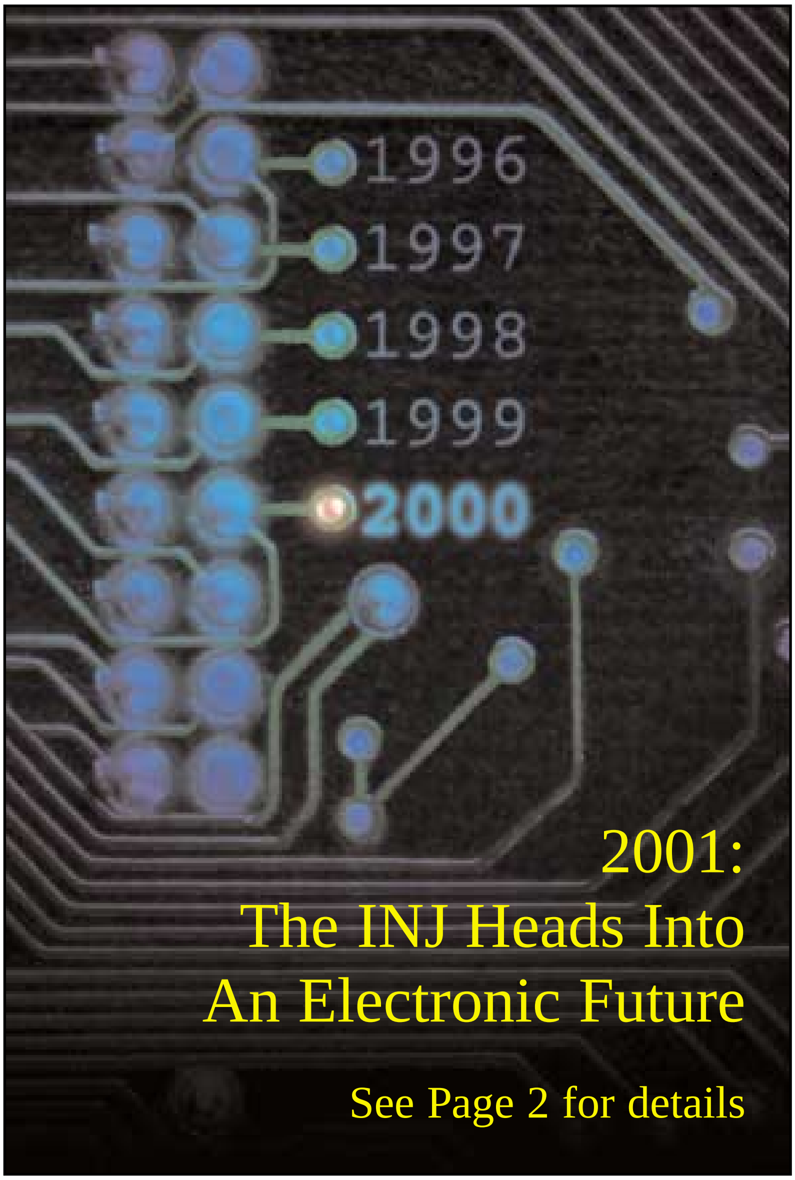
international Nonwovens Journal

A Science and Technology Publication

Volume 9, No. 4 **Winter, 2000**



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The International Nonwovens Journal Mission: To publish the best peer reviewed research journal with broad appeal to the global nonwovens community that stimulates and fosters the advancement of nonwoven technology.

ORIGINAL PAPERS

DEPARTMENTS

Forward Views, Past Reflections

News Flash: The International Nonwovens Journal is going electronic in 2001

How the world communicates and how the nonwovens industry gets its information is changing, and next year the *International Nonwovens Journal* is changing right along with it. Effective with the March 2001 issue, the *INJ* will be available only in a digital format.

This advanced version will be available on the INDA website at www.inda.org as a Portable Document File. The PDF format will allow for easy reading and downloading utilizing Adobe Acrobat Reader, a universal software program available for free to anyone who can access the Internet, and isn't that everyone? The online editions will have an identical appearance to the traditional printed issues and each issue will be posted on the website as soon as it is available. INDA and TAPPI will then inform their members and *INJ* subscribers via email as to its availability. To insure a smooth transition to the new format, INDA and TAPPI will be contacting each *INJ* subscriber to provide him or her with the necessary access codes before the next issue is published.

Current INDA members can access the Fall 2000 issue online today in order to preview the *INJ* in the new format. This Winter 2000 issue will also be on the website shortly, and previous issues are also archived; however, issues prior to Fall 2000 are in a hyper linked text format rather than PDF. Note, you will need your INDA user number and password to retrieve the *INJ* as well as other "member only" portions of the site. (If you don't know your user number and password, contact Ann Pleasants at INDA, 919-232-1210, ext. 120).

The reasons for this change are many fold. All facets of business, especially academia and the research community, are embracing new technologies and new ways of communicating with one another. The global nonwovens community is certainly no exception.

There are big advantages to the online format. First, it provides faster, more direct access and electronic data archive and search capability. It will be possible to perform a "full text" search of all the online *INJ* issues on the INDA website.

Another great benefit is the easy availability of color. The *INJ* has always had a color cover; however, the internal content has almost always been black and white. A lone exception was a four-page paper in the Summer 2000 issue, "Quantitative Evaluation of Nonwoven Samples Using DuPont Fiber Identification Stain No. 4 and Microscopy," by Michele Mlynar of Rohm and Haas. This excellent paper would, of course, have had greatly reduced usefulness if special arrangements had not been made for its being printed in color. There have been many other examples where the presentation of graphs and other data would have benefited greatly from the availability of color.

"We have polled our members extensively, both in the universities and research institutions as well as the industry in general, and have found a general acceptance of publishing in a digital format," explained INDA president Ted Wirtz. "The product will be the same, just its delivery different and, we believe, more streamlined."

"Each issue of the *INJ* has been archived on the INDA website for some time now and this is simply taking that process a step further into pure electronic publishing, an advance that is taking place in almost every business today," added Michael Jacobsen, INDA Director of Publications Development. "By making the *INJ* available in this manner we can expand its scope and make it available to the nonwovens community around the world."

Past Reflections

It has now been two years since the relaunch of the *INJ* and we are happy to report that the industry response has been highly positive. This response is, of course, quite gratifying to your editors and we continue to seek your input, be they positive or negative.

With this current edition we have now published six issues, two the first year and four this year. In these past two years we have published 39 original papers, mostly peer reviewed technical papers, with a sprinkling of general interest, nonwovens perspective papers to add a little spice. That's 370 pages of nonwovens-related technical information in all. We continue to have a bountiful supply of high-quality technical papers submitted for review and publication, which we feel, affirms the nonwoven industry's need for a high-quality, peer-reviewed technical journal.

Reader submissions of suggested content for the electronic version of the *International Nonwovens Journal* are always welcome. These contributions can range from a proposed topic and suggested author for a guest editorial, to a patent that should be reviewed or a news item or release that should be summarized for a department such as Emerging Technology Watch. The *INJ* will continue to move forward, evolve and improve with such input. ***— INJ***

Rob Johnson
DK Smith

P&G Asks Nonwovens Industry To Partner For Progress

The key to success is focusing on technical development, not on cost

Dr. Karl-Michael Schumann, Director, New Platform Technologies Division, Corporate R&D at Procter & Gamble, offered the keynote speech at the inaugural INDA/TAPPI International Nonwovens Technical Conference, in Dallas, TX on September 26. In his paper Dr. Schumann challenged the nonwovens community to come to P&G with the technologies that will drive both parties down the road to success in the 21st Century. In return, he promised, P&G would partner with the companies that lead the way.

What follows are excerpts from Dr. Schumann's presentation.

As you know, P&G manufactures and sells disposable hygiene and other products for every-day usage to literally billions of consumers around the globe. In this business we can only be successful if on one hand we truly understand what can improve the lives of people in the various geographies, and if on the other hand we provide those consumers with products that deliver meaningful benefits and great value. Where we do this consistently, we can gain their loyalty and can build a successful and expanding business, not only for P&G, but also for our business partners and suppliers.

Meaningful performance benefits and superior value are predominantly based on innovations in both the design of our products and on innovative materials these products are made of. For more than three decades the nonwovens industry and P&G have partnered quite successfully in this innovation process.

Nonwovens, in some way, have made disposable hygiene consumer products, as we know them today, cost feasible. For example, if we replaced the nonwovens top-sheet in a baby diaper with a woven cotton material, we would increase the cost of a case of baby diapers by about $10. Nonwovens are also an important visual reinforcement that communicates aspects of both functionality and convenience of a specific product to the consumer.

Over time, the nonwovens used in disposable products have become more and more carefully engineered materials. They add performance and value to the product, and thus improved nonwovens became one of several factors that sustain continuous product improvements, leading in turn to further growth of the product categories.

An Historical Overview

To pick a few examples:

• Initially, back in the 1960's, we used a resin bonded rayon substrate as topsheet for Pampers diapers. It communicated well that this was really a disposable product, but in use it felt almost as wet as cotton.

• A polyester sheet in the mid-70's was the first dryness improvement, even though small in magnitude.

• It was followed by thermal bond polypropylene in the early-80's, which was quite hydrophobic and therefore much dryer.

• Starting in the late 80's we have seen polypropylene carded and spunbond nonwovens in diaper outer-covers, and as of the 1990's they were used as fluid acquisition layers in absorbent cores. Overall, disposable products dramatically drove the nonwovens production.

As we at P&G transition into the 21st century, nonwovens have penetrated into a broad range of global consumer products in most of our business units. Today we use nonwovens in baby care and feminine care applications, in adult incontinence products, in dry dust acquisition wipes, and in wet cleaning wipes, for cosmetic facial wipes, for dry laundry applications, and even for portable heating implements. The volume and value of our nonwovens materials purchases developed accordingly. For baby care products alone we currently purchase materials from dozens of different suppliers around the world. Since 1996 our nonwovens purchases have increased by more than 50%.

In the near future we hope to see several of our new products and current product improvements expand fast globally, such that our total nonwovens purchases will again increase dramatically within the next three to five years. In fact, Procter & Gamble will spend three times as much on nonwovens in 2003-2005 as we did in 1996.

While this sounds like a great business outlook, and we have every reason to be optimistic, merely hoping for the best is not good enough. In order to turn this opportunity into reality, we will have to make some substantial changes in how we operate, both at P&G and in the nonwovens industry.

Focus On R&D, Not Cost

Historically, P&G and its nonwovens suppliers had focused first on cost reduction, and second on functionality, or new materials. To achieve the lowest possible cost, we have developed new materials and processes with many different roll good suppliers. Most of them are regional companies either in the Americas, Europe or Asia. To be clear, this strategy has served us well in the past, when maybe once or twice in a decade a significant innovation in nonwovens functionality for our products made it to the market. And cost reduction will continue to be very important.

But the functional requirements of nonwovens in the more recent years have become much more specialized. A product like a baby diaper, which used to contain just one or two different types of nonwovens, today builds on five or six different nonwovens, each fulfilling a specific function. In addition, we have now different types of dry and wet wipes, portable heating implements and laundry products, all of which are based on nonwovens. Each of them has different functional requirements. Materials innovations are needed in more and different directions and on a much faster frequency. And, the recent and future global introductions of new nonwoven-based products with accelerated market growth will also require a new and different approach to nonwovens development and supply.

Responding to those changing conditions, we will have to focus in the future first on materials innovation, second on speed to market globally, and third we will continue to focus on cost. I recognize that it is complex, and it will require a different mindset, new skills, and significant investments, both in building stronger relationships, and in building global capabilities.

Changing The P&G Mindset

All of us will hopefully be able to develop a stronger mindset of partnership and collaboration, rather than competition. We all will need to develop a truly global business mindset, rather than a regional or local one. We need to nurture long term thinking, and true product creativity. We need to acquire skills like "should-cost analysis," like waste elimination and elimination of cost, which do not add value to the final consumer product. In this process, P&G will take the initiative in establishing strategic development partnerships, based on innovation and speed to market.

These will focus on a group of nonwovens companies whose competencies match up with our future product and materials needs. We expect this to be a smaller number of partners, which we will select based on three criteria: on a proven track record of innovation and speed, on their capability to supply materials globally, and on a minimum overlap in core competencies. This is not an entirely new approach for us. In several of our other materials areas, predominantly those for our fabric and home care business, we have seen outstanding results from synergistic development alliances with multiple key suppliers.

And clearly, we at P&G will have to do our part to reduce the barriers to better working relationships, to get to mutually beneficial relationships in which all of our partners closely collaborate in driving innovation with high speed. Here is how we plan to change:

Dr. Karl-Michael Schumann

• We will be more transparent on success criteria and rewards for success.

• Where significant materials and performance innovation occur, we will better balance purchase volume for innovation and cost.

• We will appropriately support the globalization of our key partners. Our specifications will become performance specifications, rather than material prescriptions. They will be global specifications, regional or local executions will be eliminated over time.

Change Is Expected

What changes and investments do we expect from our industry partners? First, and most importantly, we would like to see you radically upgrading your research and development capability. We believe this will work best if you can bring together a critical mass of very diverse top R&D talent, people that can innovate jointly over the whole materials supply chain, starting with experts in polymer synthesis and resin formulation, over fiber spinning and web lay down, into the physics of post web formation treatments, and the design of composite materials.

Second, we would be delighted to see you installing strong and highly flexible pilot scale manufacturing capability. How fast can we get from a new materials concept to consumer testable prototypes? How quickly can we change from one prototype to the next improved one after we have obtained the first test results? What is the maximum prototype turnover within a given time frame? As you know, these are important questions determining how long it will take to develop a new product and get it to the market.

And finally, the industry really needs state-of-the-art manufacturing assets for all types of nonwovens in all regions. We need to get identical materials onto our converting lines in every region, regardless whether these materials come from a nonwovens plant in Finland, Germany or Canada or Japan. This requires that your manufacturing assets get much more standardized than today, and are designed for top quality assurance.

You Can't Go It Alone

Individual companies alone might be able to realize certain elements of this future. Other elements will require a very close cooperation of several industry partners. We all may need to apply new business models, solutions that are outside of our normal comfort zone. I see no reason why in nonwovens we cannot experiment with enterprise models used with huge success in the automobile and electronic industry.

I would like to take this opportunity to invite and challenge this industry: come forward with delivering breakthrough consumer performance via focusing on new materials functionality, and speed to market. We will listen. We will value a diverse variety of technical ideas and approaches in searching for the best solutions to consumer problems. We will go all the way with you. We can take your innovations to the consumer market – globally.

I am entirely convinced that the potential for the nonwovens industry together with a global consumer products company is brighter then ever before. I believe we have seen nothing yet! Stay tuned. ***— INJ***

DIRECTOR'S CORNER

Work/Life Programs

A major change has occurred over the past several years regarding an integration of the working life of an individual compared to their private life. This is highlighted by articles in several popular magazines that recognize stand-out employers and assess why they're considered desirable places to work. This can be typified by a listing of such categories as "Best Companies to Work For," "Best Companies for Working Mothers," "The Best Small and Growing Companies," and similar listings.

This concern has been accelerated in the past few years by the advent of employee shortages, particularly shortages among technically trained and qualified personnel. The increasing number of women in the workforce has also led to an increased concern of this nature.

All of this can be summed up in the recognition that an employee spends a considerable amount of their waking hours at work, and at the same time spends a considerable amount of time with their families and other personal activities. An effective employee is one in which the these two spheres are integrated to the benefit of performance and satisfaction in both areas. If an employee has problems in the personal area, it invariably impacts the work area. Similarly, the environment of work area can greatly influence the quality of personal life.

Testifying to the mounting concern in this area is the existence of an institute that focuses on this aspect of corporate performance and plays a major role in compiling the list of top companies. This is actually called the "Great Place to Work Institute," located in San Francisco.

The Institute's Project Director, Ann Nadeau, has said of this concern, "Great workplaces have a strong people philosophy where senior management has made it a top objective to create and foster a work environment that is a superior workplace for their employees." She adds that such great workplaces are ones that have "a high level of trust between employees and managers, and the employees are enjoying what they do in their job as well as the other people they work with."

This has resulted in many companies large and small organizing an effort that goes by a variety of titles. One common term applied to the concept is "Work/Life Program." This term recognizes that an individual has a working life and another life outside of work but the two must be integrated and balanced. When such integration and balance is most successfully accomplished, both the "work" and "life" segments benefit and thrive.

One characteristic of an employee-friendly company and workplace is one that has open lines of communication. One successful company has indicated their Work/Life program has involved a distinct cultural change, in that they have sought a culture that is more open, more candid and one in which professional and personal issues can be discussed and resolved to mutual benefit.

One company that has provided considerable leadership in Work/Life programs follows a "leadership model," but outlines specific behaviors that employees at all levels are expected to demonstrate. In their environment, such leadership behaviors include treating employees with dignity and respect, setting clear objectives, and communicating. The aptly named Work/Life Effectiveness Manager for this company has indicated that expectations in each of these areas actually rise as an individual reaches higher levels in the organization.

One manager for a company that has historically given attention to this concept points out that the company has allowed its employees to vote on their working hours as far back as the 1930's. The selected time period (7:30 a.m.-4:15 p.m.) proved to be ideal for the dads who wanted to get home early to their families. The more modern approach taken by this company, which was initiated a couple of decades ago, realized that it wasn't just dads anymore. In the early 1990's, the company reassessed its Work/Life programs and dedicated a department to them in 1992. The strategy of their program is to treat an employee as a "whole person." This involves a recognition that people don't just leave their families at the door when they come in to work.

DuPont began surveying its employees about Work/Life issues about 15 years ago. This originally focused on the increasing number of women in the workplace and a recognition that women must have special Work/Life issues. However, their surveys quickly established that men have Work/Life issues also and that everybody has similar types of problems; as these problems are examined and addressed, performance and satisfaction in both spheres can increase.

As a company, DuPont has maintained for decades that "Safety is the No. 1 concern at DuPont." The company claims to have zero tolerance for safety incidents. This concept has been transposed into work environment concern and the company now has zero tolerance for people treatment issues.

An increased concern with Work/Life environment has led to many new features in the workplace. Childcare centers is one of the obvious and very successful activities. An emergency "backup childcare center" is a relatively new outgrowth of this activity. Among some others:

• The development of on-site fitness centers has become rather widespread and many companies can attest to the pay-off from such centers. Many companies provided payment for health club membership where they cannot provide a fitness center, or to emphasize the wellness benefits after working hours.

• Some companies provide a sabbatical leave of 4-to-6 weeks after a certain period of service.

• Several offer concierge services to cut down the amount of "running around" their employees need to do.

• Some companies provide facilities for the servicing of employee automobiles.

• Several companies help pay for adoption expenses and otherwise assist in this activity.

Flexibility in working arrangements, both in terms of hours and location, has also received considerable attention. Such flexibility decisions are made with the business needs as the paramount concern. However, it is usually possible to devise something that is both best for the company and beneficial to the employee. Such arrangements include flexible start times, part-time employment, telecommuting, compressed (or expanded) workweeks and job sharing.

As one human resources specialist stated, the "issues of looking at how things get done, looking at the needs of both the company and the employee, can provide maximum results." Considerable latitude is provided in many of these arrangements. The reason why someone wants flexible work arrangements doesn't matter; instead, maintaining or improving performance is most important.

At one company, employees submit a business plan that analyzes their job responsibilities and assesses how those responsibilities can be fulfilled under nontraditional work arrangements. That business plan is then reviewed by the employee's manager to assess whether a nontraditional schedule can work for both of them.

For the academic director, modification of some these programs would be required. However, the basis premise can still be exploited; namely, that a Work/Life partnership exists and that the participants can and should work to the benefit of all.

In 1995, a survey of its employees about its Work/Life was made by DuPont. They found that employees who had used the Work/Life programs felt more supported by the company, less stressed and less burned out, and less likely to leave the company and more likely to recommend the company as a place to work; most of them indicated more willingness to go the extra mile for the company.

As might be expected, many companies involved in the Work/Life initiative have found that recruitment and retention of employees is greatly benefitted by such programs.

Laboratory Air Quality

With the very considerable focus that exists on indoor air quality (IAQ) as it relates to office buildings, schools, homes and other sites, there is still a need to carefully consider the quality of air within another confined space---the research laboratory.

Within the last few weeks a new standard has been approved for Laboratory Ventilation. This approval comes from the American National Standards Institute (ANSI) and the American Industrial Hygiene Association (AIHA). This 3-year revision effort has been led by Dr. Lou Di Berardinis of MIT, an expert specialist in this field.

The new standard not only provides specifications for achieving laboratory safety, but also includes an audit form for users to determine whether compliance with the standard has been achieved.

The standard provides complete details on laboratory chemical hoods as well as other laboratory containment devices such as gloveboxes, ductless fume hoods and special purpose hoods used in laboratories.

Good air quality promotes the health, comfort and well-being of laboratory users. Where toxic materials are involved, with statutory requirements built around Permissible Exposure Limits (PELs), then the requirements of OSHA may govern the situation.

Additional features of the new standard include performance tests (requirements for commissioning, testing and specifications, flow measurement, hood static pressure, routine and special tests) as well as work practices, preventative maintenance, air cleaning and special laboratory areas.

Although indoor air quality in laboratories is best managed by utilizing successful architectural and engineering design concepts before the laboratory is actually constructed, considerable experience and help is available on assessing current laboratory situations and methods for retrofitting to meet minimum requirements.

Existing laboratories with indoor air quality concerns can be successfully investigated and problems corrected. Initiating proper laboratory work habits and practices, along with modifying improperly functioning ventilation systems are generally found to be the major corrective actions required.

Investigation of such air quality problems in laboratories particularly focus on face velocity measurements of exhaust hoods, room pressure measurements and air sampling for chemicals or other concern. Observation of the work practices of individuals in the laboratory is also very important.

For more information: D. Jeff Burton, IVE, Inc., Bountiful, Utah; 801-298-8996; Fax: 801-298-9098; www.eburton.com. Burton is a specialist in laboratory ventilation, having published a book entitled "Lab Ventilation Guidebook." Also, Steve Hays, Gobbell Hays Partners, Inc., 217 5th Avenue North, Nashville, Tennessee 37219; 615-254-8500; Fax: 615-256-3439. ***— INJ***

STANDARDS DEVELOPMENT

By Carl Palenske
Manager, R&D Core Laboratories,
Kimberly-Clark Corp., Roswell, GA

I have been the chairman of INDA's Standard Test Method Committee for the past nine years, representing Kimberly-Clark Corporation on this committee for the past 11 years. During my 34 years at Kimberly-Clark, I have dealt with standardizing test methods and laboratory management. All of us in our industry have noted a spectacular change in how we are conducting business, here in the U.S. and globally. These changes have been dramatic as it concerns standardized testing methods. In the last 10-15 years these changes are bringing new challenges to our industry that must be addressed.

• Our testing equipment has become more precise, but also more costly. Our technology in this area is changing so fast that our equipment is obsolete before the test methods can be finalized.

• At the present time globally there is a very aggressive attitude within some organizations toward increasing the size of one's portfolio of standard testing methods.

• The customer base for most of our companies has changed geographically from local U.S. markets to one that is now global in nature.

I would like to address the above issues as they relate to Timing, Cooperation, Excellence, Openness and Communication.

Timing

I feel the time lapse between submission of a procedure and its issuance is one of the biggest roadblocks to progress that faces all standard-setting organizations. To address the situation facing our industry it is important for the associations to complete the processing of a new test method into a standard within one year. The INDA Standard Test Method Committee is meeting this goal. Primarily because this committee has four working sessions a year, this goal is met without losing its emphasis on excellence.

This issue of timing is not just U.S.-based, but rather is being globally driven. The CEN organization is being very, very aggressive and has made its intention known by publishing goals as follows: "In a global marketplace, the objective of the standards development process must be a single internationally recognized, technically valid standard that allows products to be distributed for commerce worldwide without change or modification." The implied intent is that it will be that standard setting organization.

Cooperation

It is imperative that the U.S. standard setting organizations set-up a consortium by industrial sectors, i.e. Nonwovens, Disposables and Textiles. This grouping would eliminate duplication of effort and standardize the protocol format. When setting this protocol we (the U.S.) should prepare these standards so that they are globally executable. Where there is a global synergy between associations, harmonization should be investigated.

Excellence

In this day of high technology and global customers as well as the need to be "world class," our test methods need to be of the highest quality. The research that backs these procedures (new or old) must be above reproach and demonstrate the most current technology. A new strategic goal statement made by the Presidency of the EU at CEN's European Council in Lisbon, March 23 and 24, 2000 was: "To become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion."

Openness

Openness can take different forms. First, the open format of the U.S. standardizing bodies allows all interested parties access to the standardizing process. I find that most U.S.-based standardizing bodies require a balanced membership, balancing producers and consumers, which broadens the knowledge base and strengthens the technical expertise of the body. This base becomes the vehicle for creating credible, good procedures containing best practices.

