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Pulp and Paper Chemistry



... Is an integrated chemical process

"Paper chemistry is an amazing process," says John Heitman, a professor of chemistry at North Carolina State University. "People use paper all the time, but they don't think about where it comes from and what it's made of." Likewise for students of chemistry, the pulp and paper industry is relatively unknown. So, departments of pulp and paper technology actively recruit high school students to their programs-many of which are industry supported and provide attractive scholarships.

Pulp chemistry and paper chemistry are integrated processes, but each is carried out somewhat separately. Chemists in the paper-making business tend to gain experience with both pulp and paper science, because knowledge of both is integral to the smooth running of a paper mill.

Pulping is a process of delignification-removing lignin from wood while leaving cellulose fibers intact. Most pulping is done through a "Kraft" delignification process, which uses sodium hydroxide and sodium sulfide to chemically remove lignin. After delignification, the color of the pulp is dark brown. If white paper is desired, the pulp is bleached. Delignified, bleached pulp is fed into paper machines after undergoing other chemical processes that produce the desired quality and characteristics for the paper. "Sizing" chemistry gives the paper resistance to moisture; "retention" chemistry binds fillers and shorter fibers into the paper; and "wet strength" chemistry ensures that products like paper towels will not disintegrate in water.

... Is a changing industry

"Paper-making is changing rapidly," comments Martin Hubbe, senior research scientist at International Paper. "Concern about environmental impact is changing some of the chemical processes and the chemistry used in paper-making. A lot of the new emphases are on recycling and de-inking technologies." In addition, chemists are turning to chlorine dioxide and hydrogen peroxide as pulp-bleaching alternatives, given the concern over the effect of chlorine, the traditional bleaching agent, on the environment.

... Requires broad knowledge

Chemists in the pulp and paper business say their work is always geared toward industrial applications. Entry-level chemists are likely to spend most of their time in the lab, but as their careers progress, they will dedicate increasingly more time to processes in the mills. "You have to remain open-minded in this business," says George Batten, senior manager for technical

service and applications at Georgia-Pacific Resins. "Paper-making encompasses so many different disciplines: chemistry, chemical engineering, mechanical engineering, and microbiology," he says. He adds that knowledge of all these areas and the ability to think about them in an integrated manner contribute to success in paper-making.

This broad base of knowledge should extend into business and marketing. "In the past, R&D labs and sales departments were seen as adversaries," notes Cynthia Olson, director of technical marketing at Betz Paper Chemicals. "But in this competitive, commercial world, the two need to be partners."

A degree in chemistry is a solid foundation for working in the pulp and paper industry. But, even as an undergraduate, a student's course of study should offer breadth. "Chemistry is, of course, important. But engineering courses are also useful," says Hubbe. "A great deal of what we do involves optimization of processes and to understand the processes, it's helpful to have an engineering background."

Meg Watters, a lab chemist at Arizona Chemical, adds that students should not limit their focus on obtaining a broad scientific background. "You have to have a life outside your studies. The social skills you develop in college are the best preparation for the team work environment which is a vital part of industry today."

Indeed, employers in the pulp and paper industry consider interpersonal skills an important asset, along with academic training. "For example, a paper machine has fixed costs of several thousands of dollars per hour," says Batten. "It is most efficient to run the mills all the time; and, if you are a chemist working with a mill manager who is under stress to keep the processes running and not lose money, you need to be able to understand the pressures on him and to be able to help integrate his job with yours. Thus, it helps if you are an easy-going person and can deal with stress and other people under stress."

... Is characterized by openness

"Once in the industry, people tend not to leave it, even if they switch jobs from company to company," says Hubbe. "If you stay, you may encounter the same people again and again, he adds. "There's a wonderful quality of openness in the business-openness which, I believe, is greater than that in other chemically based industrial processes."

John Heitman Academic Research

"During the course of my career, I have worked in both pulp mills and paper mills. I then joined the staff in the department of wood and paper science at North Carolina State University to teach and do research. The academic environment gives me the opportunity to pursue my area of research interest rather than having my work directed from company headquarters.

