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Study of the Industrial Potential of Radioisotopic Methods in the Textile Industry

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Introduction

This report is divided into four sections which reflect the four different types of potential (or actual) utilization of radioisotopes in textile manufacture or processing. These are radiation gauging, irradiation to promote chemical change, irradiation to promote dissipation of static electricity and utilization of tracers for control. The bulk of the report is concerned with the first of these divisions for two reasons: one, there seem to be many potential uses for radiation gauges; two, most of the time spent on the project to date has been devoted to this area. Although no sections of the report can be considered complete in the sense that a comprehensive study of all segments of the industry has been completed, the section on the use of radiation gauges is well along the way. Only two important branches of the industry have been omitted, non-woven fabric manufacture and synthetic fiber manufacture. The parts of the industry involved in producing yarn and woven fabric have been covered in sufficient depth that it is unlikely that any processing step used by an appreciable fraction of the industry has been left out of consideration.

Utilization of Radiation Gauging

Introduction

This section is subdivided into the following categories:

1) Current uses and unsuccessful attempts;

2) Proposed uses that appear feasible, in need of little development, and easy to evaluate;

3) Proposed uses that appear feasible, in need of little development, but hard to evaluate;

4) Proposed uses that appear feasible but require development;

5) Proposed uses that require extensive development;

6) Proposed uses that do not appear feasible.

In the first category are included all uses, successful or unsuccessful, which have been carried to completion. The unsuccessful applications are included because the reasons for failure give information about the problems involved in the introduction of radiation gauging into the textile field. Preliminary development work, occasionally of considerable scope, has been done on some of the proposed uses listed in the other categories, but none has been carried through to completion.

The next two categories contain proposed uses which seem to require little development work. The requirements for gauging are being met by radiation gauges in other applications, and the same is true for the control circuitry in the cases where control is involved. Also the mechanism whereby the process can be controlled is evident. The two categories differ in the ease with which results can be evaluated. In the first, the benefits of the application could be evaluated readily in terms of reduced chemical costs, increased speed of operation, or the like. In the second, the benefits would not appear at the process being controlled but would result from a higher quality end product or from reduced costs in later stages of production. Generally speaking evaluation of such proposed applications would require expensive, large-scale tests.

The proposed uses outlined in categories 4 and 5 would all require moderate or extensive development. The uses in category 5 would require the development of new machinery designed to utilize the potentialities of radiation gauging for control to accomplish tasks now done with no control other than initial machine settings. The inclusion of a potential use in one of the categories 2 through 5 is to some extent arbitrary, but, in general, the estimated amount of work required to bring a proposed use to technological fruition increases from category 2 to category 5.

The last category is included for two reasons. First, since the ideas involved might occur to other workers, some duplication of effort may be avoided. Second, if some method could be found to circumvent the apparent lack of feasibility, worthwhile uses for radiation gauges would be developed.

(1.) Current Uses and Unsuccessful Attempts

Control of Coating. The utilization of radiation gauging in the control of coating processes is widespread. All of the current applications have certain features in common. Coating material is applied to the fabric, for example, by drawing the fabric through a treating tank; and the amount taken up is controlled, usually by altering the setting of a pair of squeeze rolls. A radiation gauge senses the thickness of the untreated fabric and another senses the thickness of the final treated fabric (often after some type of curing in an oven). The weight percentage of coating (based on the final weight), corrected for variations in weight of the untreated material through use of an appropriate time-delay circuit, is then used to activate automatic control of the squeeze rolls and plotted on a chart to provide a permanent record of machine performance. The amount of material applied to the fabric is quite a large fraction of the weight of the treated fabric and long-term variations resulting from gradual changes in machine setting or feed stocks are more serious than short-term variations resulting from fluctuations in weight of the untreated fabric.

It has been estimated that 60% of all tire calenders used for applying the body stock to the dipped cord fabric are controlled withradiation gauges. Other similar applications include the manufacture of aritifical leather, pressure-sensitive tapes, vinyl-coated fabrics, and abrasive cloths. In these applications the use of radiation gauging can be termed established and successful.

