the main things to be studied is the ends down per thousand spindles per hour.

The American Cotton Manufacturers Institute and the National Cotton Council proposed a pilot plant program to the Agricultural Marketing Service of the United States Department of Agriculture. The Marketing Service became interested. After looking over several locations, Clemson was selected. The following plans resulted:

1. The Marketing Service will operate the facilities.
2. Clemson College will serve in a cooperative capacity; space will be provided in Sirrine Hall, and personnel from the textile department will serve on advisory and planning committees.

The physical facilities will consist of four cards, one drawing frame, one eighty-four spindle roving frame, and four spinning frames of two hundred fifty-two spindles each. Space is being left vacant to accommodate a combing room at a later date. The opening and picking equipment of the college will be used. The building facilities will consist of an air-conditioned laboratory and sufficient office space.

In the future the pilot plant may extend into a weaving and finishing department also.

The facilities of the present pilot plant will be used as a service facility by other divisions of the United States Department of Agriculture, as well as by local division.

One of the immediate problems is to find how cotton can best be handled between the time it opens in the field and the time it reaches the mill platform. This problem will extend into many phases of harvesting, ginning, packaging, and marketing.

Clemson College is very proud to have been selected to cooperate in this project.

Mr. Gaston Gage, Dean of the School of Textile here at Clemson, says, "I believe as time goes on, the Clemson College community will become the cotton research center of the United States and the world."

Gage Appointed Dean of Clemson Textile School

Acting President R. C. Edwards announced Tuesday that the Board of Trustees has named acting dean Gaston Gage, Dean of the School of Textiles.

Dean Gage is a native of Chester and has been acting dean since November 1, 1957. He joined the staff as an instructor in 1932, became associate professor in 1943, and later head of the yarn manufacturing department. He served as an overseer in the card room, spinning room and cloth room at Aragon Baldwin Mills in Chester prior to 1932.

Mr. Gage is a transfer from the University of South Carolina, received the B.S. from Clemson in 1921 and earned the B.Ed. at Penn. State in 1941. He also studied at the University of North Carolina.

Mr. Gage is a member of the American Society for Testing Material; International Organization for Standardization; Technical Committee on Textiles; American Society of Quality Control; National Council for Textile Education and the Textile Institute. He is also a member of the Kappa Alpha, Phi Psi, and other fraternal organizations.

He married the former Ruth Vardell of Red Springs, N. C., and has two sons, Gaston, Jr., of Roeford, N. C., and Charles Vardell, of Jacksonville, Florida. He is chairman of the Pastoral Relations Committee of the Clemson Methodist Church.

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THE BOBBIN AND BEAKER
Outstanding Seniors . . .

By
Tommy Ariail

Joe Fox, from Inman, South Carolina, is a Textile Chemistry major. Joe has been active in student affairs while at Clemson, and he is now President of the Student Body. Along with his many duties as President, he is Advertising Manager of The BOBBIN AND BEAKER. He is also a member of Blue Key, Tiger Brotherhood, Scabbard and Blade, and Phi Psi.

Joe is a member of the Clemson R.O.T.C. unit in which he now holds the rank of Captain, and he is an S-4 on the 2nd Bn. staff.

He has gained valuable textile experience by working for the last four summers with the Inman Mills of Inman, S. C.

Joe has been helped with his expenses here at Clemson by the expenses here at Clemson by the Inman-Riverdale Foundation Scholarship.

W. Wayne Freed, is a Textile Engineering Senior, and he and his wife are now living in Central, South Carolina. Wayne has become familiar to the readers of this magazine by his work on The BOBBIN AND BEAKER of which he is now editor.

He has worked the last three summers as an engineer's aid at the DuPont plant in Aiken, S. C.

Wayne has done a good job on The BOBBIN AND BEAKER staff where he has been Managing Editor and is now Editor. He is also a member of Phi Eta Sigma Fraternity, Phi Psi, N.T.M.S., Council of Club Presidents, and was elected to “Who’s Who in American Colleges and Universities” his junior year.

Wayne was awarded the Sedge-Wooley Scholarship his junior year and the American Viscose Scholarship his senior year.

Kenneth W. Powers, Jr., a Textile Senior from Stonington, Me., is one of the most active students on campus. He is a member of Blue Key, Tiger Brotherhood, Scabbard and Blade, Arnold Air Society, Phi Psi, and he is the Business Manager of The BOBBIN AND BEAKER this year. He has also been a member of the Pershing Rifles, Tiger Band, and on “The Tiger” staff. Ken was also awarded the Distinguished Air Force R.O.T.C. Cadet award and at present he is working as Tigerama Skit Chairman.

Ken holds the rank of Cadet Major in the Air Force R.O.T.C., and he is also a Wing Training Officer.

His experience in the textile field has been gained by working two summers at the Wellman Combing Company of Johnsonville, South Carolina.

Ken has been helped with his expenses by the Wellman Foundation Scholarship.
Oven-Drying In Ginning Damages Cotton

By

John Graham
Textile Research Department, School of Textiles
Clemson, S. C.