Second, the openness of U.S. industries to allow new test methods to go forward and to be standardized is essential to growth of the industry as a whole. I realize that within a corporation there are items of a proprietary nature that include test methods and these items should remain within the corporation. However, there are new techniques and new, innovative adaptations appearing rapidly. Issuing test methods on these new developments will give the parent corporation and the U.S. in general a competitive edge.

Failing to be open has its consequences. The number of researchers in the U.S. as a percentage of the industrial work force is much larger than in Europe. However, the sense of urgency is heightened in Europe. If we don't issue new standardized test methods into the public arena, we will lose this technical advantage when someone else on the global scene does.

As stated before, the CEN organization has a very aggressive program to adopt test methods. Within the CEN organization there is a program referred to as the Framework program. Currently, this program has the designation of "Fifth Framework" and will be in operation from 1998 to 2002. Its stated purpose is to advance the European position as it relates to research and technological developments. Fifth Framework is sponsored and fully funded by the EU. One of its key programs is called Competitive and Sustainable Growth. The total budget for these Framework projects is 14.96 billion Euros.

The EU states that research is critical to economic growth and employment, and should be at the center of the EU's policymaking process. The EU states a need to develop a common approach to financing large research facilities in Europe, to make better use of direct and indirect aid particularly in the form of patents and risk capital to encourage private investment in research and innovation.

At the same time Europeans are enlarging their budgets for research, i.e. the Fifth Framework and the Joint Research Center, U.S. corporations are tightening their corporate belts so that they may be more competitive in the marketplace in the short term. As this global picture unfolds I see our U.S. industries gradually losing their position competitively and unable to maintain sustainable growth unless we have a similar vision and a program similar to Fifth Framework.

Communication

Communication has always been very important to the success of any business, even more so today. Here in the U.S., whether at associations, industry or government, the pace of our activities and our priorities are changing greatly for a number of reasons. Some of those reasons include:

- Globalization of U.S. corporations.
- Corporate mergers.
- Corporate restructuring.
- Corporate sectoring.
- Corporate downsizing.
- Electronic communication.

The speed at which today's information is being generated and outdated, along with the massive volume of this information, makes it almost impossible for anyone to remain current. In the past, we could remain updated by simply reading six or eight periodicals monthly, but this is no longer true. Parts of today's vast knowledge base are going virtually unnoticed because of the sheer volume, the ever-changing priorities and the frequency of job changes. For these reasons many public documents are virtually "top secret." We who are living in this age of voluminous information must address and solve this problem for ourselves.

Conclusions

If the United States truly wants to continue to compete in the global marketplace of this New World order, we had better set our own aggressive goals and actively participate toward their achievement.

All of the U.S. industries that have affiliates worldwide must encourage their counterparts to take an active role in whatever (national, international or global) organization best meets their needs as a standardizing organization.

We must remember that we are living and working in a global society where a balanced approach to the production of standardized test methods is necessary. For any global plan to work it will require all global members to cooperate and compromise if needed without losing time and expertise. ***— INJ***

The Assessment of Cross Machine Openness Uniformity Of A Fiber Feed Matt

By Ayad Oumera, Abdelfattah M. Seyam and William Oxenham, Nonwovens Cooperative Research Center, College of Textiles, North Carolina State University, Raleigh, NC

Abstract

The one-dimensional characteristic of yarn has resulted in very little attention being given to the uniformity of carded web in the cross machine direction. The development of nonwovens has prompted researchers to reconsider the importance of cross machine uniformity in determining the total uniformity of the carded web. It is therefore important to develop manual and on-line techniques to quantify cross machine uniformity at both the input and output of the card.

At the card input, uniformity is taken as representing both mass and openness characteristics of the feed matt. While at the card output, there are many available techniques that allow the on-line measurement of the mass uniformity of the carded web, determination of uniformity at the input level is more difficult. The approach that was taken was to use an off-line technique to find the mass and openness of the feed matt at different locations across the card.

While traditionally mass as a property has been given a lot of importance, much less attention has been given to the concept of openness. This is due in part to the difficulty in quantifying openness. Openness is believed to have great significance in determining the overall quality of the carded web, especially with regard to the formation of neps. In order to make the concept of openness more clear, it was found necessary to develop a way of quantifying it. This was done by performing a compression test on the feed matt, and then fitting the compression data with an exponential curve. The coefficient of the exponent was used to represent openness. This approach was used to find the effect of the feed roller (pin type) on cross machine uniformity. It was found that the squeezing of the feed roller did not have an effect in redistributing the mass of the feed matt, but did have an effect in changing the openness of the feed matt.

Because of the difficulty involved in the handling of the feed matt, a newly developed technique is suggested to characterize openness. While this method still relies on the compression characteristics of the feed matt, it is more appropriate because it is performed on-line. Preliminary results are reported. It was found that thickness measurement under carefully selected pressure value could be used to characterize openness precisely.

Introduction

Carding is considered to be the most critical process in determining the longitudinal and transverse uniformity of the nonwovens. While traditionally the focus has always been to improve the longitudinal uniformity of carded web, much less attention has been given to the cross machine uniformity. Some studies have suggested that the carding process in itself results in very little fiber movement in the cross machine direction and that any variations in that direction must be due to variations already present at the feeding stage. Other studies have mentioned that the possibility of fiber movement during the transfer of the fibers from one carding field to the next is very real. An important goal of this paper is to try to resolve this issue and determine the actual physics that fibers go through during the carding process.

What is generally meant by a "better carded web" is a more uniform web in mass in both the longitudinal and transverse directions. The uniformity of the carded web is itself greatly influenced by the mass and openness uniformity of the feed matt. While the concept of mass uniformity is very clear and can be easily measured, the concept of openness uniformity is much less clear. There is no doubt in the mind of textile scientists that a well opened feed matt will result in a better carded web with fewer neps. The reason being that a well opened tuft of fiber gives a much better chance for the card elements to perform their carding action, to individualize, and to distribute the fibers more uniformly. There is no standard method of quantifying openness, and this property has been mainly qualitatively assessed. A novel technique that was developed at the Nonwovens Cooperative Research Center (NCRC) labs and aimed at quantifying openness is described in this paper. Once openness is quantified then this property, along with mass, are used to determine whether the pressure applied by the feed roller of the carding machine results in a redistribution of the fibers across the machine direction.

By quantifying openness, it is then possible to combine this property with mass measurements in order to have a more comprehensive and complete definition of uniformity. This will allow a complete characterization of the input feed matt, which can be combined with loading measurements at the levels of both the cylinder and the doffer, to provide information about the movement of fibers both along and across the machine direction. It is then possible to determine the amount of dispersion that takes place and the reasons for it. It is hoped that this investigation will lead to a detailed explanation of the carding mechanism at the microscopic level and to recommendations in improving the overall quality of nonwovens.

Previous Work

Card web uniformity along the machine direction has been studied by many researchers [1,3,7]. The variables affecting such uniformity were identified and improvements suggested. However very few studies [2,4,6] have been found in the literature addressing the problem of card web uniformity in the transverse direction. This scarcity is due to the fact that the transverse direction has long been neglected, because in the production of yarn the resulting carded web is condensed and the uniformity in the transverse direction becomes less meaningful. It is only recently in the development of two dimensional carded webs that the uniformity in the transverse direction has had renewed interest.

In its publication entitled “Woollen Carding” [6], the Wool Industries Research Association (WIRA) has conducted tests in which feed slivers of white and blue blends were laid side by side along the feed sheet. The output web was then collected on a roller and examined for the presence of dispersion, in which case the width of the bands would have increased. The results included two clear pictures on the input and output web where it can be clearly seen that the dispersion of the fibers in the cross machine direction is negligible. The conclusion of the report was that “apart from some effects due to air currents near the edges of the card which can be minimized by the use of side shields, there is no major movement of fibres across a card, so that any trend in weight from side to side must be caused by a trend fed into the carder.”

Air currents generated by the card are mentioned as a possible factor that can cause fiber to disperse across the card. This is becoming more and more important with the continuous increase in speeds in modern carding. The negligible effect found in this study should be looked on with the limitations of the study. The study was performed on a roller-top card where the carding field is discrete, as opposed to the continuous carding field (between flats and cylinder) in flat-top card. The other limitation is that the study was performed with wool fibers, which are long fibers. It is intuitively expected that the dispersion will be less than shorter fibers because long fibers can be held for longer times than short fibers [4]. Another more important limitation of the study is the fact that slivers were used at the input as opposed to feed matt coming from the chute feed. Fibers in slivers have a higher degree of parallelism than fibers in the feed matt. The higher degree of parallelism could mean that during the transfer of fibers from one carding element to the next more fibers will be captured from their leading ends, and therefore more fibers will remain straight, which means that less dispersion takes place. In the case where the input is a feed matt, most fibers are not captured by their leading ends, which means that fibers are more likely to disperse.

Another important study that covers the subject of fiber movement in the cross machine direction has been conducted by Cherkassky [2] and published in 1994. Although the study is quite theoretical in nature, it can be considered as the first study where the web is modeled in two dimensions. The mathematical model considers both the longitudinal transport of fibers and the diffusion in the transverse direction. Cherkassky believes that in the case of nonwoven material, it is necessary to use a two dimensional model because the output web retains its width. He also suggests that since the card does not have any mechanism where the fibers are guided longitudinally, the motion of fibers in the cross machine direction should be considered. The reasons that are given for the possibility of fiber dispersion are the non-uniformity of air flow in the carding zone and the variability in the point of capture of the fibers during their transfer between the different carding zones. The study is limited in the sense that it is only applicable for continuous carding fields. The concept used in the modeling needs to be extended to cover discrete carding fields.

The work published by Cherkassky was used later by Meng to develop a new mathematical model that covers the carding fields of both roller-top and flat-top cards [5]. In both Meng and Cherkassky’s work, the underlying assumption in the development of the model is that fibers disperse (move in the transverse direction) only at the transfer points. Outside these zones, dispersion is considered to be negligible. There are two possible methods of fiber transfer either from a low to a fast moving surface or the opposite. When the fibers are transferred from a fast to a slow moving surface, fibers are first compressed by the fast moving surface and are then picked up by the slow moving surface in a compressed form. Fibers picked up in a compressed form are more likely to disperse in the transverse direction. In the case where fibers are transferred from a slow to a fast speed moving surface, the fiber is usually stretched by the fast moving surface before being picked up; this means that the possibility of fiber dispersion is more remote. This analysis of fiber movement at transfer points gives a possible explanation for the actual mechanism that takes place.

Meng [4] has performed a number of experiments to evaluate the amount of fiber dispersion that takes place during the carding process. A number of clearly separated fiber stripes (separated by empty space) were fed to the card to allow the transfer of fibers to occur without interaction between neighboring stripes. The same experiment was also performed using black and white stripes laid side by side. The width of the stripes was measured before the feed roller and off the doffer. It was found that fiber dispersion was greater for flat-top card than roller-top card. Higher dispersion was found for side stripes compared to middle stripes, and for short fibers compared to long ones. Dispersion was also found to vary with the type of fiber used. The work performed by Meng [4] showed that there is some amount of dispersion that takes place during the carding process. This is in contrast with the WIRA findings, which suggest that the amount of dispersion is negligible. The work previously performed did not consider the openness of the fibers when making comparison between the stripes. Openness is believed to have a significant impact on fiber dispersion, as the more the fibers are interlaced with each other, the less freedom they have dispersing. Moreover, if dispersion occurs from areas of high mass to areas of low mass, uniformity could be improved.

Openness Considerations

Openness has mostly been used in a qualitative or descriptive sense. It is known to be important but it is not given enough attention. In order to complete the definition of uniformity, added to the concept of mass uniformity must be the concept of openness uniformity. An attempt is made in what follows to quantify openness uniformity of the feed matt using a technique based on its compression characteristics.

Test Procedure

The material used in the experiment was cotton with fiber length of 1.04 inches, with strength of 26.4 gf/tex and with a fineness of 4.6 micronaire. The material initially collected was located right after the chute feed but before the feed roller. The material was very fluffy and hard to handle without distortion. The idea was to use rectangular cardboard (91cm x 36 cm) and insert it below the material and then pull it along with the material. Paint was used to draw on the strip collected eighteen 25 cm^2 squares with a 2 cm diameter circle drawn at the center of each square as shown in *Figure 3*. The strip with eighteen circles drawn on it was then placed on the compression tester to perform the actual compression test. The same procedure was used to collect at different times two more strips located before the feed roller, and three strips after the feed roller (this was done by removing the lickerin).

Figure 1 shows a schematic representation of the compression device that was to perform the tests. A circular piston 20 mm in diameter was manufactured to perform the compression test on the samples. One side of the piston can be screwed onto the top of the load cell and the other side is a smooth circular area that will compress the sample during the test. A steel plate was manufactured to hold the sample during the test. The plate is perforated in the center (2 cm diameter hole) to allow the piston to move past the plate and perform the compression test on the sample placed on top of the steel plate. The direction of the compression test was reversed from the conventional test because it is believed that in the conventional test the weight of the piston will take the load cell from a state of tension to a state of compression. In this region (tension to compression zone), the results obtained from the load cell are not reliable. In conventional tests, the weight of the piston is small compared to the ultimate compression load of the sample so that its effect can be neglected. However in the test performed, this effect is not negligible and efforts were made to minimize this source of error.

For each compression test, the displacement of the cross heads was set at 29 mm/min., and the compression test was performed until a final sample thickness of 10 mm. Each strip was sandwiched between the top part of the compression tester and the steel plate carrying the strip, as shown in *Figure 1*. The initial separation of the top part and the steel plate is set at 75 mm, so the piston compresses the sample 65 mm. From the speed of the cross head and the scan rate (5 scans/sec), it is possible to transform load vs. time in terms of load vs. thickness of the sample. Eighteen compression tests, each corresponding to a different location across the width of the card, were performed for each strip collected (a total of six strips were collected, three before the feed roller and three after the feed roller). After completing the compression tests on a strip, the strip was cut with a pair of sharp scissors into the 25 cm^2 squares, and each square was weighed.

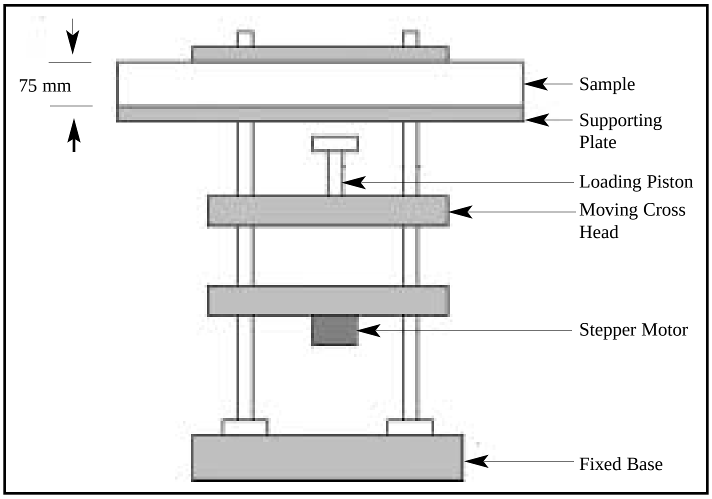

Figure 1
SCHEMATIC REPRESENTATION OF COMPRESSION TESTER

Data Analysis

Data was collected at the rate of 5 scans/sec. Preliminary tests showed that a certain amount of data filtering is needed to eliminate some of the noise that is coming from the operation of the step motor that drives the loading piston *(Figure 1)*. The filtering method that was used is the moving median technique. It consists of picking up the first five (five is used as an arbitrary number) voltages (y_1,y_2,y_3,y_4,y_5) and then selecting the median among them y_{3m} which is then associated with time x_3 and used as the first data point. The next step is to shift up one data value and then collect the next five voltages (y_2,y_3,y_4,y_5,y_6), and pick up the median y_{4m} which is associated with time x_4. This filtering process is done on-line during the collection process. The purpose of this process is to eliminate among each of five points the high and low values fluctuations, which are considered noise. A typical load versus time curve of filtered data, obtained while testing a cotton sample, is shown in *Figure 2*.

It can be noted that the curve obtained in *Figure 2* can be divided in two portions. The first portion, corresponding to high decreases in the sample thickness for very slight increases in load, is almost linear. This portion corresponds to the resistance of the few fibers sticking out from the level of most other fibers; this, of course, is not related to the openness of the fibers. The second portion, corresponding to low decreases in sample thickness for high increases in loads, is the exponential like portion of the curve. This portion represents most of the fibers being compressed with the air voids in-between being kicked out. This latter portion is physically related to how open the

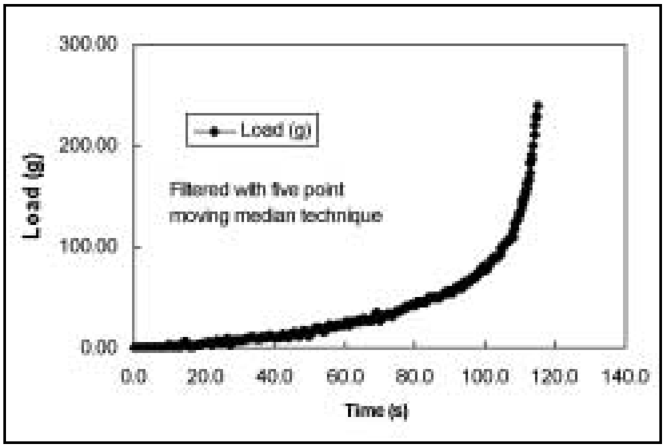

Figure 2
TYPICAL COMPRESSION CURVE
FOR A COTTON SAMPLE

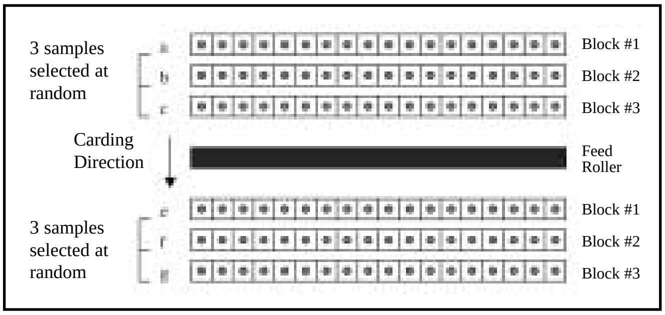

Figure 3
COLLECTION AND DIVISION OF STRIPS

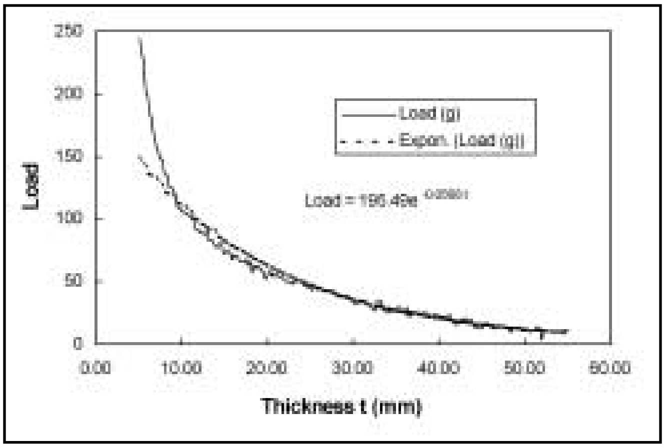

Figure 4
COMPRESSION TEST RESULTS FOR SAMPLE F1
AND FITTED EXPONENTIAL CURVE

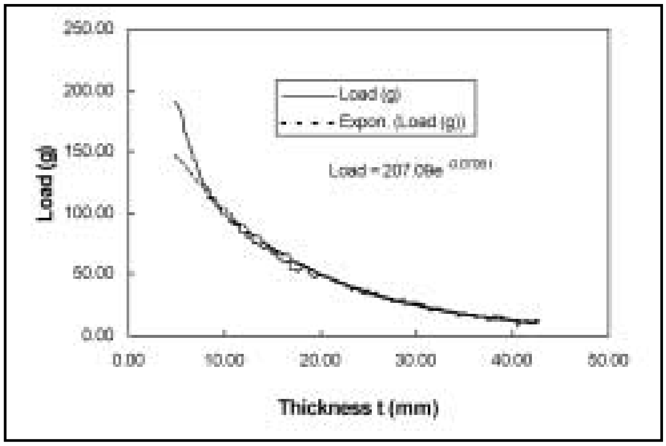

Figure 5
COMPRESSION TEST RESULTS FOR SAMPLE F2
AND FITTED EXPONENTIAL CURVE

fibers are. The interesting part of the curve is the exponential like portion of the curve, which is believed to provide valuable information about the openness of the sample being tested. To get useful information about this portion of the curve, it is necessary to fit it with an exponential curve, which is equivalent to plotting the points on semi-log paper, and then performing a linear regression analysis. It is believed that the slope determined by the regression analysis gives a measure of the openness that is characteristic of the sample being tested. The difficult part in the procedure is to determine the point that separates the linear part from the exponential like part of the curve. It was decided arbitrarily that the point of separation would be the point corresponding to a load of 10g. The portion of the load-time curve between the point corresponding to a load of 10g and the point of maximum load are fitted with an exponential curve. The value of the exponent regression coefficient is taken as representing openness.

Results

Figures 4 and 5 show the actual compression curves obtained along with the fitted exponential curves for the first two samples tested *(sample f1 and f2 in Figure 3)*. The equation of the fitted exponential curve is displayed on each graph. It is believed that the value of the exponent term in the displayed equation is a measure of the openness of the sample at that location.

In summary, each square in each strip has two corresponding properties measured, one is the mass and the other is the coefficient of the fitted exponential curve to the compression curve. *Figures 6, 7 and 8* show the mass before and after the feed roller for the first, second and third strip, respectively. It can be clearly seen by comparing the three figures that no clear trend can be picked up for the effect of the feed roller on mass uniformity in the transverse direction, so the conclusion is that the feed roller does not result in a redistribution of the mass in the cross machine direction.

Figures 9, 10 and 11 show the absolute value of the exponent regression (openness is taken as the negative of that) coefficient before and after the feed roller for the first, second and third strip, respectively. It can be clearly seen by comparing the three figures that there is a clear trend. The value (absolute value) before the feed roller is clearly lower than the corresponding value after the feed roller. This means that the openness before the feed roller is higher than the openness after the feed roller. The conclusion that can be made is that the feed roller has a significant effect in changing the compression characteristics of the feed matt. This is expected as the feed roller applies a significant amount of pressure and shear to the feed matt due to

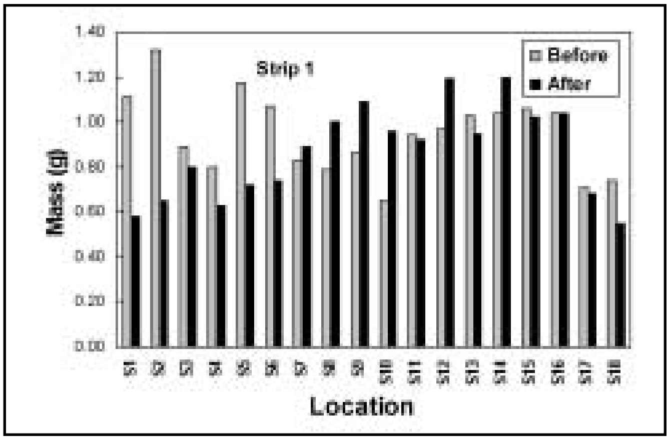

Figure 6
MASS DISTRIBUTION BEFORE AND AFTER THE FEED ROLLER FOR THE FIRST STRIP

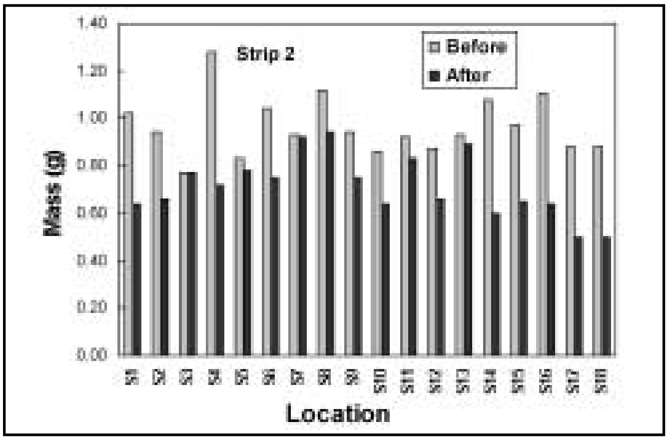

Figure 7
MASS DISTRIBUTION BEFORE AND AFTER THE FEED ROLLER FOR THE SECOND STRIP

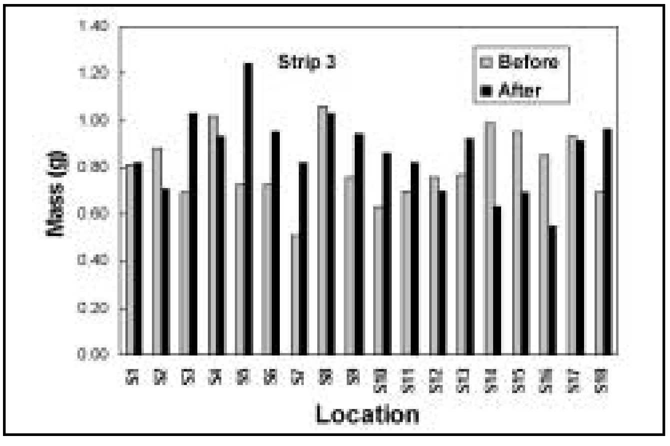

Figure 8
MASS DISTRIBUTION BEFORE AND AFTER THE FEED ROLLER FOR THE THIRD STRIP

the feed plate being stationary.