Water Uptake and Evenness of Wear of Papermaker's Felts. The Huyck Corp. has two radiation gauges which they transport to customer's plants and use for service in customer problems. For example, they follow the water uptake of papermaker's felts from place to place on a machine to study changes occurring during the production cycle. Changes occurring with time give some indication of evenness of wear and gradual changes in felt properties. Actually many papermakers have radiation gauges and some of them use them in a similar fashion. A weakness in using the gauges to follow wear results from lack of discrimination by the gauge; wear may be covered up by uptake of dirt or density changes resulting in changes in water uptake.

Fabric Wear and Abrasion Testing. A radiation gauge has been developed by the Textile Research Department of the School of Textiles, North Carolina State College and Radiation Counter Laboratories, Inc. on behalf of the Quartermaster Field Evaluation Agency for use in testing wear of garments. A positioning device enables the test area of the garment (usually the knee) to be introduced into the gauge in a reproducible manner and the test area is then weighed non-destructively. Thus changes in weight can be followed as a function of use conditions.

Pin-Drafter Control. A pin drafter equipped for control by a radiation gauge was developed by Industrial Nucleonics Corp.

and Warner and Swazey Co. The pin drafter takes several loose strands or ropes of fibers and, by a combing and drawing operation, makes the fibers more parallel and draws and condenses the input strands into a single strand. The radiation gauge was mounted on the pin drafter so that the final strand passed through it on the way to the receiving can. The gauge determined the linear density of the final strand; the signal from the gauge activated a control unit which controlled the amount of drafting (by controlling the speeds of the drafting rollers) and hence the linear density of the combed strand. The unit worked well and provided excellent can-to-can uniformity and good short-range uniformity.

The unit was not accepted commercially for two reasons. Addition of the gauging and control system would have roughly quadrupled the cost of the pin drafter, and it was not felt that the improvement in product justified the increase in expense. (It might be noted that the advantages of the controlled unit would appear in greater speed or ease of handling in later steps of production and in an improved final product; advantages which are difficult to evaluate without large-scale testing.) Second, a simpler, much less expensive control unit activated by a mechanical feeler was capable of providing almost as much improvement as the unit using radiation gauging.

(2.) Proposed Uses that Appear Feasible, in Need of Little Development and Easy to Evaluate

Control of Rug-Back Sizing. In the production of tufted carpeting, a latex coating is applied to the back of the carpeting to anchor the tufts and to provide body. A back sizing is also applied to other carpeting to reduce sleaziness or to serve as a bond for a woven paper scrim which is applied to mask blemishes and improve appearance. The use of back sizing is increasing and there are 10 oz. to 16 oz. of back-size per sq. yd. of carpet. The cost of latex is the largest single chemical cost in rug manufacture.

The latex is applied by bringing the rug back in contact with a kiss roll which revolves with its lower portion in a trough containing the latex. The process is completed by an oven cure to harden the latex. The amount of latex applied can be controlled by varying the speed of the kiss roll.

Industrial Nucleonics Corp. studied the feasibility of controlling this process by radiation gauging. They concluded that installation of gauges before and after the kiss roll with control equipment similar to that used in coating operations would provide satisfactory control. They also made a study of the economic feasibility of control with the assistance of a rug manufacturer and published their findings in Control Engineering 5, No. 10, 84, (1958).

As a basic economic model the following factors were taken:

1. $2\frac{1}{2}$ million sq. yds. of rug processed per year.

2. Total processing costs including latex cost $2.50 per sq. yd.

3. Sales price $5.50 per sq. yd.

4. Margin $3.00 per sq. yd.

After a survey using a portable gauge, they estimated that from $12,000 to $20,000 worth of latex in excess of necessary requirements was used per month and that controllable cyclic variations occurred. It was estimated that an increase of machine speed of 1% could be realized with better control which would mean an increment in profit margin of (2.5×10^6) (0.01) ($3.00) = $75,000 per year. A decrease in excess sizing of 50% would result in a saving in latex of ($15,000) (12 mo.) ($\frac{1}{2}$) = $90,000 per year. Initial costs of installation were estimated at $57,000 (to be depreciated over 5 years) with annual maintenance costs of $2,000 per year. Thus a return of $151,600 for a cost of $13,400 was projected.