When cotton gins were less complex, cotton classers could often detect excessive gin damage because rough fiber treatment was frequently accompanied by visible marks of “rough preparation”, usually associated with dense seed roll or moist cotton which causes nepiness, seed coat rupture and an abundance of large tangled masses of fiber. With the trend toward rougher harvesting methods has come the modern gin with dryers, seed cotton cleaners and lint cleaners. Over 80% of the gins in the United States have drying equipment. It is recommended that cotton not be dried below 5% moisture in ginning, and 7% moisture is considered optimum for preserving the fiber quality. It has been estimated that 4/3 of the Delta cotton crop is ginned with less than 6% moisture. The number of bales penalized annually for rough preparation has dropped to less than 5%.

From the manufacturer’s point of view cotton ginned too dry may be worse than cotton ginned too wet, because the cotton classer cannot look at a sample of cotton that was ginned too dry and tell how dry it was ginned or to what extent, if any, ginning in the dry state has damaged the fiber, and consequently, cotton damaged from ginning in the “heavily dried” state can be sold and bought for good cotton.

In a 1953 U.S.D.A. ginning circular it was stated: “There was a tendency for length and to some extent, fiber-length uniformity and tensil strength to become increasingly lower under more intense drying.”

A year later results of a ginning study by Leitgeb and Wakeham were published showing the degrees of damage to various fiber properties considered important to manufacturing performance. Compared with some of the same cotton ginned without heat at 6% moisture, cotton dried at 250° F to 3.8% moisture during ginning gave the following results: 17% decrease in the upper half mean length, 17% increase in the number of fibers shorter than 1/2 inch, 12% increase in fiber elongation, 2% decrease in water absorption, 6% decrease in skein strength of medium yarn, 2% increase in yarn nonuniformity, and 14% increase in the number of ends down in spinning. The same drying was accomplished at 450° F and many of the above types of fiber damage were shown to have been aggravated by drying at this very high temperature. A government publication made this year on work now in progress shows that cotton cleaned with overhead cleaners, ginned at between 2% and 3% moisture content and subsequently cleaned in a two-stage lint cleaner showed the following effects due to over drying in the gin: 13% decrease in visible foreign matter, 17% decrease in upper quartile fiber length, 21% increase in the number of fibers shorter than 1/2 inch, 8% decrease in yarn strength, and an increase in ends down in spinning of 8% for 30’s yarn and 17% for 40’s yarn.

Even though gins will run smoothly on extra dry cotton, in the very dry state the fiber is in poor condition for ginning. When moisture in cotton is reduced 1½ the strength is lowered 6% and other fiber properties such as density, brittleness, and dielectric constant are also changed. Cotton manufacturers have always recognized this fact and have therefore always practiced some degree of moisture control. Cotton should receive as careful treatment in ginning as in manufacturing, and since it is now known that damage occurs from ginning cotton with either high moisture content or with low moisture content, moisture control must be practiced at the gin.

Research needs to be done not only in controlling the average moisture in seed cotton during ginning, but a study should be made of the moisture gradient throughout the length of the longer fibers on the seed as it reaches the gin stand. It is likely that the lint drying methods being used dries the exposed ends of the long fibers to a greater extent than the end attached to the seed. If this problem is found to exist, then perhaps a more penetrating type of heating such as “induction heating” should replace the hot-air convection method now being used.

Recent studies have revealed that over-drying in ginning is a greater hazard than over-heating. Tests have shown that cotton dried to 3% moisture content in ginning gave about the same yarn strength, fiber length, and yarn appearance whether the temperature in the drier was 300° F, 200° F, or 130° F. It has been shown, however, that gin drying at temperatures above 400° F can permanently affect such fiber characteristics as color, fluorescence, moisture re-
gain, and modulus. It should be pointed out that high temperatures in the driers also increase the hazard of over-drying.

Some moisture removed in the gin drier can be restored before the cotton reaches the gin stand. One test showed that 1½ moisture can be added to over-dried cotton between the seed cotton cleaners and the gin stand.

There is hope that some day cotton gins will be able to accurately control the moisture in the seed cotton they gin. But gins are not the only cause of some cotton giving poor spinning performance. Until high length variability has been largely eliminated from baled cotton the manufacturer will need a cheap rapid method for the determination of the length variability in cotton. The present methods of fiber sorting are too slow and too costly to be applied to each bale, and an improved method must be devised.

In a study of spinning performance of cotton heavily dried in ginning, one manufacturer found that an additional cost of ten dollars per bale was incurred in processing such cotton. Through the years spinning tests made by the Department of Agriculture and others have consistently shown that a high variability of fiber length in cotton adversely affects yarn quality and spinning performance. A decrease of 5% in coefficient of length variability will add 1 lb. skein strength to 22's yarn, which is the same strength increase obtained by adding 1/32 inch to the upper quartile length. From recent work on spinning quality of cotton where accurate spinning end's down data was acquired it has become apparent that a high proportion of fiber shorter than 1/2 inch in cotton can be extremely detrimental to its spinning quality. A recent U.S.D.A. publication shows 86% of the variation in ends down in spinning 40's yarn was associated with variations in the proportion of fiber shorter than 1/2 inch.