On-Line Measurement of Feed Matt Openness

Although the technique described in the previous paragraphs

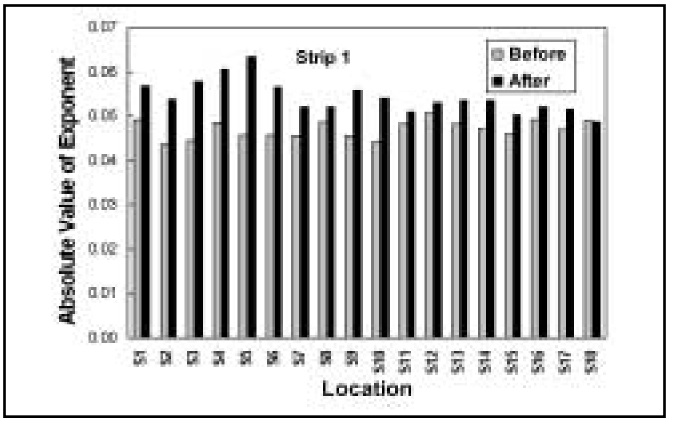

Figure 9
ABSOLUTE VALUE OF EXPONENT REGRESSION COEFFICIENT BEFORE AND AFTER THE FEED ROLLER FOR THE FIRST STRIP

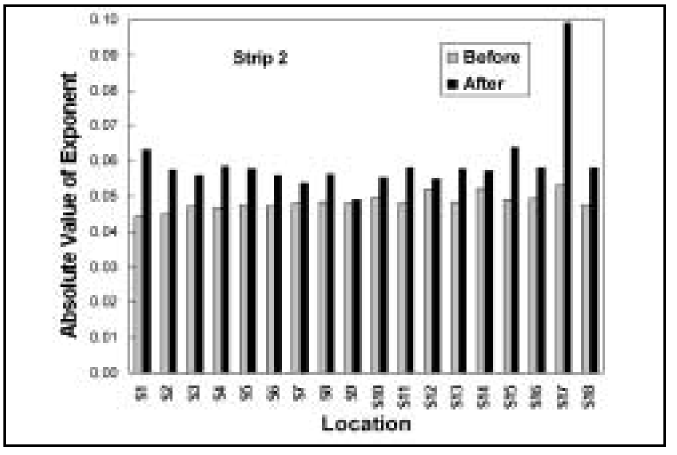

Figure 10
ABSOLUTE VALUE OF EXPONENT REGRESSION COEFFICIENT BEFORE AND AFTER THE FEED ROLLER FOR THE SECOND STRIP

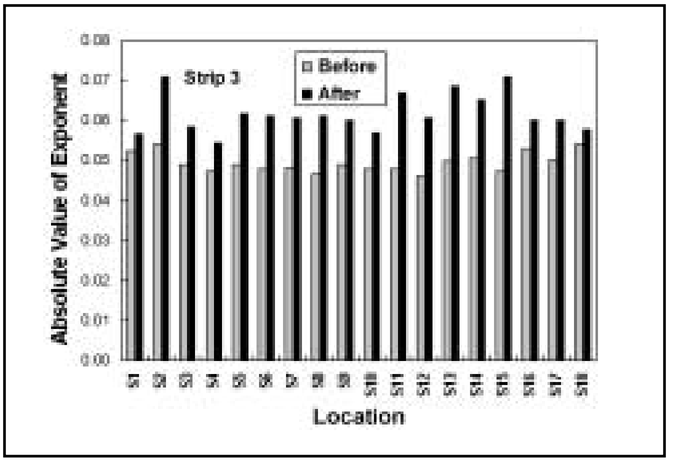

Figure 11
ABSOLUTE VALUE OF EXPONENT REGRESSION COEFFICIENT BEFORE AND AFTER THE FEED ROLLER FOR THE THIRD STRIP

showed some reasonable results, it did involve some problems in the handling of the feed matt prior to testing. These problems were especially visible during the transport of the feed matt. In order to improve on the technique and eliminate some of the handling problems, it was decided to use the compression characteristics of the feed matt but do it on-line. The idea is to perform a compression test on-line.

In order to verify whether using the compression characteristics can be used to detect different levels of openness and to further check that such a process can be done on-line, it was decided to perform some preliminary experiments to that regard. These experiments were performed on raw cotton with the same characteristics as described previously. In order to obtain different levels of openness, separate lots of cotton were respectively run through the opener once, twice, three times and four times. These lots were then run through the card while at the same time performing a compression test at the level of the card input.

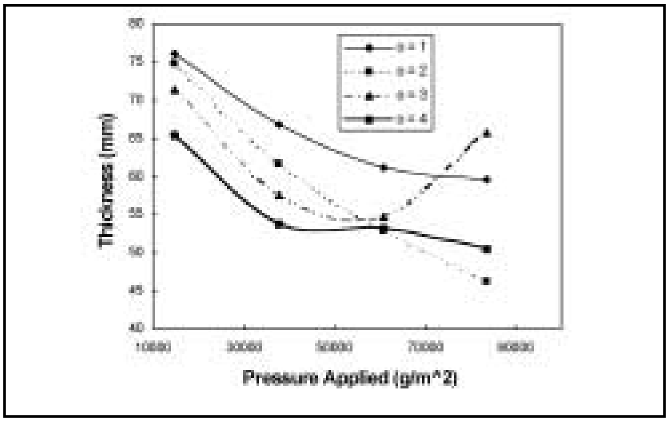

Figure 12
THICKNESS VS. APPLIED PRESSURE FOR DIFFERENT OPENING CYCLES

Figure 12 shows the compression curves obtained for different levels of opening cycles. The results show that at relatively low pressures there is a decrease in thickness for higher degree of fiber opening. At higher pressures, the thickness is no longer related to the degree of opening. This is clear in *Figure 12* where at higher pressure the different curves intersect themselves. The important result is that a suitably applied pressure can be used to determine the level of openness through thickness measurements.

Conclusion

The literature show that scientists do not agree on whether the carding process results in any movement of fibers in the cross machine direction. The results found by WIRA concluded that the carding process does not result in any significant movement. In his theoretical analysis of nonwoven webs, Cherkassky pointed out the possibility of fiber movement in the cross machine direction when fibers are being transferred from one carding zone to the next. In order to study fiber dispersion during the carding process, it is necessary to develop techniques to measure web uniformity both at the input and output of the card. Many studies in the literature have dealt with measuring mass uniformity at the level of the output,; however, none has dealt with measuring both mass and openness of the feed matt.

A novel technique has been developed in which some specific information of a compression test performed on the feed matt can be used to quantify openness. A regular compression test was performed, and the exponential like portion of the compression curve was fitted with an exponential equation. The coefficient of the exponent was used as the quantity that characterizes openness. A more advanced and reliable technique was also developed to use the compression characteristics of the feed matt to determine the level of openness through thickness measurements under a suitably applied pressure.

In order to study the effect of the feed roller on mass and openness uniformity, three strips of material were taken before and after the feed roller. The mass and openness of the strips across the machine direction was found as described previously. The results showed that the feed roller does not change the mass distribution of the feed matt. However, it was found that the feed roller had a significant effect in changing the openness characteristics of the feed matt in the transverse direction.

Acknowledgment

The authors are deeply grateful to the Nonwovens Cooperative Research Center for providing continuous financial support for this project.

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A Note on the Effect of Fiber Diameter, Fiber Crimp and Fiber Orientation On Pore Size In Thin Webs

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This paper discusses the implications of fiber and web properties on pore size and shape. A large series of simulated images are generated to study the effect of web density, fiber crimp and angular distribution on pore size and shape. Pore characteristics are analyzed for each of the series using object geometry. The results indicate that crimp and fiber orientation significantly influence the pore characteristics.

Background

It is well known that for a given fabric density and structure, smaller fibers result in smaller pores and better barrier properties, as well as higher flexibility and hand. It is not surprising that there is much effort underway to produce micro-denier and nano fibers in both meltblown and spunbonded fabrics. Similarly, there is significant interest in the use of bicomponent splittable fibers where the fibers are split to form smaller fibers during processing. What is equally important however, is that the pore size and shape characteristics are also influenced by fiber crimp and most importantly by the fiber orientation distribution function (ODF). The interactions between fiber diameter, crimp and ODF have received little or no attention. This situation is intensified by the fact that there are no reliable models available for predicting these characteristics as a function of the process and/or the material.

Both meltblown and spunbonded fabrics are planar, with little or no order or orientation through the thickness. Therefore, the pores in lightweight webs may be idealized as two-dimensional entities. This allows the isolation and characterization of the pores easily. In an attempt to establish the interactions that exist between pore characteristics and fiber and structure properties, we employ a set of simulated images with varying properties. The simulation procedures have been previously discussed [1]. The simulated images reveal the degree to which fiber size and crimp and fabric structure affects the pore size and shape.

Material and Methods

A large set of “nonwoven” images were simulated. These were produced by using the m-randomness method described previously [1]. The set contains images varying in ODF, images employing the same ODF but varying in their crimp, and as images varying in their fiber diameter. The details are given in *Table 1*. Typical images are shown in *Figures 1-4.*

When dealing with ODF anisotropy, an anisotropy parameter f_p can be defined, with the help of the ODF y. The ODF y is a function of the angle q. The integral of the function y from an angle q_1 to q_2 is equal to the probability that a fiber will have an orientation between the angles q_1 to q_2. The function y must additionally satisfy the following conditions:

f_p can be defined as

$$\psi(\theta + \pi) = \psi(\theta)$$

$$\int_0^{\pi} (\theta) d\theta = 1$$

The anisotropy parameter varies between -1 and 1. A value

$$f_p = 2\langle \cos^2 \theta \rangle - 1$$

$$\langle \cos^2 \theta \rangle = \frac{\int_0^{\pi} (\theta) \cos^2(\theta_{ref} - \theta_i) d\theta}{\int_0^{\pi} \psi(\theta) d\theta}$$

for f_p of 1 indicates a perfect alignment of the fibers parallel to a reference direction and a value of -1 indicates a perfect perpendicular alignment to that direction. f_p is zero for a random assembly.

Image Preprocessing

Table 1
SIMULATION CONDITION

Fiber Diameter (mm)	Fiber Crimp (%)	ODF standard deviation	Fiber Diameter (mm)	Fiber Crimp (%)	ODF standard deviation
2	0	10, 15, 20, 25, 30, 35, 90	6	0	10, 15, 20, 25, 30, 35, 90
	5	10, 15, 20, 25, 30, 90		5	10, 15, 20, 25, 30, 90
	10	10, 15, 20, 25, 30, 90		10	10, 15, 20, 25, 30, 90
	15	10, 15, 20, 25, 30, 90		15	10, 15, 20, 25, 30, 90
	20	10, 15, 20, 25, 30, 90		20	10, 15, 20, 25, 30, 90
	30	10, 15, 20, 25, 30, 90		30	10, 15, 20, 25, 30, 90
4	0	10, 15, 20, 25, 30, 35, 90	8	0	10, 15, 20, 25, 30, 35, 90
	5	10, 15, 20, 25, 30, 90			
	10	10, 15, 20, 25, 30, 90			
	15	10, 15, 20, 25, 30, 90	10	0	10, 15, 20, 25, 30, 35, 90
	20	10, 15, 20, 25, 30, 90			
	30	10, 15, 20, 25, 30, 90			

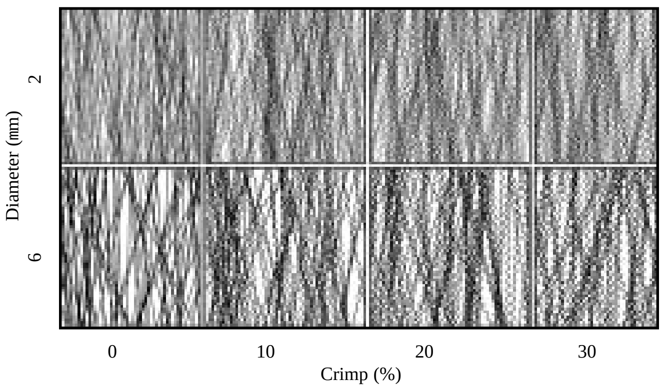


Figure 1
TYPICAL SIMULATED IMAGES AS FUNCTION OF FIBER CRIMP AND DIAMETER AT ODF STANDARD DEVIATION, 10.
(MEAN: 90; STD. DEV.: 10)

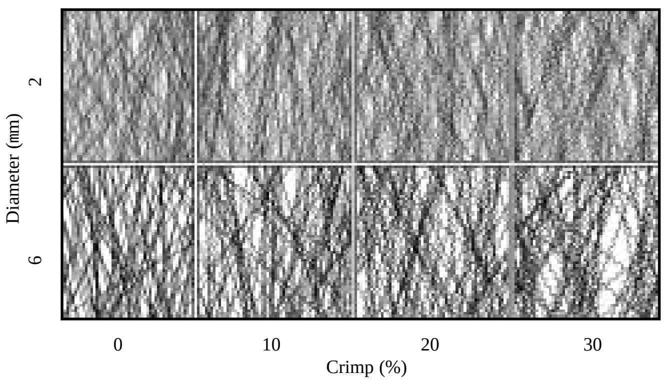


Figure 2
TYPICAL SIMULATED IMAGES AS FUNCTION OF FIBER CRIMP AND DIAMETER AT ODF STANDARD DEVIATION, 20.
(MEAN: 90; STD. DEV.: 20)

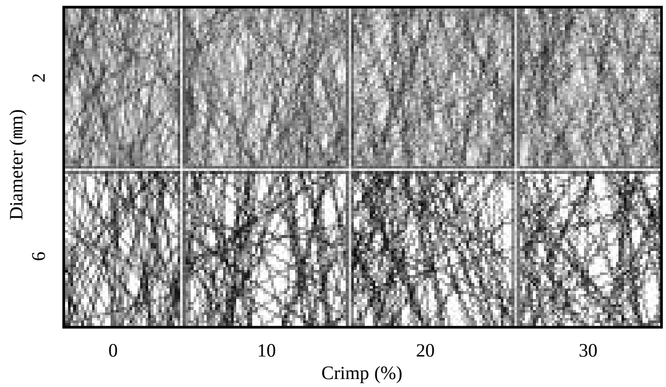


Figure 3
TYPICAL SIMULATED IMAGES AS FUNCTION OF FIBER CRIMP AND DIAMETER AT ODF STANDARD DEVIATION, 30
(MEAN: 90; STD. DEV.: 30)

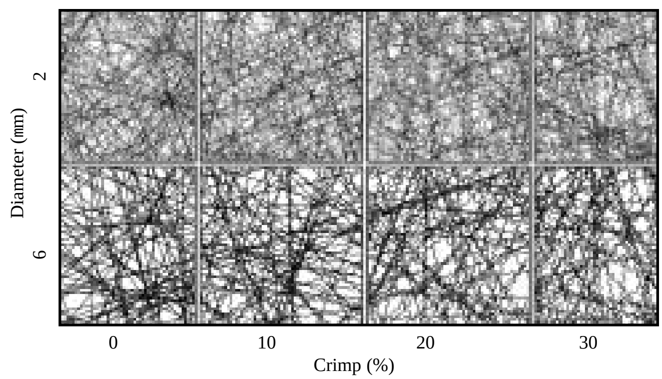


Figure 4
TYPICAL SIMULATED IMAGES AS FUNCTION OF FIBER CRIMP AND DIAMETER AT RANDOM ODF

The size and shape of an object can be easily determined from its boundary. The steps involved in obtaining the object boundaries have been given detailed treatment elsewhere [2]. The following discussion outlines a general application protocol.

Our simulated images contain two kinds of pixel values: foreground or 'on,' and background, or 'off.' We employ morphological procedures for extracting thinned (one pixel wide) boundaries from these binary images. Unfortunately, thinned boundaries sometimes contain artifacts (e.g., short branches) or adjacent boundaries may be connected by a few pixels. We have implemented a series of neighborhood operations designed to disconnect contiguous boundaries or prune small branches. The resulting image will contain closed line segments of one pixel in thickness without any branch or corner connections. In our system, we represent line segments as a series of directions with the aid of a chain-code algorithm [3-5]. The chain-codes are converted to coordinates in a two-dimensional plane as needed to perform necessary calculations.

Size Analysis

There are numerous geometrical descriptors available that can help quantify various aspects of size and shape. We use the following geometrical descriptors to determine Area *(A)* and Perimeter *(P)*:

where (Dx_i, Dy_j) are points in the pore, (x_k , y_k) and (x_{k-1}, y_{k-1}) are pixels on the enclosing boundary.

$$A = SS \; \Delta x_i \Delta y_j$$

$$P = S \sqrt{\left(x_k - x_{k-1}\right)^2 + \left(y_k - y_{k-1}\right)^2}$$

Shape Analysis

We routinely employ geometrical and Fourier descriptors to characterize and quantify shape. Geometrical descriptors are straightforward measurements of boundary geometry. We determine the boundary roundness *(R)* by determining the ratio of boundary area to the area of a circle whose perimeter is equal to that of the boundary as depicted below.

R ranges from 0 to 1. Roundness is a measure of the similarity of a given shape to that of a circle.

A measure of the shape anisotropy may be obtained by the descriptor Ellipticity

$$R = \frac{4\pi A}{P^2}$$

(*E*). Ellipticity is determined by computing the lengths of the semi-major and semi-minor axes of A_l and A_s of a best-fit ellipse of the boundary. The lengths of the semi-major and semi-minor axes can be determined from:

where I_{max} and I_{min} are the greatest and least moments of inertia, respectively. E may be calculated as:

The method we employ for the measurement of Roundness

$$A_l = \left(\frac{4}{\pi}\right)^{\frac{1}{4}} \left(\frac{I_{max}^3}{I_{min}}\right)^{\frac{1}{8}}$$

$$A_s = \left(\frac{4}{\pi}\right)^{\frac{1}{4}} \left(\frac{I_{min}^3}{I_{max}}\right)^{\frac{1}{8}}$$

and Ellipticity ensures that they are invariant to the geometrical transformations of rotation and translation. They are not, however, invariant to scaling, especially in the case of small pores. We have reported on this aspect of shape analysis previously [6]. In the case of sample images generated for this study, care was taken to ensure that the pores are within a range that would not lead to significant errors. For a description of the use of Fourier descriptors for object identification and classification, see our earlier paper [6].

Results and Discussion

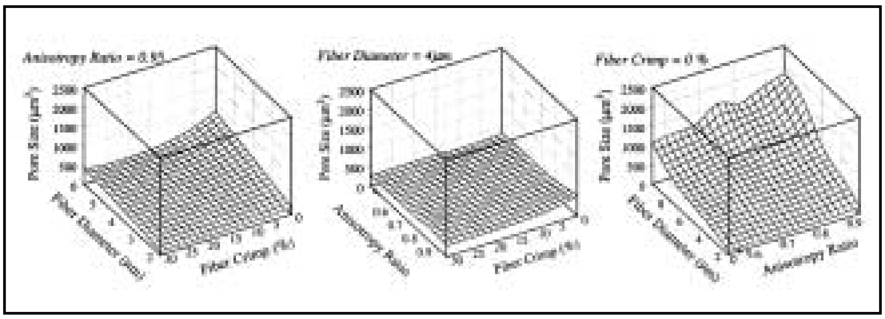
The results for pore size, pore roundness, pore ellipticity, and total number of pores are summarized in *Figures 5-8*.

Figure 5 shows the changes of pore size as function of fiber crimp, ODF anisotropy, and fiber diameter. For the same web density, an increase of fiber diameter reduces the total number of fibers per unit area, lowering the total number of crossovers per unit area. This results in increased average pore size *(Figures 5a and 5c)*.

It is interesting to note that an increase in fiber crimp results in smaller average pore size *(Figures 5a and 5b)*. To examine this tendency further, the pore size distribution is plotted as a function of fiber crimp in *Figure 6*. An increase in fiber crimp

Figure 5

CHANGES OF AVERAGE PORE SIZE AS FUNCTION OF (A) FIBER DIAMETER AND CRIMP (B) ODF STANDARD DEVIATION AND FIBER CRIMP (C) FIBER DIAMETER AND ODF STANDARD DEVIATION



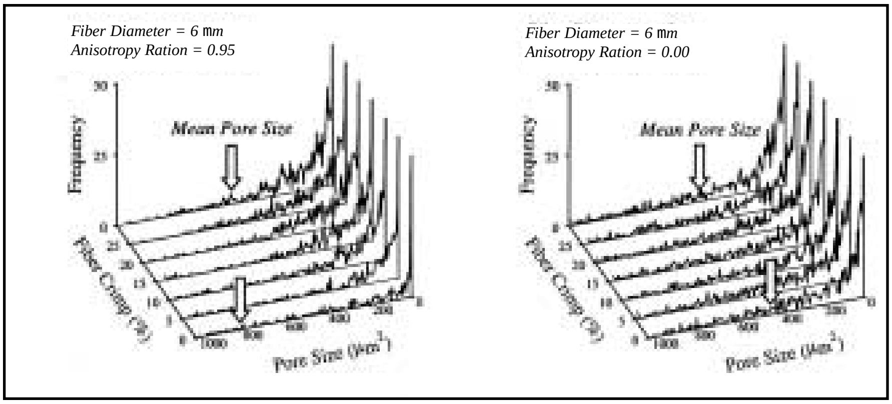


Figure 6
PORE SIZE DISTRIBUTION AS A FUNCTION OF FIBER CRIMP AT ODF STANDARD DEVIATION, 10.

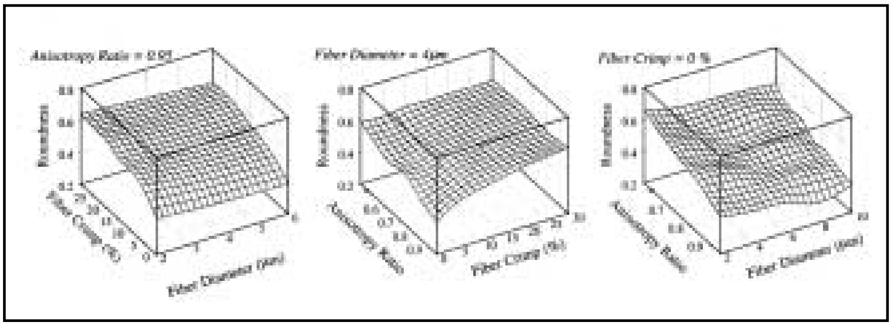


Figure 7
CHANGES OF ROUNDNESS AS FUNCTION OF (A) FIBER DIAMETER AND CRIMP (B) ODF STANDARD DEVIATION AND FIBER CRIMP (C) FIBER DIAMETER AND ODF STANDARD DEVIATION

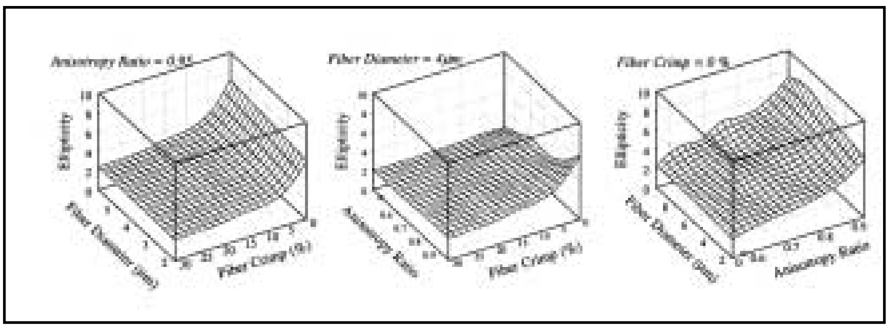


Figure 8
CHANGES OF ELLIPTICITY AS FUNCTION OF (A) FIBER DIAMETER AND CRIMP (B) ODF STANDARD DEVIATION AND FIBER CRIMP (C) FIBER DIAMETER AND ODF STANDARD DEVIATION

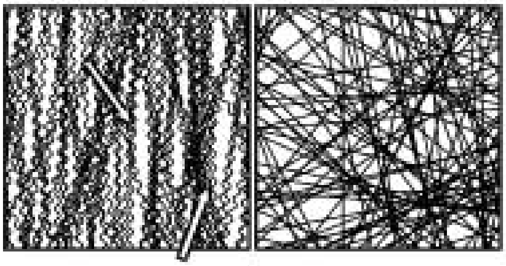
causes a shift in the distribution towards smaller pores in anisotropic structures *(Figure 6a)*. This occurs because an increase in crimp increases the number of crossovers especially in the direction perpendicular to the fiber axis. In random structures, the number of crossovers remains the same and increasing fiber crimp will have little or no effect on pore size.