"I study methods for de-inking paper in the recycling process. Other researchers are looking at applications of biotechnology or enzymatic processes for bleaching pulp and decolorizing bleach plant effluent. I study enzymes and the way they react in a water system or pulp slurry. Right now, I am working on a technology which will make it possible to introduce an enzyme into a variety of processes so that when it has done its job, it will disengage and can be used again. Much of my research is funded

by industry or a consortium of companies that are hoping to use these new technologies."

John Uptmor
Environmental Management

"As a project manager at Aquater Inc., an environmental management firm which serves the pulp and paper industry, I consult on the environmental aspects of paper-making," says John Uptmor "Most people have a bad image of the paper industry; they associate it with dioxins and polluted rivers. But pulp and paper companies have actually done more than other industries to become environmentally responsible. They recycle 400 to 600 tons of newsprint per day and plant trees for further propagation of natural resources. Still, the negative image can cause the industry to be regulated in a manner that is stringent and often inefficient.

He adds, "In one project, I researched the downstream effects of one paper mill in an area where there is a lot of paper production. I sampled biological species in rivers and assessed the production and environmental compliance costs for all paper facilities. Based on this research, we submitted a report to regulators which showed that making facility-by-facility rules was inefficient. We urged them to look at the environment of the entire river to recognize that some of the present regulatory standards were more stringent than they needed to be."

Meg Watters
Lab Chemistry

After graduate school, Meg Watters moved to Florida to work in Arizona Chemical's development lab. Arizona Chemical is a manufacturer of specialty products derived from rosin chemicals. This includes turpentine and crude tall oil, which comes from a variety of pine trees and is a byproduct of the pulp and paper-making process. From these materials, Arizona Chemical makes resins used in paints and adhesives. "I spend a lot of time running reactions and polymerizing resins such as maleic-modified rosin esters. I analyze these products at different temperatures to determine their viscosity and flow characteristics in order to develop a resin for a particular application or industry."

She adds, "This is my first job out of graduate school and I'm finding it a big transition. In school, I was used to doing reactions on a small scale. Here, we do reactions of 1,000 grams of material in a flask and then scale it up to an entire facility. It's a lot to absorb in a short amount of time, but it's very exciting."

Cynthia Olson
Marketing

"I did research for nine years and now I work in marketing," says Cynthia Olson, director of technical marketing for Betz Paper Chemicals. "People always say, 'that must be a big change.' The truth is that it's not. R&D is research with chemicals. Marketing is research with people and money. You essentially bring the same thinking process to each."

Olson's employer supplies specialty chemicals to the paper industry which help keep the paper-making machines clean, running efficiently, and producing better quality paper. "Our business is based on improving our customers' processes," says Olson, "and my job means making sure we do this at every point between R&D and sales."

She continues, "As a woman in the paper industry, I was very much in the minority in the beginning of my career. But I've never found this to be oppressive. I've come to believe that in working with men in this business, it's more how you can help them than who you are."

Martin Hubbe
Research and Development

Martin Hubbe, a senior research chemist at International Paper, followed his father into the paper-making business. "I guess you could call it a family tradition," he says. "I grew up in Maine, and my father was in research at the local paper mill." Hubbe's story is not unusual. Chemists in the pulp and paper industry frequently hail from rural areas and are recruited by departments of pulp and paper technology at area colleges and universities.

An example of the work Hubbe has done as a research chemist has been to coordinate all of International Paper's mills so that the colored paper each produces is identical. "At one time, our mills were using different paper-making processes," he explains. "Some used an alkaline process; others used an acid process. Dyes have their own personalities, and the same dye can yield a range of hues depending on the paper and the process used to make it. We needed to ensure that no matter how light hits the paper, the color of the paper produced at all our mills would look the same."

Gary Stanley **International Trade**

"My career has allowed me to take a broad, policy-oriented perspective on the pulp and paper industry," says Gary Stanley, a forest products industry specialist in the U.S. Department of Commerce. Stanley was on the original team that negotiated the U.S.-Japan paper trade agreement, and he represented the U.S. Paper industry on the North American Free Trade Agreement. "When I graduated with a degree in chemical engineering, I had no idea my career would go in this direction. But, I find it very satisfying to be involved with big changes on a national and international level."