There may be other bad aspects of over-drying cotton at the gin: There is, perhaps, increased fragmentation of immature seed and some other types of waste found in cotton. In some cases grade improvement due to gin cleaning does not add sufficient value to compensate for the loss of weight due to drying and cleaning. If not given time to condition prior to processing, extra dry cotton may upset mill production or receive further mechanical damage in manufacturing.

Cotton research faces two of its greatest challenges: the development of better moisture control in ginning, and the development of better instrumentation for the measurement of the short fiber content in a cotton sample. If these challenges are not met and dealt with successfully through adequate research, what are the other alternatives? Can manufacturers restore the spinibility to damaged cotton by combing?
A Pneumatic Method of Measuring Cotton Fiber Staple Length

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Clemson, South Carolina


ABSTRACT
A pneumatic device for measuring the Mean and Upper-Half Mean fiber lengths is described. Air is drawn through a cotton fiber beard (formed with two combs) placed over a narrow slit to form the fourth arm of a pneumatic Wheatstone bridge. It is shown that the unbalanced deflection of the "pneumatic galvanometer" across the bridge varies correctly with the number of fibers over it to enable measurement of the mean value from curves automatically drawn by the device.

For seventeen cottons data are presented, comparing the results of this method with those obtained with the Fibrograph.

INTRODUCTION
Since the pneumatic bridge developed for the Roving Evener (reported at the Cotton Research Clinic last year) would so easily measure the size of sliver or roving, it was thought the same bridge arrangement might be used to give the readings proportional to the number of fibers in a beard at any distance from the base. The beard is formed by the use of two combs as is done for the well known Fibrograph developed by Hertel. Air is drawn through the beard through a thin 0.007" x 5.0" slit in the wall of a manifold placed at right angles to the fibers. Figure 1 shows a schematic diagram of the device. It is seen that the cotton and the slit form the fourth resistance in a pneumatic Wheatstone bridge. Corresponding to the galvanometer of the electrical bridge a differential bellows is used to measure the amount of unbalance caused by the cotton covering the slit and also move the pen, automatically recording the degree of unbalance on a chart as the cotton beard is drawn over the slit from base to tip.

The bridge is operated unbalanced with a vacuum approximately equivalent to a twelve inch head of water and for the thickest beard, the differential pressure across the bridge may approximate two inches of water. Of course, a higher vacuum would give greater sensitivity. The resistances \( R_1 \) and \( R_2 \) are usually less than half \( R_3 \) and \( R_x \) but are not critical, being made of one or two inches of tubing 0.11 inches inside diameter.

The eight inch pen arm is mounted on a shaft that is caused to rotate by the differential pressure across the bellows. The pen rests lightly on the card in a holder which is moved under the pen by the same sliding frame that carries the fiber comb.

By slowly moving the frame, the cotton beard is drawn past the slit and simultaneously the card is moved under the pen so that a curve is drawn. The Mean and Upper-Half Mean fiber lengths are measured by drawing tangents to the curve as is done with the Fibrograph. This procedure is valid if the distribution of fiber lengths in the beard is similar to that obtained by the sliver clamping method in which the beard is made by clamping a sliver at a point and combing away the loose fibers on one side of the clamp.

DISCUSSION OF THE PROBLEM
For this pneumatic method to work, the deflection of the pen should be proportional to the number of fibers across the slit. Whether this is true, as would be expected, depends on several things that affect the galvanometer response to change in the resistance \( R_x \) and on the way the resistance of the slit changes with the number of fibers over it. For the Wheatstone bridge it can be shown that when \( R_x \) is two or more times greater than \( R_1 \) and \( R_2 \), the differential pressure across the bridge rises almost linearly with the increase in the resistance \( R_x \). Assuming the resistance of the slit to be inversely proportional to its area, and that the galvanometer deflection is proportional to the increase in the slit resistance, the deflection caused by covering the slit should increase faster than the percentage of the slit covered.

THE BOBBIN AND BEAKER
The theoretical increase in resistance caused by progressively covering the greater proportions of the slit (with tape), are shown in Figure 2. The deflections are plotted to a proper scale to make the two curves fit as closely as possible. It is seen that the agreement is good for covering approximately seventy per cent of the slit, which usually exceeds the working range in normal use of the instrument. The agreement of the curves shows that total effective resistance of Rx is the slit itself, which is not much affected by the resistance of the connecting tube. Trying several sizes of tubing for this connector does not seem to change the shape of the curves given for various fiber beards.

From the above considerations it is noted the deflection is not linear with the percentage of slit actually sealed off and therefore if equal increments in the number of fibers over the slit effectively seal equal increments of the slit, the deflection can not be proportional to the number of fibers across the slit.