Figures 7 and 8 show the results for roundness and ellipticity as a function of fiber diameter and crimp and structures anisotropy. It may be noted that increasing fiber crimp in a given structure results in rounder, less elongated pores *(Figures 7a and 8a)*. The combined effect of structures anisotropy and fiber crimp are shown in *Figures 7b and 8b*. Here, at low levels of crimp, the effect of structure anisotropy is significant. As crimp increases, however, the structure anisotropy becomes less dominant as many pores are small and round. Consequently, for large values of crimp there is little or no difference between the pore shapes at different levels of anisotropy. As may be seen from *Figure 9a*, a high level of crimp has resulted in the formation of many small pores while a few large elongated pores remain, the pore size and shape are similar to those in a random structure shown in *Figure 9b*. These average values, however, must be used with caution in that the large pores in the highly anisotropy structures are probably affecting other important properties such as flow, strike through and mechanical behaviors. The combined effect of fiber diameter and structure anisotropy is shown in *Figures 7c and 8c*. Here, the effect of structure anisotropy on shape is dominant. Smaller fiber diameters are expected to result in a larger number of pores and do not affect the pore shape.

The total number of pores as a function of fiber diameter and crimp and structures anisotropy is shown in *Figure 10*. It may be noted that that fiber crimp results in a significant increase in the number of pores *(Figure 10a)*. The combined effect of structures anisotropy and fiber crimp are shown in *Figure 10b*. Both appear to have a significant effect on the number of pores. The effect of structure anisotropy for different fiber diameters is shown in *Figure 10c*. The effect of fiber diameter is clear.

Concluding Remarks

It is clear that for a given web density, a decrease in fiber diameter leads to a large increase in the number of pores. The average pore size, however, decreases rapidly. An increase in fiber crimp in general results in smaller but rounder pores. This effect is amplified in highly anisotropic structures. An increase in structure anisotropy reduces the number of possi-



Normal ODF
Mean = 90
Std. Dev. = 10
Anisotropy Ratio = 0.95
Fiber Diameter = 6 mm
Crimp = 30%

Random ODF
Mean = 0
Std. Dev. = 179
Anisotropy Ratio = 0.00
Fiber Diameter = 6 mm
Crimp = 0%

Figure 9
SIMULATED IMAGES AT (A) ODF STANDARD DEVIATION 10 AND 30 % FIBER CRIMP (B) RANDOM ODF AND 0 % FIBER CRIMP

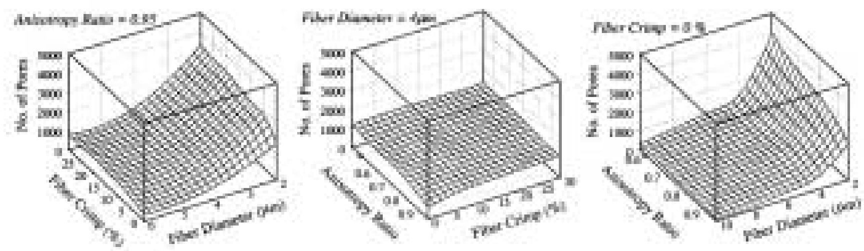


Figure 10
CHANGES OF TOTAL NUMBER OF PORES AS FUNCTION OF (A) FIBER DIAMETER AND CRIMP (B) ODF STANDARD DEVIATION AND FIBER CRIMP (C) FIBER DIAMETER AND ODF STANDARD DEVIATION

ble crossovers, resulting in fewer, larger and more elongated pores.

The maximum number of crossovers is achieved when the structure is isoptopic. In this case, the total number of crossovers will be a function of the total fiber length (i.e. density). Since density was kept constant, from all data presented above it is clear that crimp has little or no effect on pore size or shape or the total number of pores in isotropic structure.

It must be noted that other characteristics change significantly also. For example, the surface area increases significantly when using smaller fibers. This will be important in applications where a large surface area would be needed for applying surface finishes. Additionally, the bond-to-bond distance will decrease with smaller fibers. This will have implications for the way in which the material will respond to stresses.

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Single Process Production of 3D Nonwoven Shell Structures — Part 1: Web Forming System Design Using CFD Modeling

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Abstract

The paper describes the application of CFD modeling for designing a nonwoven air-laying system to produce 3D webs from staple fibers. The fibers are opened by an opening unit and carried by airflow to 3D porous moulds to form the web. The most critical parameter of the air duct is the divergent angle that in theory should be less than 7° to avoid airflow vortex. The airflow angle to the surface of a 3D mould is different at different points. To produce a 3D web with acceptable thickness uniformity, the airflow through the moulds must be regulated. This can be achieved by modifying the airflow resistance distribution through the 3D mould.

Introduction

Nonwoven fabrics are at present manufactured in a flat form, but for many applications a 3-dimensional product has to be constructed from the flat fabric. The flat fabric is packaged and dispatched by the fabric producer to a converter, who then has to unpack the fabric, lay the fabric out, cut the appropriate panels from the fabric, and produce the final product by sewing and/or fusing together the panels. The packaging, freight and labor costs and the cost of wastage inevitably generated during panel cutting can account for up to 70% of the production cost.

Research in nonwovens over the past few decades has been mainly in the areas of specialized nonwoven machines and processes, larger and faster machines, machines with better adaptability to new fibers, measuring and monitoring techniques for improved web uniformity, and the understanding of the relationship between nonwoven structures and their performance properties. The overwhelming majority of the research is related to the manufacture and use of nonwovens as essentially 2-dimensional sheet structures, although there have been a few reports on the production of 3D nonwoven shell structures.

Thomas patented a machine for producing preforms for fiber-reinforced, plastics articles [1]. It was a slow process for producing large, rigid shell objects with a simple geometry. Miura and Hosokawa reported an experiment of making 3D nonwoven structures using an eletrochemical process [2]. The nonwoven structures produced were very resin rich with a resin-to-fiber ratio of 3~4-to-1. The fibers used were only 0.8 mm in length, which can hardly be classified as textile fibers. Brucciani patented a process of moulding thermally bonded fibrous articles [3]. Due to the lack of fiber flow control, however, it was difficult to produce a structure with the desired fiber distribution and textile properties. More recently, Eldim Applied Technologies developed a meltblowing machine that is capable of forming 3D pockets on the collection belt [4], but the products are of very limited curvature and have properties closer to paper than textiles.

To successfully produce a 3D textile shell structure with the correct fiber distribution directly from staple fibers, it is essential that the principles of the fiber flow distribution over the surface of the 3D structure are understood, and the fiber distribution within the shell structure is controlled. In addition, an appropriate consolidation technique is required to give the structure the correct textile properties.

Against this background, we have carried out a major research project to develop the technology for the production of 3D nonwoven webs from staple fibers and for the consolidation of the 3D webs to the required textile properties, including strength and handle. We will report in a series of publications the technology that we have successfully developed. In this first part of our report, we will present and discuss the design of the web forming section aided by

Computational Fluid Dynamics (CFD) techniques.

CFD Modeling of 3D Web Forming System

During the last decade, commercial CFD packages have been used extensively in the design of aircraft [5] and automotives [6], and in many other engineering applications [7, 8]. However, CFD has only had limited use in textile engineering research and machinery design [9, 10], even though fluid flow is extensively used in textile processes. The CFD technique offers the means of testing theoretical advances for conditions unavailable on an experimental basis and allows the prediction of fluid flow characteristics, heat and mass transfer, chemical reaction and other related phenomena. CFD analysis complements traditional testing and experimentation, shortening the system optimization cycle and reducing the risks.

In our process, schematically shown in *Figure 1*, staple fibers are opened by an opening unit based on a roller card. The opened fibers are stripped off the cylinder by high velocity airflow and are carried to perforated 3D moulds. The moulds are placed on a guide track and are moved out of the mould chamber across the machine width into a bonding section for consolidation.

The design of the air transporting system is critical to the formation of the 3D web. The inlet of the duct, which is adjacent to the surface of the cylinder, should be narrow to provide a sufficiently high air velocity for stripping the fibers from the cylinder. The outlet of the duct is connected to the mould chamber, which must be able to accommodate the moulds, whose size is determined by the final product. The duct is thus divergent in the vertical direction. The sidewalls of the duct are parallel to each other and the width of the duct is the same as the working width of the card. The geometry of the duct, especially the divergent angle, and the airflow control requirements are determined using CFD modeling.

We used the Fluent commercial CFD package [11] for our work. The airflow was assumed to be incompressible. Because of the existence of fibers in the flow, the discrete phase model was included. A numerical mesh was generated by the definition of the system geometry. We used the Hexahedral grids in preference to the tetrahedral grids because it was more suitable to our airflow system, in which the internal structure was relatively simple and the main flow direction follows that of the air duct. However, the hexahedral grids require more effort during model construction. Because the physical geometry of the system is symmetrical to the central plane along the system, only half of the system needed to be modeled and this improved the speed of modeling. The flow used in the air-laying system was atmospheric air at normal room temperature (20±10^{o}C). The flow density and viscosity were determined accordingly.

The Reynolds numbers calculated from the flow rate and cross-sectional dimensions of the airflow system indicated that the airflow is turbulent throughout the system. For turbulence flow, the most widely used model is the *k*-e model [12]. In the *k*-e model, the turbulence effects are evaluated using two quantities: turbulence kinetic energy (*k*) and its rate of

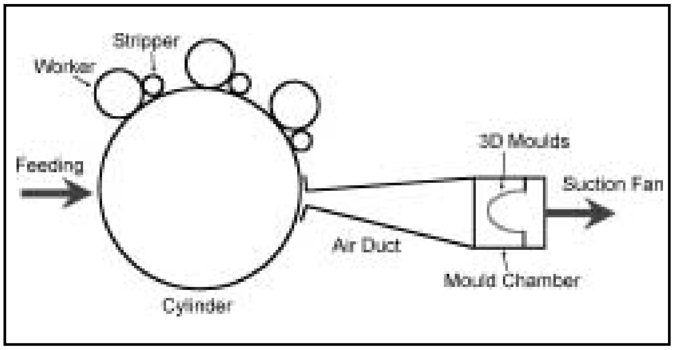

Figure 1
3D WEB FORMING SYSTEM

dissipation (e). There are two *k*-e models, the standard *k*-e model and the Renormalization Group *k*-e model [11]. We used the Renormalization Group (RNG) *k*-e turbulence model. Unlike the standard *k*-e model, which is based on Reynolds averaging, the RNG-based *k*-e turbulence model is derived from the instantaneous Navier-Stokes equations, using a rigorous mathematical technique called Renormalization Group (RNG) methods. The RNG model provides more universality and yields improved predictions for flows with high streamline curvature flows, wall heat and mass transfer, which exist in our system.

We are also interested in how the fibers are distributed in the airflow. For this discrete phase flow, the interaction between the discrete phase and the continuous phase was included for performing coupled calculations of the continuous and discrete phase flow. The discrete phase is injected into the continuous phase from a specified surface. The initial conditions for each particle stream need to be defined. These initial conditions include the particle position (x, y, z co-ordinates), velocity (u, v, w) and diameter, and also the mass flow rate of the particle stream that will follow the trajectory of the individual particle.

We used spherical particles that have the same specific surface diameter as that of fibers in the modeling. Because the drag coefficient used in the force balance equation was deduced originally for spherical particles, it is most convenient to express the geometry of an irregular fiber in terms of an equivalent diameter [13]. The equivalent diameter of a fiber is the diameter of a sphere with the same volume as the fiber itself, which can be expressed as:

where:

D_e = the equivalent diameter,

$$D_e = \sqrt[3]{\frac{6V_p}{\pi}} \qquad (1)$$

V_p = the volume of the fiber.

Because the drag force is related to the surface area of a particle, the effect of the particle shape need to be included. The shapes of irregular particles are defined by a shape factor, i.e., sphericity j [14]. The sphericity j, and 0 < j < 1, is defined as where

S_e = the surface area of sphere with the same volume as par-

$$\varphi = \frac{S_e}{S} = \frac{\pi D_e}{S} \qquad (2)$$

ticle,

S = the surface area of the particle.

Thus the specific surface diameter D_S, which is the diameter of a sphere having the same ratio of surface area to volume as the particle, is:

The specific surface diameter D_S takes into account the

$$D_s = \varphi\, D_e \qquad (3)$$

effect of the surface area, or the shape of the particle, to the drag coefficient. Therefore, using the specific surface diameter D_S is better than simply using the equivalent diameter. For the 3D mould, the porous media model is used [11].

Results and Discussion

The parameters of the flow inside the system were computed after setting the relevant boundary conditions. The standard condition for numerical convergence of the residuals of less than 10^{-3} was applied. The most critical results are presented and discussed below.

The Air Duct Divergent Angle

The geometry of the duct, especially the divergent angle of the duct, affects the airflow and the fiber distribution in the airflow. The amount of fiber depositing in a certain area depends on the air velocity passing through the area and the fiber concentration in the airflow. Therefore, these two factors were the focus of our attention in the system design.

Our system is designed to be able to produce products of up to 220 mm in diameter and this requires the mould chamber to have a height of at least 300 mm. The extra space around the mould is essential to allow the fibers to travel freely to the side surface of the mould. The air inlet near the cylinder surface has an opening of 40 mm. With these restrictions, the divergent angle also determined the length of the duct. By studying the airflow characteristics and fiber distribution with different divergent angles, the optimum flow condition can be obtained. *Figure 2* shows an example of the velocity distribution in the vertical plane when the divergent angle is 7^{o}. As the velocity vectors are parallel to the flow direction, no vortex occurs. This is the optimum case because vortex can cause fiber entanglement and in severe cases reverse flows can occur near the mould surface, disturbing the deposited fibers. *Figure 2* can also display the concentration of fibers in the flow. The fibers tend to concentrate near the bottom of the duct at the inlet end, but are gradually dispersed over the flow cross section while traveling towards the mould.

To obtain airflow without vortex, the divergent angle must be less than 7^{o}, which leads to a very long duct and large space requirement for the machine. We used a compromise design with a duct length of 1600 mm. In this case, the divergent angle was 9.2^{o}. Although a vortex occurred locally near the inlet area, it gradually disappeared to give a well-distributed

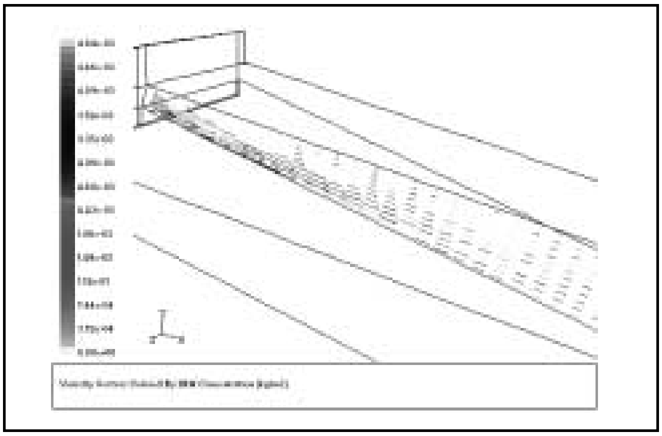

Figure 2
AIRFLOW VELOCITY DISTRIBUTION
(7^{O} DUCT DIVERGENT ANGLE)

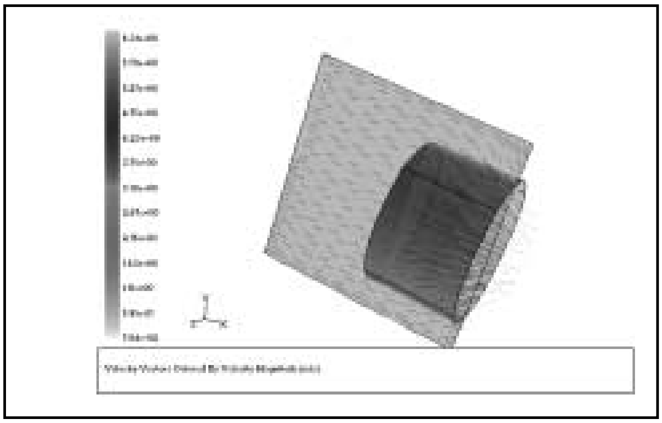

Figure 3
AIRFLOW VELOCITY DISTRIBUTION IN THE VERTICAL PLANE ALONG THE MOULD AXIS

flow near the mould chamber.

Fiber Deposition Control

The angle between the 3D mould surface and the airflow is variable at different points of the mould surface. *Figure 3* shows the airflow velocity distribution in the vertical plane around a simple cylinder-shaped mould along the axis of the mould. Mould surface sections that are parallel to the mainstream direction of the airflow have lower fiber deposition and fibers deposited in these sections tend to slip towards the mould base. The airflow distribution can be modified by altering the flow resistance distribution. As an example, *Figure 4* shows the flow distribution after a pipe-shaped buffering device, about half the length of the mould and with a solid surface, is used inside the mould. It can be seen that the airflow is guided by the buffer towards the sides of the mould. The important parameters for the control buffer are the dimension and shape. By designing an appropriate buffer, the airflow can be controlled to give a uniform fiber deposition on the surface of any given 3D mould. We are currently investigating the effects of the mould design, especially the porosity distribution, on the airflow and fiber deposition and will

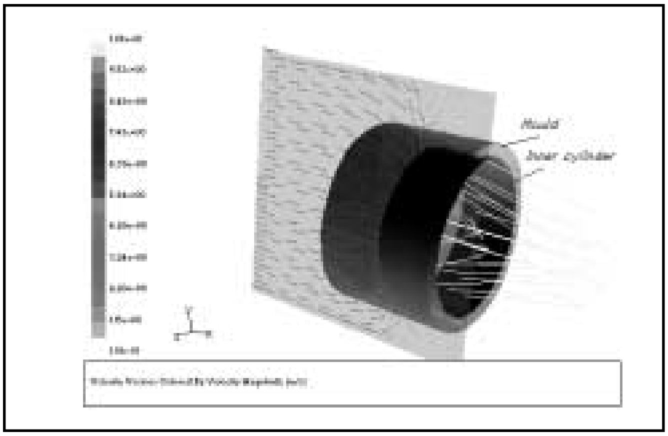

Figure 4
EFFECTS OF CONTROL DEVICE ON
AIRFLOW VELOCITY DISTRIBUTION

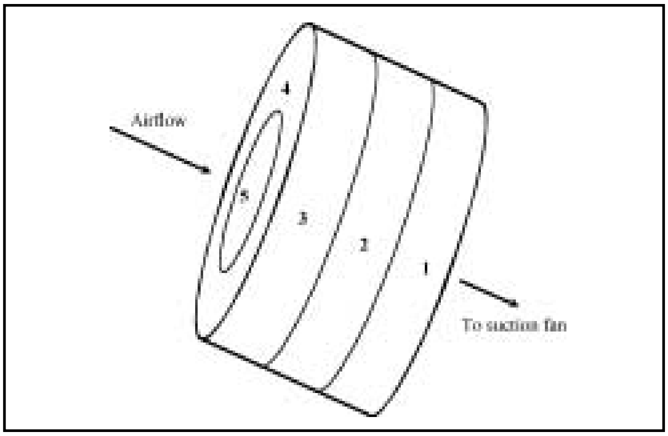

Figure 6
WEB SAMPLING PLAN

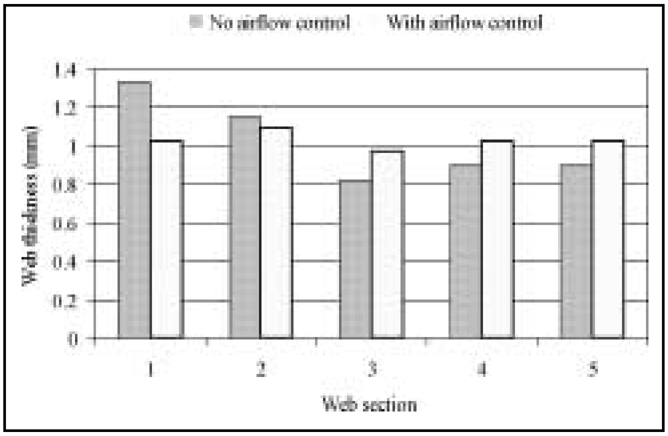

Figure 5
EFFECTS OF AIRFLOW CONTROL ON
WEB THICKNESS DISTRIBUTION

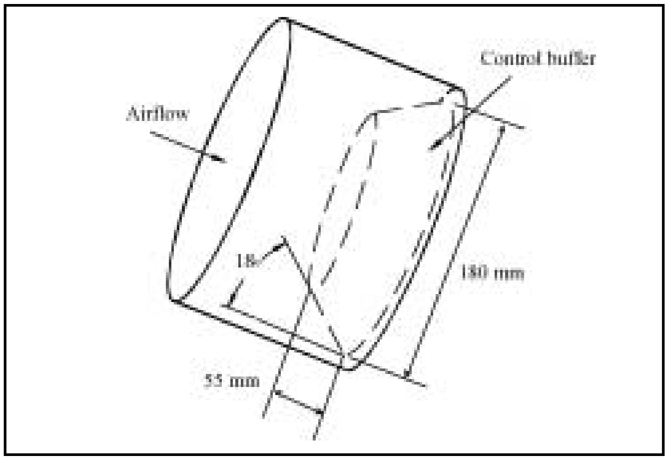

Figure 7
AIRFLOW CONTROL BUFFER

report the results in future publications.

Experimental evaluation

Based on the design criteria described above, we built an experimental rig for the formation of 3D webs. We tested moulds of a variety of shapes, ranging from simple semi-spheres to complex ones that contain flat and curved surfaces and sharp edges. The moulds are constructed from metal meshes that have a uniform perforation. We present here the results for a cylindrical mould of 200 mm in diameter and 130 mm in height. The principle for other shapes is similar.

Figure 5 compares the thickness distributions of two webs that were formed on the mould with and without airflow control. Polypropylene fibers of 1.5 denier and 40 mm length were used. The web thickness was tested using the Shirley Thickness Tester at a pressure of 5 g/cm^2. The sampling positions are shown in *Figure 6*. The side of the 3D web is divided into three equal sections. The top surface is divided into two radial sections at half the radius of the mould. Without any airflow control, the web in section 1 is the thickest as the fibers tend to move towards the bottom of the mould surface. In order to improve the fiber density distribution in the 3D web, the airflow through the sections where the web is thicker needs to be reduced. This airflow redistribution can be achieved by using an appropriate airflow control buffer. For the 3D mould discussed here, the shape and dimension of the buffer, optimized using CFD modeling, are shown in *Figure 7*. The buffer has a solid sidewall, and open top and base. As shown in *Figure 5*, the thickness distribution of the web formed using the airflow control buffer is significantly improved.

Conclusions

During the development of the technology for producing 3D nonwoven products directly form staple fibers, we have shown that CFD is a very valuable tool for optimizing the design of the flow system. The divergent angle of the air duct should be less than 7^o to avoid vortex in the airflow, although in practice the angle can be slightly larger to reduce space requirement. To produce a 3D web with uniform fiber density distribution, it is essential that the airflow through the 3D mould be regulated. The airflow control device can be optimized using CFD techniques. In the second part of our report, we will present the consolidation technology we have developed to give the 3D web the required end-use properties.

Acknowledgement

The work described in this paper was jointly funded by the Engineering and Physical Science Research Council of the United Kingdom and Pal International Ltd, UK.

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Fundamental Description of the Melt Blowing Process

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Abstract

On-line measurements during melt blowing combined with off-line web analysis are presented to fundamentally describe the commercial melt blowing process.

Introduction

We recently conducted an experimental investigation of the melt blowing (MB) process using high-speed digital imaging techniques and web measurements [1]. A high-speed commercial-like MB process was used which had a 600-hole (20 inch wide) die and we measured fiber diameter, fiber orientation angle, fiber entanglement, fiber velocity and fiber acceleration at several locations between the die and collector.

Our measurements allowed us to identify three reasons that more and larger fiber bundles are formed with increasing distance from the die: (1) the amount of fiber length occupying a unit volume of space increased with increasing distance from the die; (2) fiber orientation changed from strongly machine direction (MD) at the die to substantially cross-machine direction (CD) near the collector; and (3) fibers traveled at different speeds and in different directions because of the turbulent nature of the air flow. The overall effect of these factors was to increase the likelihood of fiber contact and entanglement with increasing distance from the die. This important feature distinguishes the MB process from the conventional melt spinning process.