Stanley's job includes tracking every aspect of pulp and paper-making, from understanding the impact of global climate change to monitoring sectors affected by the industry, such as the packaging materials. He also plays a role in drafting U.S. Environmental Protection Agency regulations. "It is necessary to have a technical background to work with these detailed, policy-specific issues," he says. "I need to understand alternatives to chlorine gas bleaching, for example, or be up to speed on new treatments for the removal of sulfur dioxide. To know where the industry is going, it is important to know where it came from and to understand its processes."

George Batten **Problem Solving**

"When I started out as a pulp and paper chemist, I spent 75 percent of my time in the lab," says George Batten, senior manager for technical service and applications at Georgia-Pacific Resins. "Now that I'm a manager, I spend between 50 and 80 percent of my time at the paper mill troubleshooting and solving problems."

"I was recently at a paper mill where everything was running smoothly; the sizing chemistry was fine, and for several hours the quality control tests on finished sheets of paper were showing consistent results. Then, suddenly, the results were way off and the tests were indicating paper near reject level. There had been no change in the chemical processes we were using and so we had to explore other sources of the problem, he says. "It turned out the mill had added a new refiner—a piece of equipment that beats the pulp and opens up more sites for hydrogen bonding. But the new plates in the refiner were cutting the pulp more than beating it, resulting in shorter fibers that needed more sizing agent. This was an example of how a purely mechanical aspect of the paper-making process can completely throw off the chemistry."

WORK DESCRIPTION

Pulp and paper chemists focus their work on the industrial paper-making process. Much of their job is geared towards improving efficiency, making the process more cost-effective and environmentally friendly.

WORKING CONDITIONS

A chemist starting in the field will likely spend most of his or her time in the lab. However, unless that chemist's work remains in research, more and more time will be spent in mill and plant facilities. Because their work is always geared toward the end product, experienced paper chemists, including those whose jobs are in the marketing department, say they spend a lot of time knee deep in paper fiber and sludge, trying to determine how to improve paper and the paper-making process.

The paper industry employs chemists at pulp and paper companies, paper chemicals suppliers, and rosin chemicals makers. Consumer products manufacturers and specialty suppliers such as felt manufacturers also hire chemists. Engineering firms and environmental management companies employ chemists to work on their contracts with the paper industry. Government employs chemists in this area in the U.S. Department of Commerce, Department of Energy, Environmental Protection Agency, and Forestry Service.

PERSONAL CHARACTERISTICS

People attracted to pulp and paper chemistry tend to be engineering-type thinkers—those who enjoy physical and process chemistry. They are open to a variety of disciplines and tend to explore scientific questions broadly, rather than burrowing into specific niches.

EDUCATION AND TRAINING

Some paper chemists say that a degree in chemical engineering is more practical than a degree in chemistry for working in this industry, and a B.S.-level chemical engineer going into pulp and paper will find a better, higher paying position than a B.S. chemist. Others recommend getting an undergraduate degree in pulp and paper technology. Traditionally trained chemists say that not having a pulp and paper degree may be a drawback in the first year on the job, but working in industry provides fast-paced training in the area.

JOB OUTLOOK

Good jobs in the pulp and paper industry are competitive, and government job openings are rare. Graduate schools of paper technology say they have a higher graduate placement rate than other degree-granting institutions, but as always, finding a job will depend on a good mixture of academic credentials, interpersonal skills, and demonstration of problem-solving capabilities. The environmental field continues to grow faster than other industries but is expected to reach maturity soon.

FOR MORE INFORMATION

Academic pulp and paper departments noted below can provide a sense of

the course work required for this field. North Carolina State University has the largest undergraduate program, and The Institute for Paper Chemistry at Georgia Tech in Atlanta is the leading graduate program. Other undergraduate departments are at the University of Miami (OH), Ohio State University, State University of New York at Syracuse, University of Maine at Orono, Western Michigan University, University of Wisconsin at Steven's Point, and University of Washington. Graduate degrees are also offered at Syracuse, Maine, and Miami. More information about the industry itself may be available through The Association of the Pulp and Paper Industry (TAPPI) (<http://www.tappi.org/>).

WHAT YOU CAN DO NOW

Chemists in pulp and paper strongly recommend that students familiarize themselves with industrial chemistry. Riegel's Handbook of Industrial Chemistry is a good source of information. Additionally, any exposure students can get to an industrial lab-through volunteer work or an internship-will familiarize them with the business and provide good experience for getting a job.

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