It would seem, then that the instrument would fail unless the effective sealing of the slit by fiber rises less rapidly than the number of the fibers. To show that this is the case, layers of 1 oz. fabric placed over the slit give deflections almost perfectly proportional to the number of layers up to eight.

The instrument can also be tested using fringes of fiber prepared by winding continuous filament fiber on boards, taping crosswise and cutting the fringes. Placing successively equal fiber fringes over the slit again gives deflections proportional to the number of fibers across the slit proving that the sealing efficiency of fibers is less as more fibers are layered over the slit. Figure 3 shows the deflections given by layers of fabric or fiber.

If a fiber with a single staple length is used in the sliver clamping technique, the beard produced should have a linear increase in fibers per cross section from the tip to the base of the beard. Assuming that preparing the beards with combs gives the same fiber distribution, the instrument should draw a straight line for such beards. For some man-made fibers, the instrument gives practically straight lines.

By cutting fiber fringes in triangular shapes one can be sure of having a strictly linear increase in fibers from tip to base of the fringe. For such fringes made of nylon fiber the curves are practically straight lines. Figure 4 shows tracings of curves drawn by
the instrument for Acrilan, Nylon, Viscose and Verel staple and for Nylon cut fringe.

The straightness of these lines and the fact that their slope is correct to give their staple lengths seems to prove that the device does indeed measure the number of fibers at each point along the beard and that for single staple lengths, preparing beards with combs gives the theoretically correct linear distribution of fiber ends in the beard. It seems surprising that the sealing efficiency for added fiber decreases at just the right rate to make the galvano-meter deflection proportional, over a wide range, to the number of fibers across the slit.

Some synthetic fibers, especially when using thick beards, gives curves convex upward. This must be due to the heavy crimp in the fiber which is straightened by the cover plate more effectively nearer the tip of the beard than at the base.

Triangular fringes of filament cut to different lengths can be overlapped to check whether the machine gives the correct mean length for known distributions. Using two triangular nylon fringes of the same number of fibers 1.70" and 1.00" the instrument draws a curve with one slope, until the shorter fiber has passed off the slit and with a higher slope from then on to the end of the longer fiber. A tangent to the initial slope gives, with fair accuracy, the mean length as 1.30" and a tangent to the final slope gives the length of the longer staple as 1.73" which is pretty fair agreement.

For the instrument to work for cotton it should give the correct mean lengths for a wide distribution of fiber lengths. The curves for cotton are always convex downward and seem to have the correct shape for the usual tangent lines to indicate both the Mean and Upper-Half Mean lengths. Seventeen cottons supplied by the U.S.D.A. and A.C.M.I. laboratories at Clemson were tested. These were check cottons for which the Fibrograph lengths were supplied. Table I gives the results of the pneumatic method compared with the given Fibrograph values. On each of the seventeen cottons six to nine readings were taken. (This first apparatus uses a single comb so

**Figure 2**

Theoretical Increase in Resistance and Actual Deflection vs Per cent of Slit Sealed

- • o Resistance
- x x Deflection

**Figure 3**

Schematic diagram showing the relationship between the number of fibers in a beard and the deflection.

**Figure 4**

Tracings of Straight-Line Curves for Cut Staple

- Acrilan
- Nylon
- Verel
- Viscose
- Out Fiber Fringe 1.65"
- Out Fiber Fringe 1.00"

**EIGHTEEN**

THE BOBBIN AND BEAKER
the average for both combs is considered one reading for each sample.) Though it may be customary in routine testing to discard readings differing widely from the mean, in this case the values in the table include the results of every test taken on each cotton and for every cotton tested.

In Figures 5 and 6 are shown the values for mean and upper-half mean length plotted against the Fibrograph readings for each cotton. It should be realized that the deviations of individual results from the general trend can be due either to errors of the Fibrograph or of this method or of both. Incidentally, the consistency of the results may increase confidence in the reliability of the Fibrograph.

CONCLUSIONS

It is noted that the Mean Length values are slightly on the low side. Possibly part of the reason for this is that the air pressure in this work, not being perfectly controlled, falls from 0.25 to 0.5 of an inch in 12 inches as the beard is moved off the slit. Keeping the pressure constant should make the curve slightly less convex downward and therefore, give slightly higher values for the Mean Length but have relatively little effect on the Upper-Half Mean values.

The apparatus seems not to be very critical as to beard thickness. None of the samples were weighed and for half of the readings different beard thicknesses were purposely used.

The method does not require any certain air pressure but only that it remain constant during the individual tests. The pressure of the cover on the beard is not critical, though probably improved results might be obtained by having a better control of it.