Some comments can be made about the economic survey just outlined. According to informed sources the profit margin assumed is probably higher than that obtained by the industry in general at the present time. On the other hand, the number of sq. yds. of rug processed per year represents no more than a few percent of the total yardage processed per year. The amount of excess latex was a value estimated for the specific unit surveyed and could vary widely from unit to unit throughout the industry. However, it is obvious that, if radiation gauging can provide any control at all, a reduction in the margin of safety above minimum performance (or alternatively a reduction in inferior goods) can be provided. Finally, since in some operations 25 yd. lengths of different constructions are run through the back-sizing unit consecutively, some complications in setting controls might occur which could decrease the postulated increase in speed of operation.

The net of all of these considerations would still seem to favor radiation-gauge control and it appears that the negligible use of radiation gauges in this application at the present time results from factors other than technical or economic feasibility.

Control of Dye Padding. In dyeing with azo or naphthol dyes, a paste composed of dye component, surface-active agent, water and a thickening agent such as starch or gum tragacanth is padded onto the fabric. A total pickup of 50%, 75%, or higher on the weight of the fabric is attained. The amount of pickup is controlled by the adjustment of squeeze rolls and variations in uptake are undesirable because of the resulting variations in shade in the finished fabric. Side-to-side variations are particularly undesirable. This process seems very similar to the various coating operations and should be amenable to the same type of gauging and control. Since dyes are relatively expensive and streaky fabrics must either be stripped and redyed, dyed a darker shade or sold as seconds, the economic incentive for control in the dyeing process is considerable. In addition an improvement in running time would be likely to result from better control.

Tenter Frame Control. In a tenter frame, fabrics are stretched and dried to a desired width and weight yield. The stretching also realigns the fabric which has been stretched and pulled out of shape in previous operations. If the final yield can be specified in terms of areal density (oz. per sq. ft., for example), a radiation gauge can obviously be used to provide a check or to control the action of the tenter frame.

Read-Out Gauge for the Study of Drying and Other Experimental Purposes. A compact, versatile, portable, inexpensive radiation gauge would seem to have many potential uses in the textile field. Current uses in connection with service problems involving papermaker's felts have been outlined. In addition, interesting information might be developed by following the break-in period of felts during which changes in density and water content can occur.

There are many problems connected with the operation and design of dryers, agers and curing ovens in which a knowledge of the rate of loss of water or the average weight of a fabric at a given position would be useful. A simple read-out gauge would seem to be an ideal solution providing a cost of, at most, a few thousand dollars could be met.

(3.) Proposed Uses that Appear Feasible, in Need of Little Development, but Difficult to Evaluate

Slashing Control. In slashing a sizing material, such as starch, carboxymethyl cellulose or polyvinyl alcohol, is applied to the yarn making up the warp to insure satisfactory running in weaving. The operations involved are a padding operation, drying, and separation of individual yarns which may have become stuck together. Control of the padding operation would appear to involve standard approaches which have been discussed already. Since sizing is shed when the yarns are separated, it might well prove desirable to provide additional gauging and control to take account of the losses during separating.

In this case, since the size is a relatively inexpensive material, savings on size would not be a primary consideration except under exceptional circumstances. The value of the control system would show itself in improved performance of the more uniformly sized warp and, possibly, in decreasing the time of the slashing operation. There does not appear to be any good way to evaluate better sizing other than large scale weaving tests. Thus, evaluation of the advantages of slashing control would be time consuming and costly. Since the gauging and control equipment are also expensive, a considerable investment would be needed before this proposed use could be evaluated.

Picker or Card Control. In the picker and the card a very non-uniform feed stock of unstraightened unoriented fibers is separated and ordered to some extent. Since the card follows the picker in the processing flow, its feed stock and product are more uniform. In principle fiber-by-fiber separation is achieved in carding.

Use of radiation gauges to monitor the lap or web produced by these machines would provide information which could be used to maintain the average linear mass of the lap or web within certain limits. Short-range lack of uniformity resulting from the inhomogeneity of the feed stock could not be controlled, since no method for altering the lap or web after gauging would be available (see below, however). Corrections against long-range production of out-of-tolerance material, resulting from improper initial setting of the machine or gradual changes in machine or feed-stock performance, could presumably be made by automatic adjustment of speeds or settings.