We also reported that fiber attenuation occurred extremely rapidly close to the die where the mean diameter was reduced to about 15% its original size after fibers traveled only about 7 mm from the die. This indicates that easily deformable fibers and large elongational forces existed very close to the die. It is important to note, however, that fiber attenuation continued to occur all the way to the collector where drag forces are expected to be small. Consequently, we proposed another mechanism of fiber attenuation based on elongational forces resulting from fiber contact and entanglement. Fiber attenuation resulting from fiber contact and entanglement distinguishes the MB process from the conventional melt spinning process.

Many people have described the MB process as fast, complex and chaotic, and individual fibers are said to have relatively low molecular orientation. Our current paper reports experimental measurements aimed at obtaining a more detailed understanding of speed, complexity, chaos and molecular orientation.

Experimental

Processing

The data presented in this paper resulted from processing 3546G polypropylene resin supplied by Exxon Chemical Company using an Accurate Products 600-hole (20-inch wide) horizontal MB line located at the University of Tennessee Textiles and Nonwovens Development Center (TANDEC). The die hole diameter was 368 um (0.0145 inch), die set back/air gap distances were 1.5 mm (0.060 inch), primary air pressure was 4 psi and resin mass throughput rate was 0.4 ghm. A rotating drum collector was placed 90 cm from the die to nearly represent the absence of a collector.

Fiber and Web Measurements

High-speed imaging techniques used to measure the diameter, velocity and acceleration of fibers on-line have been described previously [1]. A digital infrared thermometer with laser sighting and adjustable emissivity was used to measure fiber temperature on-line. Air temperature and air velocity were measured on-line with a multifunction instrument containing a platinum resistor for temperature and a pitot tube for velocity. Air measurements were obtained using the same processing conditions as those used for fiber measurements but with no resin throughput and readings were obtained at centerline positions where air temperature and air velocity were maximum.

Fiber birefringence was measured off-line using polarized optical microscopy and a single-order compensator from webs collected at various locations between the die and collector. Only the finest fibers at each location were selected for measurement. Differential scanning calorimetry (DSC) was performed off-line from webs collected at various locations between the die and collector using heating and cooling rates of 10 C/min.

Results and Discussion

Figure 1 reports mean fiber diameter and fiber birefringence measurements at different locations between the die and collector. Fiber diameter profiles measured by us are generally similar to profiles measured during single-hole MB using photography [2-4] and laser Doppler velocimetry [5].

Figure 1 shows that the MB process is indeed fast in terms of the rate of fiber attenuation close to the die and indicates that easily deformable fibers and strong elongational forces existed close to the die. The rate of fiber attenuation decreased substantially a few cm from the die. As we observed previously [1], however, fiber attenuation continued to locations where a collector might be positioned in a commercial MB line. This indicates that at least some fibers must have been deformable and forces capable of elongating fibers must have existed far from the die.

As mentioned previously, birefringence was measured only for the smallest diameter fibers at each location between the die and collector. This was done because we observed that coarse fibers at all locations exhibited little or no birefringence and restricting measurements only to the population of smallest diameter fibers helped make birefringence measurements more comparable from location-to-location. *Figure 1* shows that fiber birefringence for the population of smallest diameter fibers at each location increased rapidly beginning about 4 cm from the die. Birefringence continued to increase far from the die and may have continued to increase to locations where a collector might be positioned in a commercial MB line.

Overall, *Figure 1* shows that most fiber attenuation occurred closer than 4 cm from the die whereas most molecular orientation occurred farther than 4 cm from the die.

The MB process is often said to produce fibers with relatively low molecular orientation. Our measurements indicate that this statement is both true and false. *Figure 1* shows that the population of fine fibers produced during MB achieved birefringence values similar to those achieved in conventional melt spinning. On the other hand, coarse fibers produced during MB exhibited little or no birefringence at all locations between the die and collector. As a result of this, a population of fibers in MB webs which included all fiber diameters would exhibit a mean birefringence which is lower than that of conventional melt spun fibers.

Figure 2 reports mean fiber acceleration, mean fiber velocity and mean air velocity in the MD at different locations between the die and collector. Fiber velocity profiles measured by us are generally similar to profiles measured by others during single-hole MB using laser Doppler velocimetry [5] and air velocity profiles measured by us are generally similar to profiles measured by others during single-hole MB using a pitot tube [2].

Figure 2 shows that air velocity was maximum and fiber velocity was minimum near the die. Consequently, it is reasonable to expect that the largest drag force existed close to the die. At increasing distance from the die (and primary air source), air velocity decreased and fiber velocity increased so we should expect the drag force to decrease. At about 4 cm from the die, fiber velocity began to decrease although it remained relatively large all the way to the collector. At about 12 cm, air and fiber velocities in the MD became nearly equal and thus we should expect the drag force to be relatively small beyond 12 cm from the die.

Figure 2 suggests that a drag force capable of accelerating fibers in the MD existed only as far as about 12 cm from the die. We previously showed, however, that fiber attenuation continued to occur all the way to the collector [1]. Consequently, *Figure 2* implies that an elongational force different than drag force is responsible for fiber attenuation far from the die and supports a mechanism of fiber attenuation based on elongational forces resulting from fiber contact and entanglement.

Our measurements indicate that the MB process is not particularly fast with respect to maximum fiber speed. That is, 60 m/s (3,600 m/min) is similar to the maximum fiber speed of conventional melt spinning. The fiber velocity profile for MB, however, differs fundamentally from that of the conventional melt spinning process. Fiber velocity during MB exhibits a maximum value only a few cm from the die and then decreases over the majority of the distance between the die and collector. On the other hand, fiber velocity during melt spinning exhibits no decrease between the die and windup roll [6].

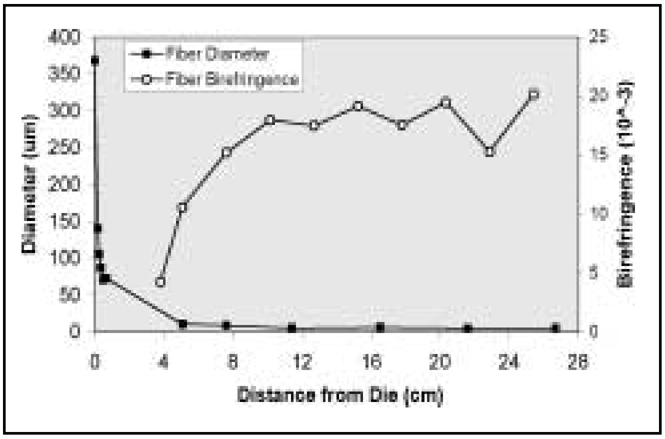

Figure 1
MEAN FIBER DIAMETER AND
FIBER BIREFRINGENCE

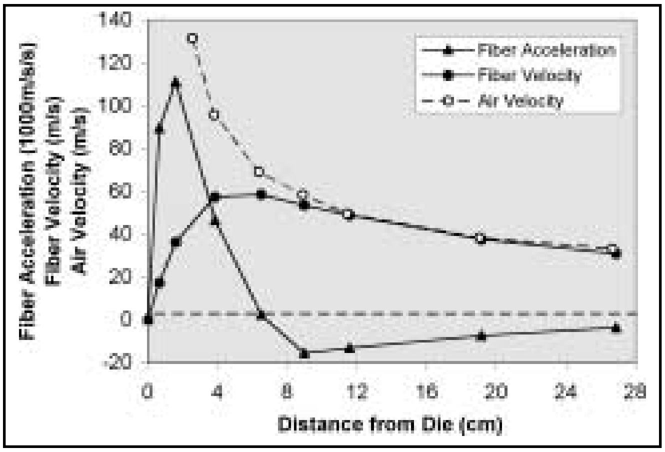

Figure 2
MEAN FIBER ACCELERATION, MEAN FIBER
VELOCITY AND MEAN AIR VELOCITY
COMPONENTS IN THE MD

Figure 2 shows that mean fiber acceleration in the MD was zero at the die, increased remarkably fast to its maximum value at only 2 cm from the die, decreased nearly as rapidly as it increased and then attained a mean value of zero at approximately 6 cm from the die. Farther from the die, mean fiber acceleration values remained small and negative all the way to the collector. These measurements indicate that the MB process may be characterized as substantially fast near the die in terms of fiber acceleration followed abruptly by deceleration.

The fiber acceleration profile for MB differs fundamentally from that expected for conventional melt spinning. Acceleration during MB is negative over the majority of the distance between the die and collector. On the other hand, acceleration during melt spinning would be expected to be only zero or positive.

As noted previously, *Figure 2* indicates that a positive drag force in the MD apparently existed as far as 12 cm from the die. However, that figure also showed that this force apparently was not sufficient to accelerate fibers in the MD beyond about 6 cm from the die since mean fiber acceleration remained negative beyond this point. This suggests that the fiber rheological force may have exceeded the drag force between 6 and 12 cm from the die.

Figure 3 shows mean fiber temperature, mean air temperature and mean fiber cooling rate at various locations between the die and collector. Fiber cooling rates were computed from fiber temperature data, fiber velocity data and distance from the die. Fiber temperature profiles measured by us are generally similar to profiles measured by others during single-hole MB using an infrared camera [4] and air temperature profiles measured by us are generally similar to profiles measured by others during single-hole MB using a thermocouple [2].

Figure 3 shows that air temperature exceeded resin temperature at the die but quickly fell below the fiber temperature as ambient air entered the primary air stream. The air continued to cool more quickly than fibers, apparently because of the greater thermal inertia associated with the relatively larger fiber mass. The temperature of fibers (and air) changed very quickly near the die (about 50,000 C/s). Far from the die, fiber (and air) temperatures changed at a substantially slower rate (about 5,000 C/s).

DSC measurements were acquired off-line from webs collected during MB to obtain ballpark predictions of the temperatures of important events occurring on-line during MB. Webs were heated in the DSC at 10 C/min to a temperature of 200 C, maintained at that temperature for 2 min and then cooled at 10 C/min to room temperature. During heating in the DSC, we observed crystallization or recrystallization at temperatures as low as 60 C and we observed peak melting temperatures at 166 C. During cooling in the DSC, we observed the onset of crystallization at 128 C. If one assumes these DSC temperatures approximate temperatures of similar events occurring on-line during MB, the fiber temperature data in *Figure 3* predict that fiber solidification began about 3 cm from the die, fiber crystallization began approximately 6 cm from the die and crystal growth may have continued all the way to the collector.

These predictions are consistent with several of our other observations. *Figure 1* showed that the rate of fiber attenuation near the die was extremely fast, an observation, which is consistent with filaments not being solidified (in an easily deformable liquid phase). Birefringence measurements reported in *Figure 1* increased rapidly 4 cm from the die, an observation that is consistent with fibers solidifying in the vicinity of 4 cm. Many researchers have reported that crystallization produces a sudden increase in fiber birefringence. If this was true in our case, *Figure 1* also suggests that fiber crystallization began 4 cm from the die and, like molecular orientation, occurred after most fiber attenuation was achieved. The fiber temperature data in Figure 3 also suggest that heat release associated with crystallization occurred at about 6 cm from the die. Predications provided by DSC also are consistent with physical properties of fibers we collected at various locations between the die and collector. Fibers collected closer than about 4 cm from the die exhibited liquid-like behavior whereas fibers collected farther than about 10 cm from the die exhibited increased hardness.

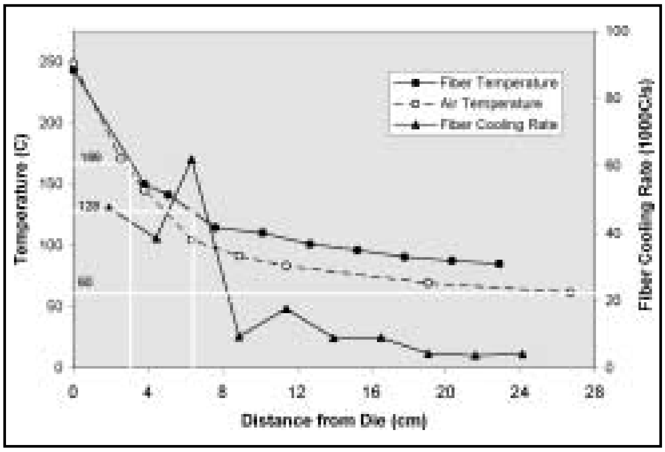

Figure 3
MEAN FIBER TEMPERATURE,
MEAN AIR TEMPERATURE AND
MEAN FIBER COOLING RATE

In sum, our observations indicate that neither molecular orientation nor crystallization occurred while fibers were subjected to the large elongational force associated with air drag near the die. Instead, most molecular orientation and crystallization occurred farther from the die. Our observations also suggest that substantial molecular orientation and crystallization began to occur by 4-6 cm from the die but it is possible that these events continued to occur all the way to the collector.

Figure 4 shows a sequence of images acquired at a single location near the die and *Figure 5* shows a similar sequence of images acquired 9 cm from the die. The direction of fiber flow in both figures is left-to-right. These images allow us to evaluate the complexity and chaos of the MB process near the die where fiber attenuation was large and farther from the die where fiber acceleration was negative.

Figure 4 shows that the fiber array structure in any given image was relatively simple. Fiber density per unit volume of space was fairly uniform, fibers were oriented fairly uniformly in the MD and limited fiber entanglement occurred. When the whole sequence of images is evaluated, we see that the fiber array structure at any particular location in space did not change substantially through time. We previously reported [1] that fiber velocity and fiber acceleration measurements acquired near the die also were quite uniform over time. Overall, these observations indicate that the MB process near the die is not complex or chaotic.

In contrast to this, *Figure 5* shows that the fiber array structure in all images 9 cm from the die was complicated. We observed substantial variations in fiber density per unit volume of space, fiber orientation and the degree of fiber entanglement. When the whole sequence of images is evaluated, we see that the fiber array structure at any particular location changed substantially through time. We previously reported [1] that fiber velocity and fiber acceleration measurements acquired 9 cm from the die also varied substantially over time. Overall, these observations indicate

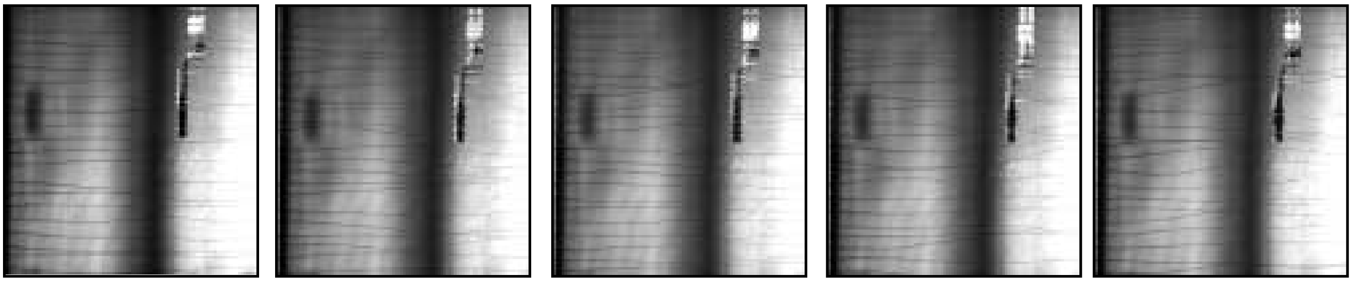

Figure 4
IMAGE SEQUENCE NEAR THE DIE; EACH IMAGE AREA = 19 MM X 19 MM AND TIME INTERVAL BETWEEN IMAGES = 2 MS; THE SLIT BETWEEN AIR KNIVES IS ON THE LEFT SIDE OF THE IMAGES

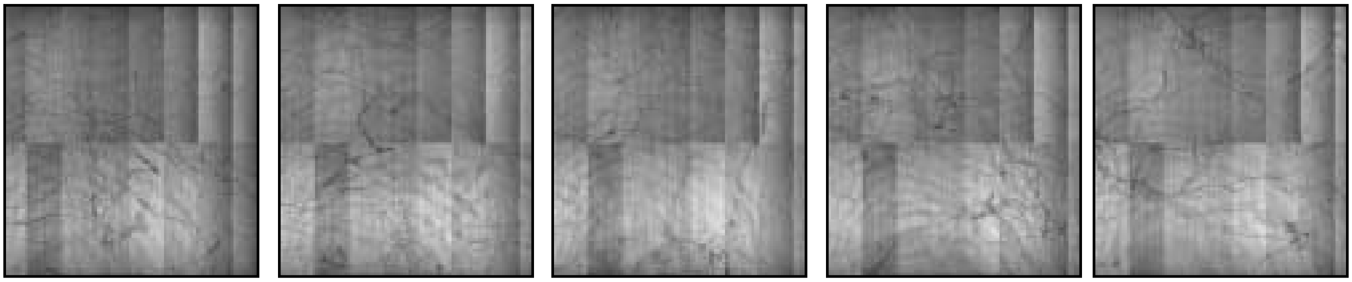

Figure 5
IMAGE SEQUENCE 9 CM FROM THE DIE; EACH IMAGE = 17 MM X 17 MM AND TIME INTERVAL BETWEEN IMAGES = 2 MS

that the MB process is very complex and chaotic far from the die.

Conclusions

The MB process was observed to be fast near the die in terms of the rate of fiber attenuation and fiber acceleration/deceleration. The MB process was not observed to be fast in terms of maximum fiber speed.

Two different fiber attenuation mechanisms seemed to contribute to the formation of small diameter fibers during MB. Air drag was substantial near the die and probably resulted in substantial fiber attenuation but air drag decreased rapidly farther from the die. Fiber contact and entanglement seemed to result in fiber attenuation farther from the die where drag forces were relatively small. In addition, fiber contact and entanglement may have contributed to attenuation close to the die.

Neither molecular orientation nor crystallization occurred near the die where large drag forces existed. Most fiber attenuation occurred near the die before fibers solidified whereas most molecular orientation and crystallization developed farther from the die after fibers solidified. Fibers that were attenuated early in the MB process exhibited molecular orientation which was similar to that of fibers produced by conventional melt spinning. However, fibers that were coarse exhibited little or no molecular orientation. When the whole population of fibers in a web is considered, one can conclude that MB fibers have less molecular orientation than fibers produced by conventional melt spinning.

The MB process was not observed to be complex or chaotic near the die in terms of the fiber array structure. However, the MB process was observed to be very complex and chaotic far from the die.

Acknowledgment

We gratefully acknowledge ExxonMobil Chemical Company for providing financial support and technical support for this project.

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Treatment and Characterization Of Kenaf For Nonwoven and Woven Applications

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Abstract

A kenaf bast fiber is comprised of a bundle of single fibers bound by lignin and pectins. It offers the advantages of being renewable, biodegradable and environmentally safe. However, it is difficult to process kenaf fibers because of the coarseness, stiffness and low cohesion of the fiber bundles. In this research, kenaf fiber bundles have been treated by both alkaline sulfide and a modified chemical degumming methods to improve fiber properties. Tensile properties, fineness, length and softness of the kenaf fiber bundles after the treatments were determined. It was found that both treatments improved the fiber fineness, softness and elongation; however, fiber bundle strength was decreased. The modified chemical degumming method was more effective. Under the optimum modified chemical degumming condition, the fineness of the kenaf fiber bundle was improved more than 50% and the fiber bundle was more than twice as soft as the raw material. These kenaf fiber bundles were much finer and softer and found to be easier to process than those obtained in earlier studies. The treated kenaf fiber bundles can be blended with cotton fibers and easily carded on a cotton card with minimum losses. The carded batts can be further processed for either nonwoven or woven applications.

Key Words

kenaf fiber, fineness, softness, tenacity, lignin, alkaline sulfide treatment, modified chemical degumming, nonwoven.

Introduction

Kenaf fibers (Hibiscus cannabinis L) offer the advantages of being renewable, biodegradable and environmentally safe. Although kenaf is being considered as a potential alternative crop in the United States, China has long been actively engaged in its development such that it currently is one of the largest kenaf producers in the world. A kenaf bast fiber is comprised of a bundle of single fibers bound by lignin and pectins. These fiber bundles are very coarse and brittle. Kenaf fibers have been traditionally used for the production of cordage and coarse yarns, canvas and sacking [1]. However, due to the challenge from synthetic fibers, such as polypropylene, the market share of conventional kenaf packaging fabrics is decreasing sharply.

Recently, kenaf has attracted considerable attention as a potential natural fiber source for both nonwoven and woven applications [2-10]. However, it is difficult to process kenaf fibers because of the coarseness, stiffness and low cohesion of the fiber bundles. As a consequence, the uses of kenaf in both nonwoven and woven products are very limited. Medium to heavier weight nonwoven mats can be made from mechanically separated coarse kenaf fiber bundles for agricultural and industrial applications by carding kenaf on a modified conventional carding machine [8]. Finer and softer kenaf fiber bundles are needed in order to make diversified nonwoven and woven products containing kenaf.

The objectives of the current research were: a) to obtain finer and softer kenaf fiber bundles by chemical treatment; b) to evaluate the effects of different treatment conditions by characterizing kenaf fiber properties; and c) to determine optimum and acceptable treatment conditions. The improvement in kenaf fiber properties and the development of new products containing kenaf should greatly increase the utilization of kenaf fiber both in nonwoven and woven markets, thereby adding value to the kenaf crop.

Experimental

Materials

The kenaf fibers used in this study were obtained from Zhejiang Province, China. The kenaf fibers, as received, were

Table 1
LEVELS OF FACTORS USED IN ALKALINE SULFIDE TREATMENT

Factor Level	NaOH Concentration (g/l) A	Treatment Time (min) B	Treatment Temperature (C) C	Liquor-to-Fiber Ratio D	Na_2SO_3 (%) E
1	100	15	20	1:10	0
2	150	30	50	1:15	0.2
3	200	60	75	1:20	0.5
4	250	90	100	1:25	1

Table 2
LEVELS OF FACTORS USED IN MODIFIED CHEMICAL DEGUMMING FACTOR

Factor Level	Concentration Of NaOH (g/l) X1	Boiling Time (h) X2	Concentration Of [Cl](g/l) X3
1.682	30	3	2
1	26	2.6	1.7
0	20	2	1.25
-1	14	1.4	0.8
-1.682	10	1	0.5

The kenaf fibers used in this study were obtained from Zhejiang Province, China. The kenaf fibers, as received, were very long fiber bundles which were harvested, then naturally retted in ponds.

Treatment methods

Several methods can be used to treat kenaf fibers [10-12]. Two different methods were chosen to use in this research based on their practicality and ease of application. The first was an alkaline sulfide treatment. This procedure involves: immersion in NaOH solution–neutralization with acid–water washing–and air drying. In this method, NaOH concentration, treatment time and temperature, liquor-to-fiber ratio and quantity of Na_2SO_3 (weight % based on kenaf) were regarded as key factors affecting the treatment. Because Na_2SO_3 reacts with lignin, it was added to aid in its removal. Furthermore, the addition of Na_2SO_3 could reduce the oxidation of cellulose in alkali solution. A saturated orthogonal main-effect experiment was designed to obtain the optimum parameters for the treatment [13]. In this experimental design, each variable is assumed to have no interaction with the others to simplify the experiment. Earlier trials indicated that the interactions have minimal effects on the results. *Table 1* shows the levels of each factor used in this experiment.

The second treatment was a modified chemical degumming method which was previously used in ramie processing [11]. The procedure involves: immersion in acid solution, boiling in NaOH solution, bleaching with NaClO, washing with acid, rinsing in water, refining in NaOH and Na_2SO_3 solution, washing in water and air drying. In this experiment, NaOH concentration, boiling time and chloride ion [Cl-] concentration were regarded as key factors affecting the treatment. A universal rotatable experiment was designed to achieve the optimum parameters for the experiment [14]. The levels of each factor used in the experiment are shown in *Table 2*. More analyses of fiber properties were performed on fibers from this experiment than those from alkali treatment because better results were expected. All references to changes in fiber properties in the following discussion are statistically significant at alpha -0.05 unless otherwise stated as non-significant.

Property measurements

The treated kenaf fibers were opened on a Roller-top card normally used for processing ramie fibers. The following properties of the opened kenaf fiber bundles were evaluated and compared with raw kenaf:

(1) Tensile properties of breaking load, elongation and tenacity were determined on an XQ-1 fiber tensile tester designed by the China Textile University. Fiber bundles were tested at a 10 mm gage length.

(2) Softness of kenaf fiber bundles were measured by the twist method [12]. In this method, kenaf fiber bundles were gripped on a twister. Twist was applied on the fiber bundles until they were broken. The more twist which can be applied to the fiber bundle, the softer the fiber bundle.

(3) Fineness (tex) and length: A group of kenaf fiber bundles was straightened, aligned together and cut into 50 mm long segments. The weight (W, mg) of the fiber bundles was determined, and then the number (N) of fiber bundles in that group was counted [12]. The fineness of kenaf fiber bundles was determined by:

$$\text{Fineness (tex)} = 1000W/(50N)$$

The length of a kenaf fiber bundle was simply measured along the fiber bundle with a ruler.

(4) The lignin content of raw and treated kenaf fibers was determined according to the Chinese Standard Test Method GB 5882-86 [15].