Table 1

<table>
<thead>
<tr>
<th>Mean Length (Inches)</th>
<th>Upper-Half Mean Length (Inches)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Fibrograph</td>
</tr>
<tr>
<td>1.73</td>
<td>1.18</td>
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<tr>
<td>1.07</td>
<td>1.13</td>
</tr>
<tr>
<td>1.08</td>
<td>1.13</td>
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<td>1.11</td>
<td>1.09</td>
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<td>1.15</td>
<td>1.12</td>
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<td>1.08</td>
<td>1.13</td>
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Figure 5

Figure 6

ALL ISSUE 1958
Arranging a small motor to move the comb always at a constant rate may give better results than these obtained by moving the comb by hand. Possibly using the galvanometer balanced as a null instrument might improve the results. This can be done by using a second slit in the arm R, mounted at right angles to the slit for the cotton. A wedge type shutter over the second slit would be moved horizontally with the card while the pen would be lowered vertically with the cotton comb. There is a question whether the improvement would justify the additional cost and complication in operation.

Development of this instrument is still in progress but results to date seem to show promise for a pneumatic method of measuring staple length that would have the following advantages:

1. Requires no calibration or warm-up period.
2. Be free from drift.
3. Be easily checked at any time with synthetic fiber fringes of known length distribution. These could be furnished with each machine.

REFERENCES

Another question often arising among high school students is: “May I take graduate work at Georgia Tech or do I have to enroll in another school after graduation?” The A. French Textile School is equipped for graduate courses. Graduate courses may be scheduled in both options. Master of Science in Textile Engineering and Master of Science in Textiles are degrees offered. A graduate student works on his degree with such courses as Natural and Synthetic High Polymers, Advanced Yarn Manufacture and his Masters Thesis, naming but a few.

After four years of schooling the textile student is ready for the competitive industrial world. How is this graduate equipped and what are his opportunities? By the diversified program in his college years the graduating textile student has many choices and positions open to him. Actually, few industries today offer as many chances for success to young people as do the branches of the textile industry. Designers, salesmen, chemists, engineers, laboratory technicians, overseers, inspectors and specialists in machine operation and efficiency, personnel problems, testing, time studies, merchandising, and product development represent but a few of numerous trained technicians required by textile industries.

The Cocker
9 Cylinder
High Speed Slasher
For Cotton, Rayon, Spuns, and other Type Yarns
This is one of the many highly efficient warp preparatory machines built by Cocker.

Others are:
High Speed Rayon and Cotton Slashers
High Speed Section Beam Warpers for Cotton
High Speed Spindle Driven Warpers for Rayon
High Speed Balling Warpers
High Speed Tricot Warpers
High Speed Fabric Warpers

Also Contract Machine
and Stainless Steel Work

High Speed Heavy Duty Collecting Beamers
Warp Steam Chests
High Speed Warpers for Dye Beams
Magazine Cone Creels for Cotton and Rayon
Special Creels
Warp Dyeing Machines
Special Warp Handling Equipment
Stainless Steel Cylinders and Vats for all
Textile Purposes
Thus a textile engineer has many lanes opening to him upon graduation. His calling may be research where he works with the basics of textiles. He may perfect a machine that will be used by a fellow textile engineer in production work. He may decide that design is his field and draw up a new loom to be sold by still another engineer in sales. It is easily seen that the textile engineer, irregardless of his branch, is an invaluable aid to the textile industry and its progress.

A graduate in the Chemistry and Dyeing option is also faced with many opportunities upon completion of school. Commercial bleaching, dyeing or finishing plants are positions appealing to the majority of these graduates. But the synthetic yarn field and the manufacture or sale of textile specialties are becoming larger and larger outlets for these graduates. A great deal of the textile chemist’s work in these commercial plants is research. Due to this experiment testing, orlon, nylon, dacron and numerous other synthetic fabrics are everyday words. They are being used in clothes and cloth products to an extent never before believed possible. Colors are more numerous and designs more varied. Handsome clothes, previously acceptable only handmade, are now being readied for sale in production quantities.

With his B.S. in Textiles, the manufacturing option student is ready to begin work in a mill. Actually he is ready to begin in the office of a mill. With his expert knowledge of textiles and the industry coupled with his training in office work insures for him an executive type job. He may begin as an overseer or foreman on the floor, but promotions are rapid. From these jobs the position of production manager is entirely feasible. Once his climb to the top has begun, the peak depends upon the capabilities and potentialities of the person himself.

There should be no doubt in anyone’s mind that the textile industry is filled with opportunities and security for anyone interested in science or engineering. It is a growing field, branching in all directions. With a little interest and work, a future life of security can be had in the field of textiles.

**ITS YOUR FUTURE — CHOOSE IT WISELY**

(Continued from page 7)

operation and textile chemistry. All of this work is related to the practical problems of management, marketing, costing, quality control and industrial relations. A knitting option is offered under this curriculm. A total of 150 credits are required for a textile manufacturing degree of which 65 are for textile subjects.

**TEXTILE CHEMISTRY**

Textile chemistry provides thorough training in the pure chemistries and in textile testing, microscopy, bleaching, printing, dyeing and finishing. Because of the close connection between production and research, the fundamentals of textile manufacturing are also taught. As a textile chemist you would be responsible for giving textile goods their sales appeal. This includes color, sheen, feel and many of the more dramatic properties introduced by modern finishing such as water repellency, crease resistance, permanent pleating and “wash and wear” features.