It is generally agreed that uniformity at every step of production is to be desired and that the early steps, such as picking and carding, occupy a special position because they determine the quality of the feed stock for later operations. Mechanically actuated devices are in use at the present time to provide some long-range control of pickers. The use of gauges (as outlined in this section) would not eliminate any steps in processing, and it is doubtful whether production of either picker or card could be increased to any important extent. Thus, the potential advantage of such an utilization of gauging and control would lie primarily in the improved quality of the picker lap or card web produced. This would manifest itself in more economical production costs or superior quality of the final product. Predictions of improvement would be made difficult by the essential lack of short-range control. Again, large-scale mill tests would be needed to evaluate the potential use.

Evenness Read-Out Gauge. There are many devices designed to measure the uniformity of various fibrous assemblies from picker laps to yarns and fabrics. Most of these devices utilize some electrical measurement such as change in capacitance. These devices tend to require careful calibration since they are essentially empirical in nature and some are disproportionately sensitive to changes in water content. The direct measurement of mass offered by radiation gauges would make them simpler and more flexible, although in the case of yarns some development work might be needed to provide suitable sensitivity. However, the high comparative price of radiation gauges and the adequate performance of the electrical gauges in a fixed use makes it difficult to justify the radiation gauge, especially since none of the gauges has proved of great importance in control, their use being primarily limited to research studies.

(4.) <u>Proposed Uses that Appear Feasible but Require Development</u>

<u>Control of Resin Application.</u> A large amount of cotton fabric is treated with materials which can polymerize within the cotton fibers and can interact chemically with the cellulose of the fibers to form cross links. Examples of treating materials are urea-formaldehyde, melamine-formaldehyde or epoxy resins. The treated fabrics have better resistance to wrinkling and better recovery from wrinkling than untreated fabrics. The resins are applied in a padding operation which is followed with an oven drying and curing operation, the entire process taking place on the resin range.

There are two potential uses for radiation gauging in this process. First, the average amount of resin applied could be controlled by the standard techniques which have been discussed in connection with other padding operations. Such control would presumably minimize production of off-standard goods and possibly increase speed of production, although the limiting factor on speed seems to be oven capacity rather than control. Probably no saving on resin costs would occur. Over-treatment with resin results in severe deterioration of the mechanical properties of the fabric with the result that errors tend to be made on the side of undertreatment. This leads to the second possible use of radiation gauging for control. At the present time thin places in the fabric trend to be overtreated with resulting weak spots. To avoid this the average level of treatment is kept below the optimum level. If, in addition to long-range control of the average level of application, information on the presence of thin spots from an initial gauge measuring untreated fabric (which would be present for control of average level of treatment) could be used to control the application of resin to the thin spots in the padding, a considerable improvement in product could be achieved. It is, of course, evident that the same control system would also eliminate undertreatment of thick spots.

Such a use of the maximum potential of radiation gauging would appear to require a certain amount of development work. Thin spots may be only a few inches long with a resultant need of foot-by-foot or even inch-by-inch control. Thus, the mechanical operation used to control the padding and its attendant control circuitry would need to be rapid and precise, the more so because speeds of up to 130 yd./min. are in use with resin ranges, although some reduction in speed could undoubtedly be tolerated in the interests of a superior product.

Since resin ranges cost in the neighborhood of $150,000, the costs of gauging and control would not necessarily be out of line with the total capital costs of the resin finishing operation.

<u>Blending and Feed Control.</u> The process of blending fibers is becoming increasingly important in the textile industry. Blends of various chemically different types of fibers are increasing in use and various lots of natural fibers are often blended

to produce more uniform running characteristics in spinning. A new law requiring the labelling of blends, with responsibility for meeting the proportions stated on the label falling on the manufacturer, will intensify the importance of suitable blending procedures.

Current blending procedures involve the weighing out of alternate layers of raw stocks in the appropriate proportions to form a sandwich which is passed through operations similar to picking and carding to form a web or strand in which the fibers are presumably uniformly blended. The blending is essentially a batch operation.

Not much is known of the principles involved in the blending of different batches of fibers; however, it would seem that the more nearly the feed stock to the picking and carding steps approached the final desired blend, the greater the chance of achieving that blend would be. In other words, the thinner and more numerous the layers in the sandwich, the more likely the picking and carding operations would be to produce a uniform blend. If a feed stock for the blending device were to be formed by continuous addition of the components of the blend in the proper proportions, results similar to those obtained with a batch of many thin layers would presumably result. The production of such a feed stock would require accurate weight-sensitive metering devices. Radiation gauging with appropriate control circuitry would appear to be ideally suited to the development of such a device. For example, the speeds of conveyor belts delivering each component to the blender could be controlled by a circuit actuated by a radiation gauge for each belt so that the mix fed into the blender always contained the fibers in the proper proportions.