Results and discussion

1. Alkaline sulfide treatment

Table 3 shows the detailed treatment conditions and testing results. Data on raw kenaf are also included in the table for comparison. It can be seen from *Table 3* that after treatment, the tensile properties and softness of the kenaf fiber bundles were changed. The breaking load of

Table 3

EFFECTS OF VARIOUS ALKALINE SULFIDE TREATMENTS ON KENAF FIBER BUNDLES

Treatment	NaOH, g/l	Time, min	Temp., C	Liquor: Fiber	Na_2SO_3 %	Soft,twist/ 10 cm (CV%)	Streak load, N	Elong.,% (CV%)
1	100	15	20	1:10	0.0	39.2 (11.1)	856 (21.1)	2.8 (9.8)
2	100	30	50	1:15	0.2	33.0 (12.7)	790 (18.7)	3.1 (11.4)
3	100	60	75	1:20	0.5	47.5 (12.8)	1096 (17.9)	2.9 (12.1)
4	100	90	100	1:25	1.0	41.2 (13.4)	810 (22.4)	3.1 (10.2)
5	150	15	50	1:20	1.0	45.5 (15.1)	1010 (23.5)	3.0 (11.3)
6	150	30	20	1:25	0.5	39.1 (15.7)	526 (23.5)	3.0 (12.4)
7	150	60	100	1:10	0.2	50.7 (11.8)	806 (23.1)	4.0 (14.1)
8	150	90	75	1:15	0.0	52.6 (18.2)	1024 (26.2)	4.0 (12.7)
9	200	15	75	1:25	0.2	44.4 (17.3)	946 (21.4)	3.7 (14.1)
10	200	30	100	1:20	0.0	48.3 (16.7)	718 (22.7)	4.0 (11.8)
11	200	60	20	1:15	1.0	43.4 (15.4)	906 (23.4)	3.2 (13.5)
12	200	90	50	1:10	0.5	50.4 (18.3)	934 (22.5)	3.1 (9.8)
13	250	15	100	1:15	0.5	61.6 (14.7)	677 (25.6)	4.4 (12.7)
14	250	30	75	1:10	1.0	63.5 (15.3)	677 (25.2)	4.0 (14.1)
15	250	60	50	1:25	0.0	50.6 (18.8)	887 (19.8)	3.1 (15.2)
16	250	90	20	1:20	0.2	34.3 (19.1)	875 (23.5)	3.0 (15.1)
raw material						32.1 (13.7)	1120 (24.7)	2.4 (14.9)

increased. This is probably because the adhesion between single fibers decreases as lignin is partially removed by alkaline sulfide treatment. Lignin acts as a binder, which holds the single fibers together. When lignin is removed, it becomes easier for fibers to slide pass each other under the strain of breaking load. Therefore, breaking strength is reduced. This result is consistent with previous findings [7].

Under the combined action of NaOH and Na_2SO_3, lignin was partially removed. Lignin is the main component contributing to the high rigidity of the kenaf fiber bundle. It can be seen from *Table 3* that the softness of a kenaf fiber bundle was improved after the treatment. This is attributed to partial removal of lignin.

Analysis of variance on the experimental data showed that NaOH concentration and treatment time had the most significant effect on the treatment. It was found that the theoretical optimum treatment condition was: NaOH concentration, 250 g/l; treatment time, 60 minutes; temperature, 75 C; quantity of Na_2SO_3, 0.5%; and liquor to fiber ratio, 1:20, assuming that the order of importance of fiber properties in carding is breaking load, softness and elongation. The properties of the kenaf fibers treated under these optimum conditions compared with the raw kenaf material are shown in *Table 4*. It is seen that fiber softness was significantly improved, lignin content was reduced, strength was decreased and elongation was increased after the treatment.

2. Modified chemical degumming

The treatment conditions and the testing results for modified chemical degumming are shown in *Table 5*. The results indicated that, except for tenacity, the properties of kenaf fibers were improved. This was consistent with an alkaline sulfide treatment.

(1) The fineness of kenaf fiber bundles was significantly affected by the concentration of NaOH and boiling time because these two factors affect lignin removal. The less the lignin content in the fiber bundle, the easier the separation of kenaf fiber bundles during opening, and therefore, the finer the kenaf fiber bundle.

(2) The kenaf fiber bundle length was significantly affected by the concentration of NaOH, the concentration of [C1] and the boiling time. The higher the concentrations of NaOH and [C1-] and the longer the boiling time, the shorter the

Table 4

COMPARISON OF THE PROPERTIES OF KENAF TREATED UNDER OPTIMUM ALKALINE SULFIDE CONDITION WITH THOSE OF UNTREATED KENAF

	Softness, twist/10cm (CV%)	Break load, N (CV%)	Elongation, % (CV%)	Lignin content, %
Raw material	32.1 (13.7)	1120 (24.7)	2.4 (14.9)	18.52
Treated	56.6 (19.1)	768 (21.8)	3.4 (14.3)	15.18

Only one determination for lignin content.

Table 5
EFFECTS OF MODIFIED CHEMICAL DEGUMMING ON KENAF FIBER BUNDLES

	NaOH g/l	Time, h	[C-1] g/l	Fine, tex (CV%)	Length, mm (CV%)	Tenacity, cN/tex (CV%)	Elong., % (CV%	Soft, twist/10cm (CV%)
1	26	2.6	1.70	3.14 (22.1)	58.2 (22.7)	15.7 (23.4)	3.2 (10.7)	68.5 (11.2)
2	26	2.6	0.80	3.2 (17.8)	67.8 (21.2)	19.8 (21.2)	3.8 (11.2)	68.9 (10.4)
3	26	1.4	1.70	2.9 (15.3)	59.4 (23.4)	13.8 (17.8)	3.7 (13.5)	69.9 (11.4)
4	26	1.4	0.80	2.34 (21.7)	64.6 (20.8)	17.3 (27.4)	3.8 (11.7)	67.8 (12.3)
5	14	2.6	1.70	2.99 (24.8)	70.7 (25.4)	13.5 (24.3)	3.2 (14.2)	68.5 (10.7)
6	14	2.6	0.80	2.73 (21.8)	74.4 (24.4)	19.1 (19.8)	3.5 (10.6)	65.4 (11.2)
7	14	1.4	1.70	3.23 (20.2)	59.9 (24.7)	14.0 (22.5)	3.3 (9.5)	66.6 (11.5)
8	14	1.4	0.80	3.16 (19.9)	60.9 (23.8)	13.5 (25.7)	3.1 (11.4)	62.6 (13.4)
9	30	2	1.25	2.23 (21.4)	64.6 (25.4)	11.7 (21.3)	3.5 (16.2)	69.1 (12.3)
10	10	2	1.25	1.94 (20.8)	73.7 (18.9)	19.8 (20.1)	3.4 (13.7)	66.1 (16.5)
11	20	3	1.25	3.81 (23.4)	49.3 (23.8)	14.7 (17.2)	3.1 (14.2)	70.9 (12.1)
12	20	1	1.25	3.36 (25.1)	59.2 (24.5)	14.8 (14.1)	3.4 (14.3)	67.0 (10.9)
13	20	2	2.00	2.34 (27.3)	57.3 (26.6)	19.1 (22.7)	2.8 (12.6)	75.1 (14.1)
14	20	2	0.50	2.13 (22.1)	57.6 (26.2)	21.8 (21.8)	3.3 (10.9)	59.6 (14.1)
15	20	2	1.25	2.66 (20.2)	62.3 (21.7)	19.0 (20.4)	3.3 (13.4)	63.8 (9.9)
16	20	2	1.25	2.66 (18.7)	50.0 (23.3)	17.9 (25.2)	3.1 (14.3)	66.7 (12.4)
17	20	2	1.25	2.99 (17.8)	52.5 (21.9)	16.3 (19.7)	3.0 (15.1)	64.5 (11.2)
18	20	2	1.25	2.76 (21.4)	52.6 (23.8)	16.3 (22.3)	2.8 (13.8)	60.4 (10.8)
19	20	2	1.25	3.1 (21.1)	52.6 (24.5)	16.2 (17.9)	3.2 (12.7)	62.6 (12.1)
20	20	2	1.25	2.46 (24.1)	55.5 (21.7)	16.1 (21.3)	2.9 (11.2)	64.9 (12.4)
Raw material				4.08 (25.3)		27.7 (23.4)	2.4 (14.9)	32.1 (13.7)

Table 6
COMPARISON OF THE PROPERTIES OF KENAF TREATED UNDER OPTIMUM MODIFIED CHEMICAL DEGUMMING WITH THOSE OF UNTREATED KENAF

	Fineness, tex (CV%)	Tenacity, cN/tex (CV%)	Elongation, % (CV%)	Softness, twist/10 cm (CV%)	Lignin content, %
Raw material	4.08 (25.3)	27.7 (23.4)	2.4 (14.9)	32.1 (13.7)	18.52
Degummed	1.75 (23.8)	20.7 (24.5)	3.3 (12.4)	70.4 (13.5)	13.84

Only one determination for lignin content.

fiber bundle length. Again, this was due to higher lignin removal and greater strength loss. The fiber bundles were more easily separated and broken during opening, which resulted in shorter fiber bundle lengths. The concentration of [C1-] was the most important factor affecting fiber bundle strength. Chlorination weakens the fiber; therefore, fiber bundle tenacity decreased when the concentration of [C1-] increased.

The optimum value for each property was determined based on the response surface. Considering that the order of importance of fiber properties in carding is fineness, tenacity, softness and elongation, it was determined that the theoretical optimum parameters were: concentration of NaOH, 14 g/l; concentration of [C1-], 1.0 g/l; and boiling time, 140 minutes. *Table 6* shows the properties of the kenaf fiber bundles treated under optimum conditions compared with those of raw kenaf. The results indicated that the fiber bundle tenacity was lower after the treatment. Both the fineness and the stiffness of kenaf fiber bundles were reduced more than 50%. These kenaf fiber bundles are much finer and softer than those obtained in the previous study [5,7]. It has been demonstrated that these fiber bundles can be easily carded on a cotton card with minimum losses [9].

The properties of the kenaf fiber bundles treated under the optimum modified chemical degumming conditions were compared with those of kenaf treated under the optimum alkaline sulfide treatment conditions. It can be seen from *Tables 4 and 6* that kenaf fibers treated under optimum modified chemical degumming conditions were much softer than fibers treated under optimum alkaline sulfide treatment conditions. More lignin was removed by the modified chemical degumming method. Also, less NaOH was used in this modified method.

Conclusions

Kenaf fiber bundles were treated with both alkaline sulfide and modified chemical degumming methods. Both treatments improved the fiber fineness, softness and elongation; however, fiber bundle strength was decreased. Optimum treatment parameters were determined for both methods. The modified chemical degumming method used much less NaOH than the alkaline sulfide treatment method. Fiber bundles treated with the modified chemical degumming method were finer and softer and these fiber bundles are more acceptable for both nonwoven and woven processing. The kenaf fiber bundles treated under optimum modified chemical degumming conditions can be easily carded to be further processed into either nonwoven or woven products. Value-added, diversified nonwoven and woven products can be made from these kenaf fibers.

Acknowledgements

The authors thank Dr. Bryan T. Vinyard for his patience and helpful suggestions during both the conduct of this research and the preparation of this manuscript.

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The NONWOVENS WEB

Cybersquatting Battle

A considerable number of new words have entered the English language (and many other languages) with the introduction of computers, the Internet and cyberspace. One term that has received considerable attention in recent months is "Cybersquatting." This term describes the action of an individual claiming a web address that incorporates an established trademark or name of a company or group without any association or authorization from the group. The squatter, of course, hopes to then sell the address to the trademark holder or group that desperately wants to use that name as their own logical web address. Such sales have actually involved price tags of $1 million and more.

In the past, a court battle has often been required to reclaim these names from web poachers. However, with a recent change in trademark law and in the dispute resolution policy governing domain names, this necessity can be avoided.

The body responsible for dispensing and controlling domain names is the Internet Corporation for Assigned Names and Numbers (ICANN). As of October 1999, ICANN has established a Name Dispute Resolution Policy that simplifies and reduces the cost of such a resolution compared to full legal action.

Under the previous policy, a company that had a legitimate claim to a domain name would register a complaint; upon such action, the holder of the domain name had 30 days to prove stronger or prior rights. If they could not do so, the domain name was put on hold, with the result that nobody could use it. The only recourse to the trademark holder was to sue for the rights to the domain name, involving a substantial delay and legal costs.

The current ICANN policy requires complainants to clearly show they have the right to a name or trademark and that the existing domain name is identical to the trademarked name or is so similar that substantial confusion would result. This then establishes the point that the person who initially reserved the domain name has no legitimate right to it, but rather acted in bad faith in reserving or claiming the domain name.

An arbitration board of ICANN reviews the situation within 45 days, following which they may award the domain name to the party with the strongest claim. Over the course of the past several months, over 75% of such decisions have favored the trademark owner/complainant.

An alternative approach available to the trademark holder is to bring action under Federal law (Anti-Cyber Squatting Consumer Protection Act) to regain the domain name and to seek statutory damages.

Obviously, the best way to avoid the entire problem of cybersquatting is for a company or organization to register a critical trademark as domain names on a worldwide basis, and establish their validity through use. Another responsibility of the valid holder of the name is to identify cybersquatters as they may appear.

Where two organizations might logically want the same name for their use and both have an equally legitimate claim, it is simply a matter of which one registers the name first. The obvious message is to cover your product names, tradenames and other critical identifiers – and early!

This, of course, does not completely eliminate the problem, as many trademarks and organizations are being faced with sites that use their name, followed by such expressions as "sucks," "not" and similar. The same is true of sites that are anti impression of a concept. As an example of the latter of interest to the nonwovens industry is a web site that strongly discourages the use of conventional tampons.

Ergonomics Computer Workstations

A considerable amount has been said establishing workstations that correspond to ergonomic principles. This has particularly true in the research sector when considering a computer workstation design.

Despite the fact that statistics from the Bureau of Labor on Injuries and Illnesses serious enough to require days away from work show a drop of 15.6% in the number of problems attributed to repetitive typing and key entry, there is still reason for concern. Although these data show keyboarding incidents to remain at a very low level, problems arising from repetitive motion in all job categories were 3% of the cases requiring days away from work. For those who have had to deal with such injuries, the problem goes on.

Within the Department of Design and Environmental Analysis at Cornell University, serious scientific and statistical study has been devoted to the problem. Sufficient progress has been made from such ergonomic research studies and class work that the Cornell Human Factors and Ergonomic Research Group has assembled guidelines for use in designing computer workstations that in accordance with sound ergonomic principles.

While these guidelines contain a great deal of what could be called "common sense" they are very appropriate for every computer user to review and compare their own personal situation. Further details are available from the Cornell website (http://ergo.human.cornell.edu). Consider the following points in light of your own situation and then use good common sense in adapting and adopting these guidelines for your individual situation.

1. How will the computer be used? If several persons use a computer station, the arrangement should be capable of satisfying wide extremes. If the individuals use the computer only for a few minutes, the ergonomic issues may not be a high priority. However, if a person uses the workstation for one hour per day or more, a decidedly ergonomic arrangement is called for.

2. What kind of a computer will be used? Most ergonomic guidelines are fashioned for use of a desktop computer with the keyboard separate from the computer screen. Guidelines for a laptop computer use are more difficult, because laptop design limits the options and intensifies the problems. For sustained laptop computer use an external monitor should be considered. Also, an external keyboard with a negative-tilt keyboard tray is desirable. Combining both of these options with a docking station may give the best arrangement.

3. What furniture will be used? All of the computer components should be placed on a stable working surface. If a significant amount of writing on paper is done at the station, then the flat works surface should be between 28 and 30 inches above the floor for adults. A high-adjustable system for the keyboard or mouse surface is desirable, for a system that allows you to tilt the keyboard away from you slightly for a better wrist posture (negative-tilt). This should allow the use of the mouse with the upper arms relaxed and as close to the body as possible.

4. What chair will used? A comfortable chair is an important part of an ergonomic arrangement. If more than one person will be using the computer, consider a chair with adjustable ergonomic features. A fixed height chair can be used, providing that it is comfortable to sit in and has a good back rest.

5. What kind of work will the computer be used for? The type of work carried out at the computer station will dictate the best arrangement. For word processing, the best keyboard/mouse position is a high priority. Surfing the web or graphic design calls for the best mouse position, as that feature will likely be used to the greatest extent. Data entry calls for the best arrangement for the numeric keyboard/keyboard. Extensive game use calls for arranging the best keyboard, mouse or game pad as the high priority.

6. What can you see? Any paper documents that are read during the computer use should be placed as close to the computer monitor as possible. These should be positioned at a similar angle as the monitor, which calls for the use of a document holder where possible.

The computer monitor should be placed directly in front of the user and facing the user, not angled to the right or left to avoid too much neck twisting. Also, best viewing is done with the work material being viewed in the center of the monitor rather than at the top or bottom. The monitor should be centered on the user so that the body and/or neck isn't twisted when looking at the screen.

The computer monitor should be positioned at a height that does not require the user to tilt the head up to see it or bend the neck down to see it. When seated comfortably, the users eyes should be in line with a point on the screen about 2-3 inches below the top of the monitor. The average individual sees more visual field

Top Web Sites

While it is recognized that a web site that gets a massive number of "hits" may not be success otherwise, this is an interesting measure of the utility of a particular site.

Thus, it is interesting to review the Top Ten Sites revealed by a recent study covering a one-week period. The number of hits for the site is based an average daily unduplicated visitors.

Not surprisingly, there doesn't seem to be a science-oriented web site in the entire group.

MOST POPULAR WEB SITES

Web Site	Daily Hits
1. Yahoo.com	10,287,000
2. MSN.com	9,236,000
3. Hotmail.com	5,027,000
4. Netscape.com	4,653,000
5. Microsoft.com	4,283,000
6. Passport.com	4,167,000
7. AOL.com	3,597,000
8. Real.com	2,142,000
9. Lycos.com	2,118,000
10. Iwon.com	2,066,000

From a companion study, the following web sites were rated as being the fastest growing on the Internet, using the same criteria.

Web Site	Visitors	Percent Change
1. Cheaptickets.com	122,000	136.6%
2. Ameritrade.com	112,000	118.4
3. Pepsistuff.com	109,000	115.1
4. E4me.com	116,000	99.4
5. Discovercard.com	117,000	86.4
6. Pioneerplanet.com	97,000	85.7
7. Prizes.com	100,000	83.9
8. Capitalone.com	145,000	82.9
9. QVC.com	113,000	82.3
10. Stattrack.com	102,000	80.7

below the horizon than above, so this position should provide the user with the most comfortable viewing point.

When seated back in the chair comfortably, raise your arm; at this point, your fingers should touch the screen. If the text on the screen is too small either use the larger font or magnify the screen imagery of the software.

For individuals who wear bifocal corrective glasses, the monitor should be tilted backward and the height adjusted for comfortable screen viewing.

7. Posture, posture, posture! Many studies reveal that good posture is the basis of good workstation ergonomics. Good posture is the best way to avoid a computer-related injury. To insure good user posture, make sure the user can reach the keyboard with their wrists straight and as flat as possible (not bent up right or left or bent up or down). The users elbow angle (the angle between the inter-surface of the upper arm and the forearm) is at or greater than 90 degrees to avoid nerve compression at the elbow. Also, the upper arm and elbow should be as close to the body and as relaxed as possible for mouse use. It is also very important to be situated as to avoid over reaching.

Insure that a full back support is employed by sitting back in the chair. Also, the feet should be flat on the floor or on a foot rest. The head and neck should be as straight as possible and the posture should feel relaxed for the user.

All of the additional accessories that are to be used frequently must be placed close so that they can conveniently and comfortably reached. The keyboard should be centered for the user. This means that the “B” key should be centered on the midline of the user.

If telephone use is involved, the phone should be close to the user and easy to reach.

8. Where will the computer be used? Other environmental conditions have an important impact on a well-designed ergonomic workstation. The lighting should not be too bright. There should not be any bright light glare on the computer screen. The computer monitor should not be positioned against a bright window or facing bright windows so that the screen looks washed out.

Ventilation with fresh air and adequate heating or cooling should be employed. Noise can cause stress in tense muscles, so a quiet workplace for the work station is desirable. The use of low-volume music, preferably light classical music to mash the hum of fans or other sound sources is helpful.

9. Take a break! All ergonomists agree that it’s a good idea to take frequent, brief rest breaks.

Eye breaks should be frequent, looking away from the computer screen. Every 15 minutes, this eye break should involve looking away from the screen for a minute or two at a more distant scene, preferably something more than 20 feet away. This lets the muscles inside the eye relax.

Also, blink your eyes rapidly for a few seconds as this refreshes the tear film and clears dust from the eye surface. Most typing is done in spurts rather than continuously; between these periods of strenuous activity, take a rest, which allows for periods of relaxation of the fingers. During this time the fingers can be flexed rapidly to relieve tension.

Also, schedule rest breaks every 30 to 60 minutes. Use of a timer to insure such a break is desirable. It is also possible to install ergonomic software on the computer to assist in developing such habits and practices.

10. What about ergonomic gizmos? These days you can purchase just about anything with an “ergonomic” label. Much of this isn’t necessarily true, and some products claiming ergonomic benefits can actually cause harm. What about ergonomic keyboards. The popularized split keyboard only addresses issues of hand ulnar deviation; research studies show that vertical hand posture (wrist extension) is more important.

Again, some of the most useful guidelines in this entire effort are: Does it make sense? Does it feel comfortable?

For further information on this research and how to design the most comfortable work environment: Human Factors and Ergonomics Society (http://hfes.org).

Scientific Information

With access and availability of the World Wide Web, it's not as though we need more information. As Rutherford D. Rogers, Librarian (1985) said, “We are drowning in information and starving for knowledge.”

Despite this fact, a new and useful source for scientific information is always welcome.

A recently activated site combines a very useful source for current scientific information, along with a variety of other features, including B2B items of interest to the scientific and technical community.

The Scientific World Site (www.thescientificworld.com) now provides online access to more than 20,000 periodicals. This provides another useful option to scientists and researchers needing to search for scientific literature. Searches on this database can be based on keywords, author names or publication titles. The site includes issues from 1999 and 2000. Once a reference is located, an electronic or hard copy of the article can be ordered for a fee.

This site is interesting in that it also provides a variety of other features. The “Science Warehouse” contains a substantial listing of equipment, chemicals, biological resources and other items that can be ordered directly. Fisher Scientific maintains a catalogue and order/delivery capability on this site. Job opportunities in the scientific and technical sphere are listed, and help in job seeking is provided. A fairly comprehensive news section, including news on science and technology as well as other current activities, is available. Stock market prices are listed, along with the weather in major cities around the world.

An interesting feature of this site is a corner labeled “CoolStuff,” which promotes useful information and having fun with science. This includes databases with information on a wide variety of societies, technical and otherwise; a glossary of terms related to science, technology and business; abbreviations/acronyms of a wide variety; database of societies and organizations. ***— INJ***

RESEARCHER'S TOOLBOX

Measuring Calender Pressure

Whenever compression rolls or calender rolls are involved, a method for measuring contact pressure distribution in the nip can become critical. While strain gauges, pressure transducers and other electronic equipment immediately come to mind, there is always a longing for a simple, effective method.

In days gone by, the uniformity of a roll nip was often evaluated by passing a piece of carbon paper running against a piece of clean paper through the nip. The resulting impression provided some measure of the uniformity (or non-uniformity) of nip pressure over the surface of the rolls.

A system based on similar methodology but with much more sophisticated control is now available. This consists of the use of "tactile pressure indicating film." The use of this method reveals information on the distribution and magnitude of pressure between any contacting or impacting surfaces.

In the case of one such product, a polyester film is coated with a layer of tiny microcapsules. The application of force upon the film causes the microcapsules to rupture, producing an immediate and permanent high resolution "topographical image" of the pressure variation across the contact area. This is achieved by passing the pressure indicating film facing a "developer sheet" through the nip, the contacting surfaces or the impacting surfaces. Like Litmus paper, the color developed in the developer sheet is directly related to the psi or kg/cm^2 generated in the nip, and can be visually compared to color correlation charts or scanned and quantified with various optical imaging systems. The transfer and develop sheets are very thin (4-to-8 mils), which permits very good conformation to curved surfaces.

One company that offers such a product line is Sensor Products Inc. (188 Route 10/State Route 307, East Hanover, New Jersey 07936; 973-884-1755; Fax: 973-884-1691; www.sensorprod.com). Their product, "Pressurex" indicating film, is available in six sensitivities to the accommodate a wide range of pressures. These include a micro (2-20 psi), ultra low (28-85 psi); super low (70-350 psi); low (350-1400 psi); medium (1400-7100 psi) and high (7100-18,500 psi) pressure films. In addition to nip impressions, other applications involve heat sealing, gasketing, ultrasonic welding, injection molding, die extrusion, lamination, pressing, material testing and similar uses.