**TEXTILE SCIENCE**

Beginning this year Clemson is offering a new course in textiles called Textile Science. This new curriculum is the outgrowth of the changing textile field. This course is similar to the old Textile Engineering with the applied engineering subjects being replaced by basic courses. The amount of textile subjects will remain the same. The curriculum should be of particular interest to those students who plan to enter research or to further their education with graduate study. The basic sciences will include mathematics, physics and chemistry.

The Clemson textile faculty is a varied group composed of scholars, scientists and practical teachers. Most of them have had actual working experience in the textile industry and all of them visit textile plants at regular intervals so as to keep up with the latest developments. Many have done advanced study in their fields of specialization.

Sirrine Hall, which houses the School of Textiles, contains more than two and a half acres of floor space. Built in 1938, it was completely renovated recently and now contains the most modern textile machinery available, which is valued at more than a million dollars.

Textile education at Clemson has received great support from the textile industry itself. The J. E. Sirrine Textile Foundation now has more than one million dollars contributed by textile companies for use at Clemson. Some 250 manufacturers and machinery concerns have given equipment and special discounts on machinery to the school. You may benefit from one of the many scholarships and awards given by the textile industry.
While studying textiles at Clemson you will be in the midst of varied research projects on all phases of this extensive field. In addition to the research work carried on by the faculty, there are many projects being carried out by two government and one industrial research laboratories located in the textile building. A new Research Center is to be located at Clemson.

There are numerous scholarships and loan funds at Clemson for worthy students in need of financial assistance. Subsistence and uniform allowance are paid to those students enrolled in the ROTC programs.

Several scholarships which are available for Freshmen entering the Textile School are:

**Leon Lowenstein Foundation Scholarships** — Two $2000 awards are available annually for male freshmen who enroll in the School of Textiles, to be paid in equal installments during four years of satisfactory undergraduate study. Selection will be limited to applicants whose families have an income of $10,000 or less.

**South Carolina Textile Manufacturers Association Scholarships** — Two $2,000 awards, one from the J. P. Stevens & Co., Inc., and one from other association member companies are available for freshmen who enroll in the School of Textiles to be paid in equal installments during four years of satisfactory undergraduate study.

**Texize Chemicals, Inc. Scholarship** — A $2,000 award is available for a freshman enrolled in the School of Textiles to be paid in equal installments during four years of satisfactory undergraduate study.

**American Viscose Scholarship** — A $500 award is available annually to a rising junior or senior majoring in Textile Chemistry or Textile Science.

**Blackmon-Uhler Scholarship** — A $1000 award is available annually to a rising junior majoring in Textile Chemistry, to be paid in equal installments dur-
Burlington Industries Foundation Scholarship — A $1000 award is available annually to a rising junior majoring in Engineering or Textiles, to be paid in equal installments during the last two years of satisfactory undergraduate study. Selection is based on need, ability and evidence of good character.

Ciba Scholarship — A $1000 award is available annually to a rising junior male student majoring in Textile Chemistry, to be paid in equal installments during the last two years of satisfactory undergraduate study. Selection is based on leadership, scholarship and financial need.

Interchemical Foundation Scholarship — A $1000 award is available annually to a rising junior in Chemistry, Physics or Textile Chemistry, to be paid in equal installments during the last two years of satisfactory undergraduate study. Selection is based on scholastic ability, financial need, personality and leadership.

David Jennings ('02) Memorial Scholarship — Income from a fund donated by members of his family provides one or more awards for undergraduates, with preference for students majoring in Textiles.

Keever Starch Scholarship — A $400 award is available annually to a worthy rising sophomore majoring in Textiles.

Owens-Corning Fiberglas Scholarship — A $1200 award is available annually to a rising junior majoring in Engineering or Textiles, to be paid in equal installments during the last two years of satisfactory undergraduate study. Selection is based on scholastic ability, leadership qualities and financial resources.

Seydel-Woolley & Company Scholarship — A $250 award is available annually to a rising junior or senior male student majoring in Textile Chemistry or Textile Engineering. Selection is based on scholastic ability, evidence of leadership potential to the southern textile industry and financial need.

United States Rubber Foundation Scholarship — A $700 award is available annually to a rising junior planning a career in industry, to be paid in equal installments during the last two years of satisfactory undergraduate study. Selection is based on proven scholastic ability and financial need.

Your whole future and happiness may depend upon how and where you make your living. Before you make your final decision be sure that you are right. Consider all sides of the problem. What will the opportunity be, not only now but later, what are the chances open for advancement, under what conditions will you work, what security do you have, where will you be able to obtain employment, near home — in the South — or will you have to pull up roots and move to another part of the country?

Before making the final decision for your life's work, we would like for you to seriously consider a career in the textile field. This industry ranks high in all industries.

Remember 80% of it is in the South and 30% in the State of South Carolina. The grass may be greener in your own back yard.