It is unlikely that mechanical or electrical gauges could be used successfully in such an application. By the nature of the operation the raw stock for metering would consist of various sized clumps of fiber taken from a bale in some way. As a result a wide range of densities of raw stock would be expected. This range would probably be too wide to allow adequate calibration of an electrical gauge and would also probably make any mechanical feeler gauge inadequate.

In addition to blending, there are other operations in which a controlled rate of delivery of feed stock could be of value. The semi-continuous raw-stock dyeing used by carpet manufacturers is an example.

Control of Cloth Weight. Cloth made for certain government uses and for some manufacturers of work clothes is required to have a certain minimum weight per unit area. Although any weight above the minimum is acceptable, it is to the manufacturer's advantage to meet the minimum specifications as closely as possible since no premium is paid for the excess weight. Currently, a safety factor is applied to allow for uncontrollable variations in yarn sizes and loom operation. Although the weight of a fabric is primarily determined by its construction and the weights of the yarns, some variation might be possible by altering the take-off speed of the loom. Radiation gauging coupled with control of take-off speed might then allow the manufacturer to operate closer to the minimum specifications. Although the savings per yard of cloth would be very small, substantial amounts of raw stock would be saved on large orders.

(5.) Proposed Uses that Could Be of Considerable Importance but Require Extensive Development

Production of Greater Uniformity in Manufacture. An increase in uniformity in the spinning process is one of the most widely sought for improvements in the textile field. Somewhat paradoxically, the one application of radiation gauging carried out to date, which resulted in production of a more uniform sliver (and thus, presumably, a more uniform yarn), was not accepted by the industry. As has been explained previously the reasons for rejection were economic in nature.

To understand how radiation gauging might best be used to control and improve the spinning process, it is helpful to consider the steps in yarn manufacturing in detail. A bale of raw stock is opened, fluffed out and separated - in principle into individual fibers. The steps involved in this process are opening, picking and carding. The sliver from the card is then subjected to drafting. The operations involved in drafting act to make the fibers parallel with each other and with the axis of the strand being formed. One purpose is production of a uniform strand, the uniformity referring to the degree of parallelization, the density, and the lateral dimensions of the strand. Often two or more strands will be run through a drafting operation which will produce a strand of the same size as those fed in. The purpose of such a doubling operation is increased uniformity. In the final steps the strand is condensed and twisted to form a yarn. These steps are roving and spinning; in modern production methods, no mechanism for introducing uniformity is present in these steps.

The non-uniformities arise from two sources. They are introduced by the inhomogeneous nature of the starting material (i.e. the bale of raw fiber), and they are introduced by the various steps of processing. The former tend to be short-term in character, the latter long-term. It is obvious that placement of a radiation gauge at the exit end of a machine with appropriate feed-back controls can act to minimize machine-induced variations, but offers no method of dealing with short-term variations caused by an inhomogeneous feed stock. To deal appropriately with such variations, it would be necessary to be able to feed information ahead to a mechanism capable of taking appropriate corrective action. Radiation gauging offers what appears to be an ideal sensing element to provide information to be fed ahead. However, to obtain maximum utilization of the potential of radiation gauging, it would be necessary to redesign existing equipment to provide mechanisms to act appropriately on the information fed ahead. Although a considerable amount of engineering development might be necessary, such machines, which would perform operations equivalent to picking, carding or drafting, should give products possessing a much higher order of uniformity.

Other factors can also be considered. The several steps in processing exist because the throughputs of various machines differ and as a means of providing control. It would be uneconomical, for example, to couple one position of a draw frame capable of delivering 40 lb./hr. directly with one spindle of a roving frame delivering 0.8 lb./hr. Also, it is more economical to reprocess a picker lap which, on inspection or weighing, has been found to be substandard, than to carry it through processing and sell the substandard yarn. However, if a system providing dynamic positive control is available, the control opportunity offered by separation into steps is no longer necessary, and the various economic factors must be reassessed. For example, using radiation gauging and existing control circuitry it would appear to be possible to devise a machine to perform the tasks of the picker and the card with positive control which would provide a superior card web. The benefits of the superior product and labor saving resulting from the elimination of a step in processing would have to be balanced against the probable higher capital investment and possible increased requirements for plant space. However, the possibility of substantial economic advantages from using appropriate controls to eliminate, or condense steps in processing exists.