Laboratory Accreditation

Laboratory results can go far beyond simple guidance for planning the next experiment or plant run. In this day, such results may find their way into government compliance arguments, public liability and other lawsuits, patent litigation and numerous other business, science and technology settings. With the recent exposure of falsified data coming from a major environmental laboratory as well as from a critical national drug testing lab, there is an understandable concern with the quality of data emanating from every laboratory.

Accrediting a laboratory through the process of compliance review, audits, testing results and other methods, is designed to give assurance to the quality of the data, both to internal and external users of the data.

In the United States, there are more than 100 laboratory accreditation programs currently extant. A major effort has been going on over the past several months to coordinate these numerous and sometimes contradictory accreditation standards and requirements for U.S. testing and calibration laboratories. This work has been spearheaded by The National Cooperation for Laboratory Accreditation (NACLA). Recently, much needed assistance was provided to NACLA in their efforts by the National Institute of Standards and Technology (NIST).

These two organizations have recently agreed to work together to achieve a means to a national accreditation for laboratories. Undoubtedly achieving this result will give rise to pressure for industrial and university laboratories to qualify for such accreditation.

Wettability Analyzer

A variety of methods is available for assessing the wettability of a nonwoven fabric. Most of these techniques are empirical, hence suitable for only limited application. The definitive test method generally involves a measurement of the contact angle, using a specific liquid of known surface tension.

A new instrument has been introduced into the analytical arena that removes much of the labor and uncertainty of contact angle measurements. This is the CA-X Video Contact Angle Meter, which has been specifically designed for the analysis of the degree of surface hydrophilicity or hydrophobicity of fabrics and other surfaces.

The instrument employs a high-resolution video camera, along with a sample stage having 4-degree motion, along with an adjustable dual lighting system. These features allow close viewing, study and measurement of the drop/fabric interface, to clearly ascertain contact angle and other parameters. With the connection of the video camera to the computer, a permanent digital record is obtained for further study and analysis. For further information: Kernco Instruments Co.; 915-852-3375; Fax: 915-852-4084; Web site: www.kerncoinstr.com

Crosslinking of Coatings

The coating of a fabric or other surface is generally improved by the step of crosslinking the material comprising the coating. Such a step usually increases performance and permanence. Incorporating the crosslinking system into the coating medium is the simplest manner of operation. However, such a procedure can greatly reduce the workability of the coating due to shortened pot life of the material. Basically, the coating begins to crosslink and change before it is applied to the substrate.

A relatively simple but effective method of delivering the crosslinking component to the coated substrate has been developed by a research group from Eastman Kodak (U.S. Patent 6,071,688; June 6, 2000). This involves vapor deposition of the crosslinker in an separate layer on top of the coating.

In the specific process used by Eastman, a stream of nitrogen gas was saturated with trimethyl borate, the crosslinking agent. This agent reacted with hydroxyl groups on poly(vinyl butyral), used as the major constituent of the coating. The saturated vapor was bathed onto the surface of the coating, so that a small amount of the trimethyl borate is deposited on the coating.

The researchers point out that this method is different from atomized deposition methods, by the absence of defects formed by droplets on the coating. ***— INJ***

EMERGING TECHNOLOGY

Polymer Surface Analysis

In so many applications, it is the nature of a polymer surface that controls the behavior of a material. This is especially true in fibrous structures, where the amount of polymer surface is very high compared to the bulk structure.

Consequently, methods of analysis that are focused on the surface of a polymer, perhaps only a few atoms thick, are of special interest. Researchers at the University of California, Berkeley have been researching such analytical methods.

A technique called Sum-Frequency Generation (SFG) vibrational spectroscopy has been the subject of special study, as the method seemed to offer the potential for such controlled analyses. Recent work, under the direction of Professor Gabor A. Somorjai in the Chemistry Department, has established that this method responds only to the polymer's surface and not the bulk of the polymer. Dr. Somorjai's group has shown that SFG signals from slices of polymers do not vary with thickness. On the other hand, with Fourier-transform infrared spectroscopy, a technique that is sensitive to both the surface and bulk of polymers, the signals increase with polymer thickness [*J. Am. Chem. Soc.*, 122, 10615 (2000)].

An analytical technique that shows the structure and composition of only the polymer surface and not the bulk of the polymer can tell what chemical groups are on a polymer surface and how they are organized. Such a technique can be extremely valuable in designing biocompatible polymers and similar applications. It can also be very helpful in fully characterizing the chemical nature of a fiber or film surface. This can have implications on a wide variety of surface-related phenomena, including filtration properties, wetting characteristics, adhesive properties and other characteristics of interest to the nonwoven technologist.

Melt-Processable PTFE

Poly(tetrafluoroethylene) (PTFE) is an extremely valuable and versatile polymer, characterized by excellent chemical and thermal resistance, as well as outstanding mechanical, electrical and other properties. The total worldwide annual sales of fluoropolymers are approximately $2 billion, the largest fraction of which is PTFE.

Common PTFE is an ultrahigh-molecular-weight material. Its valuable properties would be exploited to a much greater extent, except for the fact that unlike other synthetic polymers, it cannot be melt-processed because of the extremely high viscosity of its molten state.

As a result, extraordinary processes must be employed to process such polymers; these include powder sintering, powder compaction and preparation of block polymer with expensive machining to form shaped items. These processes are generally expensive to very expensive, and so the utility of the polymer is reduced.

The use of copolymers has been attempted to improved this situation, but the resulting materials do not have all of the outstanding chemical and thermal properties of the PTFE homopolymer; also, copolymerization is relatively expensive.

A research group at the Swiss Federal Institute of Technology (ETH) in Zurich has announced a system that appears to provide a means to achieve melt-processing of these materials. Their work involved examining blends of PTFE micropowders and high-viscosity PTFE materials in various composition ratios. Processed alone, neither of these materials are satisfactory, but the ETH group has found processing "windows" from the melt-mixing of specific blends that gives good processing and good properties.

Further research is underway to study the addition of fillers to these acceptable materials, in order to overcome the creep resistance shortcoming of PTFE polymers. If fully successful, these developments could have a substance impact on the use of PTFE in nonwoven products. For more information: Paul

Smith, et. al., Macromeolecules, 33, 6462, (2000).

Flashspinning for Particle Size Control

Although this method is not actually and strictly flashspinning, it has all of the elements of such. The process is applied to pharmaceuticals in order to put the drugs in extremely fine form for facilitating efficient absorption.

The process involves using supercritical carbon dioxide ($scCO^2$) as the carrier for the drug and an accompanying solvent. This mixture is released into a particle formation vessel, whereupon the carbon dioxide disperses and mixes the solution while extracting the organic solvent. The drug is left in very fine particle size (down to 50 microns), which exhibits greatly enhanced and more uniform absorption.

New Hydrogel Materials

A new class of superabsorbent polymer-like materials has been developed by a group of Cornell University bioengineering materials scientists. In contrast to conventional SAP materials, these polymers are biologically compatible with the human body, while showing good strength and stability characteristics.

The secret behind these hydrogels is the careful combination of different components, including synthetic biodegradable polymers such as polylactive and dextran, a sucrose polymer produced in fermentation, and carbohydrates such as polysaccharides. The resulting compounds have both hydrophilic and hydrophobic properties that can reportedly be controlled for specific applications.

The developers of this new class of materials (Dr. C. C. Chu and his graduate students) have shown that one type of their new hydrogels can release anti-inflammatory and cancer-fighting drugs as well as human insulin. In addition to other biological applications, these materials could have industrial and hygiene applications. ***— INJ***

ASSOCIATION FOCUS

ANFA Organizes To Serve Asian Nonwovens Industry

An official inauguration of ANFA, the Asia Nonwoven Fabrics Association, took place November 1 to mark the formation of the new nonwovens industry group for all of the areas of Asia.

Following months of planning, this new association now represents a total of 260 nonwoven enterprises in Asia. This membership includes some of the top nonwoven companies in the world, including Japan Vilene, Kuraray, Asahi Chemicals, Toyobo, Kang Na Hsiung, CNTA Company, Xin Long, Nan Hai and Nan Xin.

In contrast to the previous Asian nonwovens organization, membership in ANFA will consist of individual companies instead of trade associations representing specific countries. ANFA will thus be a true Asian association with the participation of nonwovens-related enterprises located over the Asian region.

According to ANFA headquarters, the objectives of the new association will include:

1) Realize the establishment of a true Asian association with nonwoven enterprises from all area of Asia,

2) Organize and carry out ANEX (Asia Nonwovens Exhibition) in the normal schedule,

3) Provide members with updated market information,

4) Expand information sources for members and industry,

5) Build friendly and cooperative relationships among members.

ANFA is located at Asia Nonwoven Fabrics Association, Soto-Kanda 6-Chome Building, 3rd Fl., 2-9 Soto-Kanda 6-Chome, Chiyoda-ku, Tokyo 101-0021, Japan; 81+3/5688-4041; Fax: 81+3/5688-4042

As the new association begins operations, a sizable number of members forms the nucleus, forecasting a very vigorous and influential future. This membership is derived from the following areas of Asia: 81 Japanese, 76 Taiwanese, 63 Korean and 40 Chinese.

Also attesting to the strength of the organization is the line-up of the inaugural officers, which includes many individuals with considerable experience and influence in the nonwovens industry. The officers include:

Chairman: Tai (Jung Chi), Taiwan; Vice-Chairman: Kim (Hyun Joo), Korea; Vice Chairman: Yamada (Tadayoshi), Japan; Vice Chairman: Wang (Yanxi), China; Secretary-General: Yoshimura (Teruo), Japan

Shozo Iwakuma, former Chairman of Japan Vilene and previous Chairman of ANIC, was recommended as Honorary Chairman.

In addition to the above officers, four Directors each from Taiwan, Korea and Japan, and three Directors from China were elected.

Building on a previous heritage of many activities and substantial advancements, the new Association has announced some ambitious plans for activities to be carried out in the next year:

• Publishing an ANFA Directory and nonwoven statistics for the Asian area,

• Promotion and effective public relations for ANFA activities,

• Organize a seminar for the Asian area,

• Provide for collection and dissemination of updated nonwovens market information.

• Organize and initiate preparatory work for ANEX-03, the world-wide exhibition to be held in Asia in 2003. ***— INJ***

PATENT REVIEW

PTO becomes PBO

Late last year legislation passed the U.S. Congress that has brought several changes to the U.S. Patent and Trademark Office (PTO). One of the changes is that the PTO has become what is known as a "performance-based organization (PBO)." The concept of the PBO is that a government agency that can operate like a business in the private sector provides a special status. The PTO is the second federal agency to attain PBO status. As a consequence, this office has accepted the accountability for its performance in exchange for managerial flexibility. This permits greater latitude in employment practices and numbers outside the civil service system. Also, top managerial positions will no longer require fulfillment with political appointees that require Senate confirmation with its attendant churning of personnel.

Another important provision of PBO status is that the commissioners will have performance agreements negotiated directly with the Secretary of Commerce. This will result in the commissioners managing to an agreed-upon set of standards, not only in terms of production issues but also such issues as quality. This is significant for this office, as it is a production-based organization; quality and customer focus will now be inserted into that concept.

An interesting feature of this new arrangement is that patent examiners are receiving a considerably increased amount of training. This involves bringing experts into the PBO office for training of groups, but also for field trips by examiners to meet directly with inventors face-to-face in their labs and to obtain hands-on understanding of new technology.

Further, a program that allows examiners to go back to graduate school for additional graduate training has been revived.

Interestingly, there is no improvement in the budget arrangement for the PBO with this new system. The PBO is the only fee-funded agency in the government. Monies they receive for a variety of fees are taken from them for other government purposes. Some of this money comes back to them the following year in their next annual budget, but the department still complains of a restrictive budget.

Because of the increasing number of patent applications submitted each year, the number of patents issued by the U.S.

Patent Applications via the Internet

Along with other new procedures being introduced by the U.S. Patent and Trademark Office is the acceptance of the patents via its electronic filing system.

The PTO has permitted trademark customers to file trademark applications via the Internet for many months. Over the past few months, the office has permitted biotechnology patent filings by this means, as well.

However, the PTO plans to expand the patent filing service to most other filings in the very near future. While this may not sound like a tremendous change, it should expedite both the filing of applications as well as handling of such applications within the PTO.

Efficiency improvements of this type are sorely needed, as the pace of patenting increases. With the granting of patents to operation of the Internet, an increase in applications is inevitable. As evidence of this is the fact that the number of Internet-related patents granted in 1977 was 433, while the total in the first half of 2000 was 2,517.

All of this is a manifestation of the effort and necessity to apply modern business practices to a system that goes back over 200 years.

Expanded Patent Database

The U.S. Patent and Trademark Office had to be forced into the digital age. It wasn't until a private citizen threatened to put trademark information on the Internet that the PTO consented to participate by establishing its own trademark database on the Internet.

This was followed sometime later by putting a portion of the U.S. patents on the Internet, including bibliographical, abstracts and text of utility patents.

When this was done, the patent database put on the Internet went back only to January 1, 1976. At that time, the effective life of a U.S. patent was seventeen years, and hence this shortened database covered the patents that were still valid; at least that was the reasoning employed.

However, it is often necessary to go back to older patents in order to adequately establish the prior art.

As a consequence, the PTO recently has made such searching more convenient by expanding its Internet database to include every U.S. patent ever issued. Thus, the collection now goes back to 1790, with a total of more than 6.5 million patents.

If you're interested in a patent issued to George Washington, Edison's first patent or other historical events in the world of science and technology, the PTO web site is now the place to go (http://uspto.gov).

Patent and Trademark Office steadily increases. The percentage of those applications that eventually get allowed has remained about the same over the years, at a 75% level.

Because of this increasing load of work, the office is continually looking for qualified people to hire, and has also taken some innovative steps to retain their personnel. At the present time they have about 400 Ph.Ds and about 500 lawyers, along with about 1,500 patent examiners.

From these numbers it is obvious that the patent and trademark activity is indeed a big business and can benefit from good practices and customer relations.

RECENT NONWOVEN PATENTS

Voluminous Spunbond Web

In general spunbond nonwovens are characterized by relatively thin high density webs. This results from the fact that the calender thermobonding usually employed compresses the web and also because the continuous filaments are without crimp.

A process disclosed in this patent is directed toward producing a spunbond fabric of relatively low density. The process extrusion of continuous filaments in the usual manner except the amount of stretching following the quenching step is reduced somewhat. The filaments are formed into a web and then subjected to partial point thermobonding, without excessive action.

The partially bonded web is then passed into the nip of a pair of embossing rolls. The one positive roll has a male configuration with elevated points which engage the depressions of the negative or female roll with the corresponding recessions or depressions. As the web passes through this set of rolls, the points of the male roll engage the recesses of the female roll and stretch the filaments within and adjacent to the roll engravings. The roll is so designed that no web necking occurs, and all of the secondary stretching occurs on individual filaments rather than the entire web.

The result is a comparatively voluminous spunbond fabric, wherein the regions between the bond points have considerable loft and thickness.

U.S. 6,136,124 (October 24, 2000); filed December 22, 1998. "Process for producing a structured, voluminous nonwoven." Assignee: H. C. D. Hygienic Composites Development GmbH. Inventor: Werner Wagner.

Zone-Treated SMS Laminate

This invention relates to nonwoven webs suitable for use as a topsheet and barrier leg cuff in a disposable diaper. The fabric involved is an SMS laminate. These webs consist of spunbond outer layers and an interlayer of meltblown polyolefin microfiber. The presence of the meltblown microfiber web provides a liquid barrier that has excellent breathability.

Portions of the SMS laminate are treated with a surfactant material in order to provide rapid penetration of body fluids through the entire laminate. The treatment consists of surfactant materials which convey this capability. The untreated portion of the laminate retains its resistance to penetration by liquids, while affording good breathability and moisture vapor transmission.

In order to insure uniform penetration in the treated zones, the surfactant treatment should be on both sides of the laminates. This is most easily accomplished by using a foam applicator rather than conventional topical application techniques such as spray, kiss and padding techniques. The application of the treated foam provides sharp transitions between the hydrophilic and hydrophobic zones. The treated transition zones will normally have a width of about 3-8 millimeters, being continuous in the machine direction. After foam application, the fabric laminate is dried and slit. The treated and slitted material is then wound ready for converting into the finished disposable diaper.

Preferably, the meltblown layer has a basis weight of about 1.5 gsy, while the total basis weight of the two spunbond layers is 10 gsy. The meltblown fibers have an average diameter of 3-5 microns, while the spunbond filaments have an average diameter of 12-20 microns. The SMS laminate in accordance with the preferred embodiment has a mean pore size in the range of 30-40 microns.

U.S. 6,139,941 "Nonwoven web laminate having relatively hydrophilic zone and related method for its manufacture;" (October 31, 2000); filed December 23, 1998. Assignee: BBA Nonwovens Simpsonville, Inc. Inventors: Juris Jankevics and Glen Roberts.

Water-disintegratable Sheet

The problem with developing a water-disintegratable sheet structure is achieving a balance of durability, so that the material can survive the normal treatment in use, while at the same time providing sufficient instability that flushing or similar treatment results in disintegration of the web.

This patent discloses a process whereby this balance is achieved by a wetform process utilizing short fiber hardwood pulp along with long fiber softwood pulp, plus a water-insoluble or water-swellable binder to bind the fibers. A modest amount of synthetic fibers can also be employed to soften the structure.

Typically, the short fiber pulp is used at a blend level of 10-50 weight %, while the long fiber pulp is used at 90-50%. A water-insoluble or water-swellable CMC (sodium carboxymethylcellulose) is used as the binder material. A small amount of a bivalent inorganic salt, such as calcium sulfate, may be used to stabilize the binder at low moisture content. Also, the system can accept a small amount of organic solvent to enhance cleansing action, as these webs are suggested for use in a variety of wiping applications.

U.S. 6,132,557 (October 17, 2000); filed September 4, 1998. Assignee: Uni-Charm Corporation. Inventors: Naohito Takeuchi, Takayoshi Konishi.

Improved Softness in Flash Spun Nonwovens

Flash spinning involves the conversion of a polymer solution or dispersion into plexifilamentary film-fibril material. This fibrous web is then converted into nonwoven sheet products by area bonding or by point bonding. In area bonding, the material is thermally bonded generally uniformly across the area of the sheet. Point or pattern bonded material is thermally bonded at points or in a pattern, where the pattern creates portions of which are more strongly bonded and portions which are not as strongly bonded. Area bonded products are typically stiff and have a paper-like hand. Point bonded products tend to have softer, fabric-like feel. In disposable protective apparel, improved softness is a property that is continually researched for further improvement. Another important property for apparel applications is the fabric quietness or freedom from noise when flexed.

DuPont has relied solely upon high density homopolymer polyethylene for all commercial operations in its Tyvek7 business. Recently, however, DuPont has begun to add post-consumer recycled high density polyethylene to virgin polymer. The post-consumer recycle is primarily from recycled milk jugs. Considerable engineering has gone into the system and process to accommodate the recycled material. This has been considered a substantial advance in achieving an environmentally friendly operation.

In further attempts to utilize off-specification polyethylene, it has been found that co-polymers of ethylene and other monomers provide considerably improved fabric softness without compromising other important properties. The polymers that have been found to be particularly useful include ethylene copolymers and blends of ethylene copolymers with high density polyethylene. Ethylene copolymers which are particularly useful in this invention contain alkylolefin monomaric units, such as butiene, hexene and octene. These polyethylene copolymers prepared by means of a single site catalyst are especially beneficial in the system.

The high density polyethylene used had a melt index of 0.73 (g/10-minutes at 190^0 C. with 2.16 kilogram weight), a melt flow ratio of 34 (MI at 190^0 C. with a 2.16 kilogram weight divided by MI at 190^0 C. with a 21.6 kilogram weight) and a density of 0.96 g/cc. The solution prepared for the flash spinning operation comprised 17.7% of high density polyethylene and 82.3% of a solvent consisting of 32% cyclopentane and 68% normal pentane. The ethylene copolymer was produced using a single site catalyst and had a melt index of about 0.1 to about 50 g/10 min and a density of about 0.85 to about 0.95 g/66 with a molecular weight distribution of less than 4 with a BET surface area greater than about 8m squared/gm.

A subjective softness scale was created to provide a general comparison of softness for the various yarns and webs. For both scales, a softness of one was established for the control, which was not very soft. For the yarns, the softest were given a rating of five. For the sheets, the softest was given a rating of seven. The sheets were also evaluated for quietness. With a control, the noisiest having a rating of one with optimal rating being seven. Flash spinning with the ethylene copolymer provided considerably softer and quieter flash spun webs. Also, the inventors point out that adding what may appear to be small amounts of ethylene copolymer to HDPE also provided a substantial improvement to the flash spun products.

U.S. 6,117,801 (September 12, 2000); filed March 27, 1997. "Properties for flash-spun products." E. I. Du Pont de Nemours and Company. Inventors: David Jackson McGinty, Hyunkook Shin, Young H. Kim.

Elongatable Nonwoven Web

This process is directed toward producing a stabilized nonwoven web that can easily be elongated or extended in the cross direction (CD) to at least 60% without suffering catastrophic failure. Because the web is extensible and not elastic, the web does not recover more than 55% of its elongation upon release of the stretching force, preferably not more than 25%. Such an elongatable nonwoven web can be used in portions of disposable absorbent garments, to provide improved fit and performance in such articles.

The process comprises the following steps: (1) feeding a neckable nonwoven web in the machine direction (MD); (2) subject the neckable nonwoven to incremental stretching in the CD; (3) applying a tensioning force to the web in the MD to neck the web in the CD; and (4) subjecting the necked nonwoven web to mechanical stabilization to provide a stabilized, extensible, necked nonwoven web.

As described, the incremental CD stretching rolls are fitted with a plurality of teeth and corresponding grooves to provide CD stretching at the same time that the web is stretched and necked in the MD by a set of additional incremental stretching rolls for the MD stretching.

The nonwoven web is stabilized to the treatment provided by a plurality of stabilizing embossments in the CD direction across the full width of the web. Such treatment sets the individual fibers across the entire width of the web, thereby stabilizing the web treatment.

Suitable nonwoven webs for practicing this invention include spunbond, meltblown, Coform, and carded nonwovens that must have adequate neckability.

U. S. 6,114,263 (September 5, 2000); filed May 10, 1999. "Stable web having enhanced extensibility and method for making same." Assignee: The Procter and Gamble Company. Inventors: Douglas H. Benson, John J. Curro. ***— INJ***

WORLDWIDE ABSTRACTS AND REVIEWS

A sampling of Nonwovens Abstracts from Pira International — A unique intelligence service for the nonwovens industry

Modelling of tensile properties of needlepunched nonwovens using artificial neural networks

The tenacity and initial modulus values of needled nonwoven jute and polypropylene blended fabrics were predicted using an empirical model and artificial neural networks (ANN). The samples used had varying fabric weight, needling density and blend ratio. Results from using the models were compared with experimental values. The ANN predictions were more accurate than the empirical values derived using multiple regression analysis. A significantly lower rate of error was shown by the ANN model even when the inputs were beyond the range of inputs used for developing the model. (1 fig, 6 tab, 9 ref)

Author: Debnath S; Madhusoothanan M; Srinivasnoorthy V R

Source: Indian J. Fibre Text. Res.

Issue: vol. 25, no. 1, Mar. 2000, pp 31-36

Man-made leather produced without organic solvents

Loele is an environmentally-friendly man-made leather produced without the use of organic solvents and marketed by Teijin Ltd. Production has already begun and 300,000m is expected in year one with 400,000m in year two. Loele is made of needlepunched nonwoven fabrics processed from 0.2 denier microfibres produced by splitting polyester-nylon bicomponent fibres with a compact fabric structure. Further processing details are supplied and a greater leather touch is claimed than for other synthetics. (Short article)

Author: Anon

Source: New Mater. Jpn

Issue: Sept. 2000, pp 9-10

Municipal waste plastics recycled in blast furnaces for first time

Two new systems introduced by NKK Corp at its Keihin and Fukuyama Works process waste container and packaging plastics and industrial waste plastics. Up to 40,000t of raw material/y feeds blast furnaces instead of coke. Designed in-house, the system components are listed. The automatic PVC removal system (4,200t/day) is described and energy efficiency is detailed. The two systems have received government endorsement as environmentally beneficial. NKK's current waste plastics recycling capacity is discussed and indications of the company's expansion plans are included, together with possible joint working with manufacturers and users of plastic items to promote recycling.