If you believe that your aptitudes and long-range interests lie in the field of textiles, we should like to discuss your future with you and to have you visit or get further information about textiles and Clemson from:

The Registrar's Office

or

The Textile School
Clemson College
Clemson, S. C.

W. B. Simmons Machinery Company
TEXTILES MACHINERY & SUPPLIES
P.O. Box 1617 Phone CEdar 9-7621
GREENVILLE, S. C.
The Waste Treatment of Sulphur Dyes In The Textile Industry

By
Russel Campbell, A&S ’60

INTRODUCTION

This article shall attempt to correlate the scattered information on the waste treatment of sulphur dyes in the textile industry. These facts are both positive and negative in final results. This paper is limited to the sulphur dyes but will necessarily include combinations of dyes in some cases.

The main problem confronting the textile industry is a method of obtaining an economical and safe effluent. The process of treating the waste sulphur dyes must produce a non-toxic effluent, a disposable sludge, and a rapid and a cheap mechanical method.

Background. Although this paper is entitled “The Waste Treatment of Sulphur Dyes,” some other waste problems must be enlarged upon to fully cover the subject. There is no standard waste treatment for the sulphur dyes. This is due to the differences in location and size of the plants, and types of preparations that the plants use in dyeing. However, in general the outline in this paper will be applicable to all plants.

What does the waste treatment of sulphur dyes entail? This is determined by the use of the effluent when finally discharged. State water commissions have rivers and streams divided into classes. An excellent classification by the Commonwealth of Pennsylvania follows.

Class A. Streams to be preserved in their natural condition. All artificial pollution of these streams is prohibited and wastes of their watersheds must be treated to a high degree of purity.
Class B. Streams more or less polluted, but kept controlled to prevent detriment to public health, fish, and use for recreational purposes.

Class C. Streams so polluted that it would not be economical nor advisable to restore them but controlled so no public nuisance occurs.

What is an ideal effluent? To be an ideal effluent, after treatment it should be clear, colorless, odorless, neutral, and non-toxic. It should be free from all suspended matter and free from organic matter. The effluent should not contain any oils or any excessive mineral salts. No known method of purification will produce such an effluent.

There are many ways to treat sulphur dyes. The four main headings are sedimentation, equilization, chemical treatment, and biological treatment. A change in process may be necessary but is costly and avoided if possible.

Typical Process. To understand fully the treatment required, the process of the sulfur dyeing must be known. Sulfur dyes are a general group of direct dyes used only on vegetable fibers. They are used with the addition of sodium sulfide to the sulfur dyes of the dye bath. The exact nature of the sulfur dyes is unknown. It probably consists of organic derivatives containing sulfur as a constituent.

The principal colors of the sulfur colors are the blacks, yellows, browns, blues, and greens. They are especially fast to washing and acids in cross dying. They are soluble in an alkaline reducing medium. Sodium sulfide, sodium carbonate, and sodium chloride are used in the dye baths. Sulfur colors may be stripped by treating with chlorine bleach solution and acetic acid.

The Waste. The wastes from a sulfur dye process consists of four components. They are: dye liquor (saved), three rinses. The reason for saving the dye liquor is for economy. The spent dye liquor is made up to original strength and used over again. The sulfur dyes high concentration can be noted by this recovery plan.

Chemical Precipitation. Typical plant operations will be considered here. In many cases lab tests indicate good results but on plant scale these prove unworkable. A typical precipitation procedure will be outlined for a better understanding of some physical problems involved. Wastes from the dye house are taken to storage tanks. When a pre-calculated quantity of waste has been collected, it is mixed. Samples are checked by the laboratory. Then proper concentrations of chemicals are added. The waste is then mixed, flocculated, settled, and the effluent discant-
ed. The sludge is placed on sand beds to dry.

The strong acids are the best precipitants of the sulfur dyes. Sulfuric acid will be considered first in this class of purifying. In typical operation sulfuric acid causes too much frothing. Hydrogen sulfide is evolved in large toxic quantities. Sulfuric acid causes sludge to balk and makes continuous operation impossible. Final sludge is good. It dewatered fast and forms a good cake. In a similar operation records were kept on sulfuric acid treatment of sulfur dye wastes. Thirty-three cubic centimeters of five-tenths normal sulfuric acid per one hundred cubic centimeters were used. The result was a fine precipitate which settled to one-third of the total volume in one-half hours. There was a strong evolution of hydrogen sulfide again. Also large quantities of colloidal sulfur was present in the supernatant liquid. The supernatant liquid had a yellow tinge. The pH was lowered to 5.6, one and four-tenths off from neutral 7.0. This treatment required 72 pounds (32.6 Kgs) of 95 per cent sulfuric acid for 1,000 gallons (3785.4.1) of waste. This is to high to be considered very economical. Several good results are shown in these figures. If the melodorous hydrogen sulfide difficulty could be overcome, the acid treatment might be useful.