It is interesting that, according to E. Vockrodt Der Spinner und Weber 23, 1373 (1958), the Russians have an isotope-controlled, fully automatic bale-to-yarn pilot plant. No details are given and the schematic drawing accompanying the text gives the appearance of a coupled series of conventional units.

Card-Web Splitting. No satisfactory method for splitting a strand of fibers, such as a card web, into two equal portions exists. Although such a strand is not hard to cut, no method for controlling the size of the resulting strands is available. As a result there is essentially one strand of fibers from opener to spindle, although, by cutting the output of machines with large throughput into relatively short lengths, one fast machine is made to service many slow ones.

There is no apparent reason why controlled splitting of a strand, such as a card web, could not be accomplished with the aid of radiation gauging. Such a development would provide a new flexibility to the machinery manufacturer which might have important results. As an example, the doubling operations used to increase uniformity are currently run using several lengths of sliver. An automatic splitting device would permit automatic doubling with a resultant increase in uniformity and speed of operation.

(6.) Proposed Uses that Do not Appear Feasible

Drying Control. There are several processes in which a controlled drying operation would be desirable. The weighing of a strand or fabric with a radiation gauge is easily accomplished, but the distinguishing of water from fiber doesn't seem to be possible with radiation gauging. Since the basis weight of dry fiber varies and cannot be determined in advance, the relative proportion of water and fiber cannot be measured.

Fulling Control. In fulling, mechanical action on a wet, usually soapy, cloth causes felting to occur. This results in linear and lateral shrinkage, thickening and changes in density. Fulling is controlled by manual measurement, and, since over-fulling cannot be corrected, proper control is slow and expensive. Although automatic control would be desirable, two factors work against successful use of radiation gauges. First inability to distinguish water from fiber prevents reliable estimation of fiber content. Second length and width of a fabric must be controlled to close tolerances in many cases (papermaker's felts, for example).

Utilization of Irradiation

The industrial utilization of irradiation is much less highly developed than utilization of radiation gauging. There is not a great amount of information on the ultimate costs of irradiation as a routine industrial procedure. What is known suggests that, in cases where irradiation can be used as an alternative to a chemical process, the economic advantage lies with the chemical process. As a result, the most promising potential applications of irradiation are those for which there is no chemical alternative or those which offer some additional technological advantage.

Although polyethylene can be cross-lined by irradiation, almost all of the other polymers of interest in the textile field are degraded by massive doses of radiation. If follows that, to be promising, a process must be brought about by a dose of irradiation well below levels producing serious deterioration. For this reason emphasis has been put on polymerization processes where the high quantum yield allows relatively small doses of irradiation to be used for initiation. Two areas seem promising; grafting and impregnation with polymer.

Grafting. In grafting polymeric side chains are caused to form on an existing polymeric material. Generally speaking, chemical alternatives are not available. By copolymerization and block polymerization, possibilities for side chain formation are available, however, not to the extent offered by irradiation, which, in principle, allows the initiation of any polymerization which proceeds by a free-radical mechanism. In addition to the greater range of possible side chains offered, it is important that fibers and fibrous assemblies can be irradiated to produce grafting. This makes it possible to modify the surface of fibers without appreciably altering the interior, thus retaining properties resulting from ordering of chain residues or from intrinsic chemical character. For example, stereospecific polyolefin fibers have valuable mechanical properties which would be lost with the introduction of a second monomer in the polymerization process. Polyester fibers also have valuable mechanical properties. Both types of fibers have a tendency to cause trouble in some uses because of generation and retention of a static charge (the same is true of other hydrophobic fibers). In principle, the graft polymerization of a conducting or water-retaining surface layer onto the fibers would provide a permanent solution to the problems caused by static electrification. Since, at the present, non-permanent additive finishes are used to minimize static electrification, grafting would make possible a technological advance by making static suppression permanent and, hence, wash-fast.