Author: Anon

Source: New Mater. Jpn

Issue: July 2000, pp 7-8

JNR prospect: active adult diaper market and introduction of the Japan Homecare Insurance System

The Japan Homecare Insurance System started on the 1st April 2000. The average monthly support is JPY2,885 for people over 65 and 0.44% of their income for the 40-65 age group. The 1999 adult diaper sales increased by 17% from 1998. The introduction of this new national insurance system will accelerate the market development further and will boost related industries (e.g. nonwoven, paper and pulp, superabsorbency material and Spandex). To eliminate the negative image of adult incontinence, psychological aspects like fashionable design and near underwear features will become essential in addition to functionality. Nonwovens have a big advantage in this aspect, with their superior texture and performance to paper. (6 tab)

Author: Shimizu T

Source: Jpn Nonwovens Rep.

Issue:. 315, 10 May 2000, (Japanese)

JASPIA (Japan Superabsorbent Polymers Industry Association) – development, technical support and contribution to the paper nappy industry

Japanese superabsorbent polymers (SAP) industry has been growing, boasting the world's largest production quantity (220,600t in 1999) and high standard technology. Nihon Shokubai, Sanyo Kasei and Sumitomo Seika are the top three manufactures and together with eight other SAP suppliers formed JASPIA (Japan Superabsorbent Polymers Industry Association). JASPIA's plans include researching use of SAP in agriculture and tree-planting, setting up voluntarily specified standards, gathering information and investigating environmental issues on SAP waste. Japanese SAP manufacturers offer great support to paper nappy companies by facilitating quality assurance system, developing quality and luxury product varieties and pursuing cost performance. Business growth and market development of the paper nappy sector rely greatly on research and development of SAP manufacturers.

Author: Anon

Source: Jpn Nonwovens Rep.

Issue: no. 316, 10 June, 2000, p. 25 (In Japanese)

High-tex geo and building textiles from Germany

New technical textiles developed by the Saxon Textile Research Institute include rope-like products up to 130mm diameter for drainage applications. A porous, high compression strength core allowing water flow, is covered by a protective layer. Other drainage systems feature high tensile strength, tough mesh structures for erosion protection and soil stabilization. A triaxial chain structure based on alkali-resistant glass fibre and fibrillated polypropylene ribbon has been developed to support mineral matrices used to reinforce thin section concrete components of buildings.

Author: Anon
Source: Allg. Vliesstoff-Rep.
Issue: no. 3, 2000, p. 38 (In German)

Water block material for the waste disposal land and its laying method

Water block materials for the waste disposal land are relatively new in the Japanese market due to lack of specified testing methods, JIS (Japanese Industrial Standard) for similar materials (e.g. waterproof roofing material) is currently applied. As suggested in the Industry and Environmental Management Committee Report (May 1998), external forces on waterproof sheets and nonwoven protection mats, occurring during the construction processes, should be examined as well as primary material performance and functions. The maintenance and defect detection methods after construction are also discussed. (28 fig, 18 tab, 5 ref)

Author: Ueda S
Source: Jpn Nonwovens Rep.
Issue: no. 315, 10 May 2000, pp 48-61 (In Japanese)

Special edition II: current status of sanitary products

Unicharm KK, the leading figure in Japanese sanitary market, considers AI (adult incontinence) business as a key in the 21st century. Their AI product are designed to improve quality of life, by minimizing physical and psychological stress on both homecare taker and recipients. As exemplified by its unique products Rihabiri-pants (pants-type diaper) and Nyou-Tori-Pad (pad for urine), the pair-use of outer (former) and inner (latter) diaper achieves excellent cost efficiency, and creates a wide range of product selection depending on the degree of disability. This approach also encourages the independence of elderly people: the easy-to-exchange pad, specially designed for slightly handicapped person, will contribute rehabilitation. The main product lines are also introduced. (6 fig)

Author: Shirai M
Source: Nonwovens Rev.
Issue: vol. 11, no. 2, July 2000, pp 33-37 (In Japanese)

Polyester can absorb formaldehyde fumes

Kuraray have produced a polyester fibre to be used in upholstery fabrics capable of absorbing formaldehyde adhesive fumes released in furniture making. The crucial component is a nitrogen compound, surface bonded, which adsorbs the gas. Test results are reported and the treatment is effective for up to a year. (Short article)

Author: Anon
Source: New Mater. Jpn
Issue: Aug. 2000, p. 11

Medical textiles

Advances in textile technology and medical procedures have led to significant growth for medical textiles, and new applications are still being developed. Medical textiles can be biodegradable or nonbiodegradable, and classified into non-implantable, extra-corporeal, implantable and clothing materials. The fibres used for each application and their benefits are detailed and tabulated. They must all be non-toxic, non-allergenic, non-carcinogenic, and remain stable when sterilized. The range of materials used includes natural, synthetic and regenerated cellulose, alginate, chitin, chitosan and stainless steel. Latest developments are fibre forming enzymes, biocatalysts and use of bicomponent fibres and polysaccharide dressings. (3 tab)

Author: Ghosh S
Source: Indian Text. J.
Issue: vol. 110, no. 6, Mar. 2000, pp 10-14

Development of functional separator for a new type secondary battery

A functional separator for a new type of secondary battery has a high market potential, since its demand is in fast developing areas such as mobile phones, note computers and hybrid cars. Polyamide and hydrophilic polyolefin nonwovens are commonly used for nickel/hydrogen and lithium batteries, respectively. The required specifications of these nonwoven separators are discussed with the production methods and modification technology. As an alternative of solution-based electrolytes, lithium polymer and lithium solid electrolytes are considered to be new high performance materials. The developments of highly functional separators for the new generation of battery are anticipated. (12 fig, 11 ref)

Author: Sakai T
Source: Jpn Nonwovens Rep.
Issue: no. 317, 10 July 2000, pp 4-9 (In Japanese)

JNR prospect: a new nonwoven NOVA from DuPont (USA), based on the TYVEK technology

DuPont (USA) has developed a new nonwoven, Nova, based on the Tyvek (flush-spun nonwoven) technology. Nova is a unique nonwoven, which is composed of DuPont's Lycra (elastic polyurethane fibre), and more importantly, has a high potential as a main textile material. The key features of Nova are a woven-like texture, elasticity and waterproofing with air permeability. Levi Strauss has selected Nova as a new material for the 2001 spring collection (autumn, Paris). The introduction seminar held in Japan also received positive reaction by the apparel industry. DuPont has no clear business strategy. (1 ref)

Author: Shimizu C
Source: Jpn Nonwovens Rep.
Issue: no. 317, 10 July 2000, pp 24-25 (In Japanese)

Technology development for productivity improvement; energy saving technology for adhesion and dyeing

Foam dyeing technology is a cost effective method for nonwoven post-dyeing. Features of foam, such as generation, surface tension and stability, should be controlled to achieve high quality of dyeing, and also, high energy efficiency of dyeing process. Mechanisms of pigment migration during drying processes are discussed with improvement methods. Microwave drying is one of the newest technology, and is expected to improve drying efficiency and finishing fabric texture. (6 fig, 5 tab, 4 ref)

Author: Takaoka Y

Source: Jpn Nonwovens Rep.

Issue: no. 317, 10 July 2000, pp 26-32 (In Japanese)

Fehrer's nonwoven testing facilities completed

Fehrer's RSP-V21/R-12/Highloft web forming line and NL 9/S needler is now available for customer material trials. Various combinations of web forming, needlepunching and thermobonding are possible for nonwoven testing under production conditions, in state-of-the-art accommodation. Flat or curved needling zones can be quickly fitted on the NL 9/S preneedler. The K12 random card machine has been fitted with dust extraction and automatic cleaning devices. A second nonwoven research centre concentrates on needlepunching. The Superior Group, Florida, USA, is using a high-performance Octir/Fehrer system featuring Octir blending-carding, cross-lapping and webdrafting with a 4.4m Fehrer NL9/S to produce domestic and industrial textiles.

Author: Anon

Source: Indian Text. J.

Issue: vol. 110, no. 6, Mar. 2000, p. 108

Special edition II: medical use product using functional nonwoven, Micacure, the medical cover material for injured areas

Micacure was developed by Kotec KK, Ohgaki City, Gifu, Japan in 1992, as a result of the collaboration with Kitazato University and Mitsubishi Kasei KK as a supplier of medical use polyurethane resin. It is composed of polyurethane film (high steam permeability) and high absorbency nonwoven. The film layer contains the anti-infection reagent and high drainage function keeps the ideal condition for recovery. Micacure had passed four biological safety and six standard safety tests: the clinical trial carried out by 12 medical institutes in 1995 resulted in 136 positive cases. The medical product certificate was granted by The Ministry of Health and Welfare in Dec. 1996, followed by the national insurance application (Oct. 1997). Since its launch (Nov. 1997), Micacure is widely used in the medical area. (1 fig)

Author: Anon

Source: Nonwovens Rev.

Issue: vol. 11, no. 2, July 2000, p. 38 (In Japanese)

Discussion: operation of long-term care insurance and trends in market and materials for adult paper nappies

In April 2000, the long-term Care Insurance System started in Japan, which is regarded as good factor for growth of the disposable diaper industry. Care Insurance highlights the importance of support for the daily life issues of the elderly, including incontinence. Previously low price was the priority for adult paper nappies, but demands for quality and variety according to usage levels are increasing. The industry needs to put great efforts in public relations and research, and two leading companies, Uni-Charm and Procter & Gamble Far East, have already set up research facilities, providing personal care information. Use of airlaid nonwovens is eagerly awaited to develop innovative products, but the high price makes the application unfeasible at the moment. (2 fig, 3 tab)

Author: Konishi T

Source: Jpn Nonwovens Rep.

Issue: no. 316, 10 June, 2000, pp 12-24 (In Japanese)

Waste management of textile components after vehicle lifetime – a complex subject

The automotive industry and the German Act of Circulative Material and Waste Management have committed to reach an 85% recycling quota by January, 2006. The various types of fibres used in automotive textiles and their specifications are considered, as well as the possible ways of reprocessing materials after vehicle lifetime. Johann Borgers GmbH and Co. KG, Bocholt, Germany, has introduced Propylat needled nonwovens, made of 90% recyclate, which are 100% recyclable after use. Recycling of automotive textiles depends on technical, economical and ecological evaluation of raw materials production, processing, properties, use and aftercare, and ease of material identification and separation. (1 fig)

Author: Eisele D

Source: Tech. Text.

Issue: vol. 43, no. 3, Aug. 2000, pp E49-E51

Wettability and surface analysis of glass fibres

Wettability and surface analysis results are reported for glass fibres used as thermoplastic and thermoset reinforcements. Dynamic contact angle (DCA) measurements are made by applying the Wilhelmy technique and calculations given for work of adhesion, fibre surface energy and interface energy. A difference in contact angle hysteresis between the fibres is explained by the difference in higher surface energy components. The glass fibre thermoset reinforcement fibres display higher wettability in polar solvents then the thermoplastic reinforcements. Wettability is independent of fibre diameter for fibres with the same cross-sectional shape. Surface energy measurements can help to predict compatibility of reinforcement fibres with the polymer matrix. (5 fig, 2 tab, 11 ref)

Author: Van de Velde K; Kiekens P

Source: Indian J. Fibre Text. Res.

Issue: vol. 25, no. 1, Mar. 2000, pp 8-13

— INJ

Pira Carves Out Its Nonwovens Niche

U.K. consulting group also leads the way in providing information on publications in the worldwide nonwovens business

One of the nonwovens industry's best resources rests in a little town in the U.K., where nonwovens companies and researchers from around the world have been able to turn since the mid-1980s for consulting and research projects.

This important organization is Pira International and it bills itself as "a leading independent consultancy and research organization," with headquarters in Leatherhead, UK, located between Gatwick and Heathrow airports. It primarily serves manufacturers, suppliers and users in the paper and wetlaid specialty products sectors. "In effect," says director Dr. Grahame Moore, "We are wholesale providers of knowledge, information and expertise."

It is a role that has suited Pira well since its activity in nonwovens began in the mid 1980's with the formation of the Pira Fibramerics Programme. This program, focused on nonwovens, includes elements of Pira's mainstream activity (research, consulting, information and training), with the majority of the activity run out of the Paper and Board Group.

At that time of its formation a decision was made for the unit to focus on the wetlaid nonwovens sector, primarily because that's where Pira's knowledge based resided. "With a background in papermaking and wetlaid nonwovens, the decision was made not to get involved in drylaid-based nonwovens, but rather to develop wetlaid through to meltblown as specific areas," says Dr. Moore.

Today, Pira is recognized as an independent authority in its fields, having uniquely valuable resources especially set up to help companies develop concepts for industrial commercialization. The Paper and Board Technology Group within Pira provides research and consulting in wide-ranging areas of papermaking and nonwoven technology:

- Refining and Fiber Preparation
- Sheet forming and drying
- Process Chemistry and polymer evaluation
- Recycling Technologies
- Coating and Surface Treatment
- Environmental Solutions

One of Pira's most recognizable services to the nonwovens sector is the development and maintenance of the only comprehensive international database devoted exclusively to the nonwovens industry. The Pira "Nonwovens Abstracts" publications contain informative summaries of articles from trade and technical journals,

Subjects covered in Nonwovens Abstracts

- *Nonwovens industry in general* ... All issues of general interest relating to the industry, such as legislation and regulations, management, quality assurance and health and safety.
- *Market information* ... Includes market reports, market trends, annual statistics and forecasts on all aspects of the industry from raw materials to finished products.
- *Company information* ... Covers reports on the activities of companies involved directly or indirectly in the production of nonwovens.
- *Raw materials* ... Deals with all the fibers and additives used in nonwovens production.
- *Process technologies* ... Covers the three main areas of nonwovens manufacturing: web formation, bonding systems, and converting and finishing.
- *Composites* ... Deals with the processes in the manufacture of composites, which include the use of nonwoven materials.
- *Products and end-users* ... Covers the wide variety of applications and end-uses in which nonwovens materials are employed.
- *Environment* ... Deals with the topical issues of disposability, degradability and recyclability of nonwoven products, of possible dioxin contents of products and of the management, treatment and quality of the effluents from their production.
- *Book section* ... Reviews new book titles covering all of the above subjects, as well as specialist trade directories and reference books relating to the nonwovens industry.

conference papers, newspapers and reports from all over the world. *(The International Nonwovens Journal runs a section of the Nonwovens Abstracts every issue, see page 43 of this issue.)*

This invaluable wealth of information, dating from 1975, can be accessed direct from Pira's web site, online via host services like Dialog and STN, on CD-ROM or in a compact monthly journal. In addition, staff in Pira's Information Center is available to subscribers to answer questions and to point researchers in the right direction. Market analysts and researchers are also available to undertake market studies of nonwovens and other sectors.

The Pira Facts

• Pira is a consulting business with major publishing and conference activities, serving the printing, publishing, packaging and paper/nonwovens industries. It employs 200 full-time staff.

• Currently 35% of its income comes from working with clients outside the U.K. Over the next three years plans are in place to increase this to 50% of revenue.

• Membership dues account for 8% of revenue; Market Intelligence/Information, 8%; Publications, 16%; Conferences/Training, 20%; Technical Research, 4%; Analytical & Materials Testing, 20%; Strategic & Technical/Consulting, 24%.

• The Pira online database contains more than 400,000 records on research and development, new technology and materials, environmental legislation, market developments and competitor activity.

• Pira is one of Europe's largest business-to-business graphics arts publishers. A wide range of titles are available on the latest technological developments as well as a comprehensive range of market reports detailing industry trends and forecasts.

• Pira's Conference and Training Group organizes more than 35 two-day conferences annually in the U.K., mainland Europe and the U.S.

• Pira offers clients the opportunity to join its membership program, which provides a range of benefits tailor-made to an organization's needs, such as participation in the on-going exclusive strategic futures program. It also provides unique networking opportunities by enabling closer collaboration with 2,500 other member companies across the packaging, paper, printing and publishing industries.

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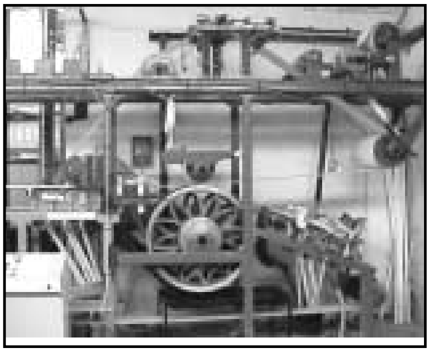


The Pira Experimental Forming System with top wire unit for upward dewatering/re-forming.

A decision was made at the start of entering the nonwoven segment in the mid-1980s that Pira would not build or buy specific pilot plant equipment. Rather, Dr. Moore points out, it sought to buy time on the best available facilities worldwide. "This decision meant that the practical work involved in the research studies undertaken was carried out at facilities throughout Europe and North America," he says.

The organization's particular strength lies in developing specialty wetlaid products and processes for clients. Pira boasts a diversity of experience embracing metal fiber filtration media, ceramic fiber insulation, combustible shell cases for artillery rounds, fiber-cement composites and catamenial products.

Its facilities do now include a unique twin–ply Experimental Forming System (EFS) with press drying unit. This unit can be adapted to a variety of conformations to emulate specific wet-laid processes, enabling Pira to research dynamic forming, drainage and surface chemical effects that contribute to process efficiency. Pira also has a separate small-scale wet forming line to evaluate the effect of raw materials on product properties. It can also make continuous webs from cellulose, synthetic and ceramic fibers.

"We operate on a fully commercial, confidential basis and can offer complete packages from market research to product development," points out Dr. Moore. ***— INJ***

The TAPPI Nonwovens Page

The TAPPI Nonwovens Division used the special occasion of the inaugural INDA/TAPPI International Nonwovens Technical Conference in Dallas, TX in late September to present its annual awards to deserving members. More than 500 people attended the INTC, and both TAPPI and INDA have already begun working on INTC 2001, September 5-7 in Baltimore, MD.

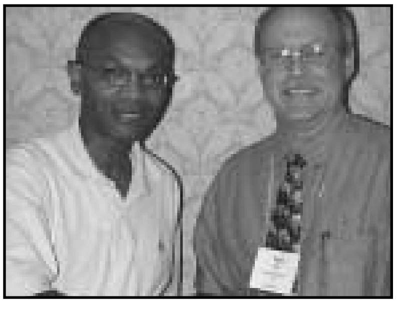
Albert Hoyle (left), president of Hoyle Associates, received the 2000 TAPPI Nonwovens Division Leadership & Service Award, while Roy Broughton, Auburn University, was presented with the TAPPI Nonwovens Division Technical Award and the Mark Hollingsworth Prize.

Marsh Hutten (left) is recognized by TAPPI president Dick Barker, for contributions to the TAPPI Nonwovens Division as Fibers Committee Chairman.

INTC 2000 Conference Chairman Pete Wallace (left), of Borden Chemical, shares a light moment at INTC with TAPPI president Dick Barker.

Spontaneous discussions were facilitated at the vendor exhibits. Pictured (from left) Ti Chou, BF Goodrich; Larry Wadsworth, University of Tennessee; Wai Ming Choi and Norm Lifshutz, both of Hollingsworth & Vose.

INTC 2001 Conference Chairman Jim Harrington (left), of Fiber-Visions, and 2001 Program Co-Chairman Tom Ryle, of Clopay.



TAPPI Nonwovens 2000 Division Chairman T.M. Singh, of Evanite Fiber.

INDEX OF INJ ARTICLES

A listing of technical papers that ran in the International Nonwovens Journal 1999-2000

NONWOVENS CALENDAR 2001

February 2001

Feb. 12-14. ***Geosynthetics Conference 2001.*** Portland, OR, USA. Danette Fettig, IFAI, 1801 County Rd. BW., Roseville, MN 55113; 651-222-2508; Fax: 651-631-9334; melanden@ifai.com

March 2001

March 11-15. ***AORN Congress 2001***. Dallas, TX, USA. Janet Paulson, AORN, 2170 South Parker Road, Suite 300, Denver, CO 80231; 303-755-6304; Fax: 303-338-4838; jpaulson@aorn.org

March 13-15. ***Techtextil North America.*** Atlanta, GA, USA. Messe Frankfurt, 1600 Parkwood Circle, Suite 515, Atlanta, GA 30339; 770-984-8016; Fax: 770-984-8023; info@usa.messe-frankfurt.com

March 26-29. ***Nonwovens Workshop Principles and Practices.*** North Carolina State University, Raleigh, NC, USA. NCSU, College of Textiles, Nonwovens Cooperative Research Center, 2401 Research Drive, P.O. Box 8301, Raleigh, NC 27695; 919-515-6551; Fax: 919-515-4556.

March 27-29, 2001. ***IDEA 2001 - Nonwovens Conference & Exhibition.*** Miami Beach Convention Center, Miami Beach, FL, USA. Marilyn Bellinger, INDA, P.O. Box 1288, Cary, NC, 27512-1288. 919-233-1210 ext. 118; mbellinger@inda.org.

April 2001

April 1-5. ***221st American Chemical Society National Meeting.*** Washington DC, USA. ACS Meetings, 1155 16th St. N.W. Washington, DC 20036-4899; 202-872-4396; Fax: 202-872-6128; natlmtgs@acs.org

April 26-28. ***INDA Annual Meeting 2001.*** Ritz-Carlton Amelia Island, Amelia Island, Florida, USA. Marilyn Bellinger, INDA, P.O. Box 1288, Cary, NC, 27512-1288. 919-233-1210 ext. 118; mbellinger@inda.org

Apr. 23-27. ***ATME-I American Textile Machinery Exhibition.*** Palmetto Expo Center, Greenville, SC, USA. J. Robert Ellis, ATME, P.O. Box 5823, Greenville, SC 29606. 864-233-2562; Fax: 864-233-0619; atmei@textilehall.com

April 24-26. ***Techtextil Frankfurt.*** Frankfurt am Main, Germany. Albrecht Rieger, Messe Frankfurt GmbH, Ludwig-Erhard-Anlage 1, D-60327 Frankfurt am Main; +49-69-7575-6017/6415/6578/6406; Fax: +49-69-7575-6541; info@messefrankfurt.com; www.messefrankfurt.com

May 2001

May 1-4. ***AFS Science and Technology of Filtration.*** Hyatt Regency, Tampa, Florida. Charlotte Stripling, American Filtration & Separations Society, P.O. Box 1530, Northport, AL 35476-6530. 205-333-6111; afs@dbtech.net; www.afssociety.org

May 26-30, 2001. ***ACIMIT - TECNO TMA TEXTIL.*** Bologna Exhibition Centre, Bologna, Italy. Italian Textile Machinery Association, Piazza Constituzione 6, 40128 Bologna, Italy. Tel: +39-051-282-111; Fax: +39-051-282-333; dir.com@bolognafiere.it; www.bolognafiere.it

July 2001

July 19-22. ***Clean '01.*** New Orleans, Louisiana, USA. Ann Howell, Riddle & Associates, 1874 Piedmont Rd., Suite 360-C, Atlanta, GA 30324; 404-876-1988; Fax: 404-876-5121; ann@jriddle.com; www.cheanshow.com

August 2001

Aug. 26-30. ***Polymers, Laminations & Coatings Conference.*** Sheraton San Diego Hotel & Marina, San Diego, CA, USA. Karen Van Duren, TAPPI; 770-209-7291. ***— INJ***

The *International Nonwovens Journal* is published by INDA, Association of the Nonwoven Fabrics Industry, P.O. Box 1288, Cary, NC 27512; (919) 233-1210; Fax (919) 233-1282; www.inda.org. Sponsored by TAPPI, Technical Association of the Pulp and Paper Industry, P.O. Box 105113, Atlanta, GA 30348; (770) 446-1400; Fax: (770) 446-6947; and ANIC (Asia Nonwoven Fabrics Industry Conference), Soto kanda 6-Chome Bldg. 3Fl, 2-9, Chiyoda-ku, Tokyo 101, Japan; 81-3-5688-4041; Fax: 81-3-5688-4042 The magazine is sent free of charge to INDA, TAPPI and ANIC members.

CALL FOR PAPERS

Joint INDA-TAPPI Conference

INTC 2001

International Nonwovens Technical Conference

September 5-7, 2001 Renaissance Harborplace Baltimore, Maryland

The International Nonwovens Technical Conference

*** Sponsored BY INDA and TAPPI ***

September 5-7, 2001, Renaissance Harborplace
Baltimore, Maryland, USA

The inaugural INTC, a joint conference sponsored by INDA and TAPPI, was held in September, 2000 in Dallas, Texas and drew more than 500 people. More than 70 nonwovens industry experts presented technical papers during the three days of INTC.

Abstracts are now being accepted for INTC 2001 in all areas of nonwovens:
• Fibers • Properties & Performance • Process Technologies
• Filtration • Building & Industrial Mat • Absorbents
• Binders & Additives • Medical/Barrier Fabrics • and More ...

By presenting a paper at the INTC Conference, speakers will reinforce their expertise within the nonwovens community; gain recognition among peers and with potential customers; enhance their reputation as a leader within the industry; provide their company with invaluable industry visibility; and their written paper will be distributed to all conference attendees in the INTC 2001 Book of Papers. For end-users of nonwoven products, this conference is a unique opportunity to tell suppliers their needs.

Call Deanna Lovell at 919-233-1210, ext. 119