Aluminum sulfate, or filter alum is a well known salt for use in chemical precipitation. However, with sulfur dyes, results similar to those of sulfuric acid were recorded. The sludge filtered good but too much hydrogen was liberated. In a particular case 18 cubic centimeters of 0.5N aluminum sulfate was used per 100 ccs of waste. Eighty-six pounds (39.0Kg) per one thousand gallons of waste was used.

Also tried in combinations were Aluminum sulfate and hydrochloric acid. Best results were obtained with 32 ccs of sulfuric acid and 3 ccs alum. This equaled 69 pounds of 95% sulfuric acid and 14.3 pounds of alum per 1,000 gallons of waste. Still settling was slow.

Ferric sulfate has been tried also. The ferric sulfate coagulates the waste without the hydrogen sulfide formation. Filtrability of the sludge was good, but settling was poor. Other iron salts such as ferric chloride and ferric chloride alum have been used in plants also. The ferric chloride gave a good precipitate with a clear supernatant liquid. The pH was 7.7 and the floc settled slow. There was no evolution of gas or free sulfur. Complete precipitation required 53 pounds (24.0 Kgs) of ferric chloride per 1,000 gallons of waste. The alum was added in an attempt to produce a larger floc. No better results were obtained however. Ferric chloride and hydrochloric acid were combined to improve the pH range. At pH below 7.8 clarification was not complete however.
Copperas and copperas-lime have been used in some plants also. The copperas produced a good precipitate but filtering of the sludge was not good. Effluent came through very highly colored. It appeared that mixing the waste in a flocculation chamber breaks up the floc. Without mixing, good filtering resulted. When lime-copperas was tried the results were favorable. There was a good floc and the sludge dried to a good cake overnight. It dewatered much better when applied in a layer 4.6 inches thick.

Chlorine has been used to treat sulfur dyes also. The results were unfavorable. Twenty-five pounds of chlorine per 1,000 gallons of waste were used. It produced a slow settling floc with a bulky sludge. A yellow color could not be removed. It has been considered uneconomical.

The use of chemical precipitants works very well with a proper coagulation agent. Good results can be obtained with proper control. The use of acid precipitates the pure dye and it can be re-used with excellent results. The dye from the sludge can not be removed when precipitated by other coagulants. Coagulants can be reclaimed in some cases and re-used. If the hydrogen sulfi de evolution could be checked, the acid treatment would have wide spread use.

The main objection to the use of chemical precipitants is the high cost. No waste plant can operate economically. Efforts to keep costs at a minimum must be used. The supervision of chemical precipitants have led to cheaper methods.

Activated Sludge. The activated sludge treatment on the sulfur dyes was attempted also. A typical activation process was used. From thirty-six gallons aeration tanks containing 500, 1500, 2500 and 3500 parts per million of solids in suspension were used. Aeration periods were for four, six, and nine hour intervals. Equal amounts of one-per cent dye waste per sewage mixture and air were used. Aeration for six hours but better than for four hours but little better for the nine hour period. Color removal was proportionate to sludge concentrations. BOD removed was affected little by the variations in air. Results over all were not too good. Chemical precipitation proved better than this method.

Trickling Filters. The waste problem has been given biochemical considerations too. The results have been favorable. S. E. Cobern reported in “Industrial Engineering Chemistry” that, “It is more economical to treat finishing plant wastes with a gage rate trickling filter plant than any other method.”

The trickling filter term may not be generally familiar. The basic principal of the trickling filter is a slow movement of waste over biological slime which increases the stability of dissolved and divided solids. The trickling filter has the same purification principals of a natural stream. Oxygen, food supply and ascorbic organisms are necessary.

The trickling filter is an artificial bed of inert matter called a media, covered with naturally formed biological slime or zoological mass over which the mass trickles. It is not a filter in the sense that it removes solids. There is a divergence of opinion on the action that takes place. It is generally conceded that the gelatinous slime holds the solids for several days. The microorganisms “work over” the solids. The outer layer of the microorganisms are known to be aerobic and the inner layer is thought to be anaerobic.

The trickling filter is the best biological treatment of mixed wastes. It is good due to its ability to maintain a constant degree of purification with varying wastes. The addition of a small quantity of nitrogen and phosphorous to the filter effluent makes the system more effective. This aids the biological growth.

As the term BOD has been mentioned, it should be defined. BOD is the biochemical oxygen demand that is the necessary amount of oxygen to oxidize matter in a stream under the influence of fact bacteria present. This is the common test for pollution of sanitary sciences.

The use of trickling filters is preferred due to the low cost of operation. The initial cost is high. It would be approximately $4500 more than the chemical system. The annual net charge would be $2500.

Summary. There are three methods for treating the sulfur dye wastes. They are chemical precipitation, activated sludge process, and the high rate trickling filters. In chemical precipitation the best results were obtained with the iron salts, ferrie chloride and ferrous sulfate. This method proved to be costly over an extended period of testing. The activated sludge process was not practical nor were the results effective. This was discarded as useless. The high rate trickling filters produced excellent results. The initial cost was high but over a long period of testing the trickling filters proved to be the most economical process. Where possible, all periods of testing were for thirty-six months.
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