A related possible application involves adhesion. The adherence of plastics and rubbers to fibers is important for many industrial applications, in particular automobile tires. The grafting on of a layer of polymer with excellent adhesive properties with respect to the plastic or rubber should provide a better adhesive bond than can be obtained today in a majority of cases. In fact an adhesive bond approaching the cohesive strength of the rubber would seem possible. This approach would appear to become increasingly promising for fibers which are chemically inert. Experiments, to date, have shown that the grafting tends to form widely separated long chains rather than the closely-spaced short chains which appear to be preferable. Further experiments will show whether or not this is a serious problem and if it can be surmounted.

It would also appear to be possible to graft short dye-receptive chains onto a fiber which is difficult to dye. Here, the grafting must occur through the fiber so that risks of degradation or unwanted changes in mechanical properties are greater. However, enhancement of dye receptivity with the aid of irradiation for special cases where wash-fastness and depth of shade are not important is already being used.

Impregnation with Polymer. Cellulosic fibers are treated with materials which can bring about cross-linking and resin deposition within the fiber. These treatments confer a degree of wrinkle resistance and recoverability to the fabric and also may be used to give rot resistance, flame resistance or other properties. Chemical initiators are currently used, but many of the reactions could be initiated by irradiation, and some of the chemical initiators cause deleterious side effects. It seems likely that in some cases the products of an irradiation-induced reaction will possess superior properties or solve special problems such as are met in military or space applications.

Utilization of Tracers

There are many possible applications of tracers in solving control problems in the textile field, a good example being control of fiber-blending operations. However, in every case the sale of radioactive material to the public and the handling of radioactive material by plant personnel with its attendant problems of health physics and personnel relations offer serious objections. The problem of health physics in the case of radioactive fibers is compounded by the fact that it is almost impossible to avoid contamination of the air with dust and lint during mechanical processing operations. Therefore, the use of tracers in control would seem to suffer from serious difficulties which would render it unfeasible except for possible special situations.

Utilization of Irradiation for Static Elimination

At the present time additive finishes, point discharges, and irradiation from radioactive sources are used to dissipate static charges. Additive finishes are used most commonly; however, no entirely satisfactory system is available, particularly where relatively high speeds of traverse are concerned. There is little agreement as to the best system to use for a given case and little basic research going on. A study of the basic principles and important parameters involved in static generation and dissipation would be very helpful. Irradiation would appear to offer advantages with respect to speed if an adequate flux of radiation could be maintained conveniently.

Discussions Held

With	Company	Subject
Professor H. Rutherford	School of Textiles North Carolina State College	Utilization of isotopes and results of AEC project at North Carolina State
Dr. P. B. Stam	J.P. Stevens & Co., Inc.	Utilization of isotopes
Dr. L. Upshur	Burlington Industries, Inc.	Utilization of isotopes
Dr. H. Billica	Textile Fibers Dept. E.I. du Pont de Nemours & Co., Inc.	Irradiation for static elimination
Mr. C. Brandt	Whitin Machine Works	Utilization of radiation gauges
Mr. C. J. Haug	Warner & Swazey Co.	Utilization of radiation gauges
Mr. R. Newton Dr. N. Armitage Dr. D. Gagarine Others	Deering Milliken Research Corp.	Utilization of isotopes
Dr. L. Reynolds Mr. A. T. Clifford Dr. R. Johnson	Riegel Textile Corp.	Utilization of isotopes
Mr. R. Jones Mr. H. J. Burnham Mr. E. E. Stiepel	Saco-Lowell Shops	Utilization of radiation gauges
Mr. G. Eckhardt Dr. H. Guenther Mr. P. Sperling	Coats & Clark, Inc.	Utilization of isotopes in thread manufacturing
Dr. R. A. Beaumont, Jr. Mr. W. F. Riley	The Huyck Corp.	Utilization of isotopes in felt manufacturing

Discussions Held (Con't)

With	Company	Subject
Dr. J. J. Hanlon Mr. E. Cogovan Mr. E. D. Frederici Others	Mohasco Industries, Inc.	Utilitization of isotopes in carpet manufacturing
Mr. H. Hedberg Mr. C. Gordon Mr. J. Sweet Others	Albany Felt Company	Utilitization of isotopes in felt manufacturing

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