Dyeing and Finishing Mills

OVERVIEW

The dyeing and finishing industry consists of establishments primarily engaged in finishing textiles on a commission basis. The industry is composed of three 4-digit SICs (2261, 2262 and 2269) which finish cotton, manmade and other types of fabrics, textile goods such as raw stock, yarn, braided goods and narrow fabrics. Typical finishing operations include bleaching, dyeing, printing and other mechanical finishing such as shrinking and sponging of cotton broadwoven fabrics. Chemical finishing is used for water repellency, fire resistance and mildew proofing.

Products from this industry include:
• Bleached fabrics
• Printed labels
• Suedes
• Bleached yarns
• Embossed fabrics
• Mercerized cotton yarns

CHARACTERISTICS

Dyeing and finishing industry shipments declined in the early 1980s as the U.S. textile industry experienced an economic downturn. However, it rebounded in the late 1980s with yearly increases in the value of shipments and experienced a remarkable 19 percent growth in 1987. (See Table 1.) This growth has slowed due to the recent strong demand for knit products (not included in SIC 226). Despite this shift in demand, SIC 226 has continued to experience moderate to high growth in the weaving and carpet industries. SIC 226 does not include firms which dye and finish broadwoven fabrics or knit goods nor firms which coat or impregnate fabrics. Yarn and thread production firms which also dye their own yarn and thread are not covered either. These firms are included within SICs 221, 225, and 228. Firms such as Burlington Industries, Milliken and Company, West Point Pepperell and Springs Industries which operate within these SICs all have large internal dyeing and finishing operations. Therefore, the figures published for SIC 226 do not give a clear indication of the size and scope of dyeing and finishing operations in the U.S.

Technological changes and market forces have caused recent structural changes in the entire textile manufacturing industry. Vertical and horizontal integration is taking place with increasing
Table 1

Dyeing and Finishing Industry: Basic Statistics (1987)

<table>
<thead>
<tr>
<th></th>
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<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>2261</td>
<td>Finishing Plants, Cotton</td>
<td>16.6</td>
<td>13.6</td>
<td>1,389</td>
<td>48.5</td>
<td>792.3</td>
<td>299.5</td>
</tr>
<tr>
<td>2262</td>
<td>Finishing Plants, Manmade</td>
<td>27.9</td>
<td>22.3</td>
<td>4,406</td>
<td>98.5</td>
<td>3,183.3</td>
<td>545.9</td>
</tr>
<tr>
<td>2269</td>
<td>Finishing Plants, N.E.C.*</td>
<td>11.8</td>
<td>9.8</td>
<td>1,268</td>
<td>25.8</td>
<td>816.3</td>
<td>192.7</td>
</tr>
<tr>
<td></td>
<td>Total</td>
<td>56.3</td>
<td>45.7</td>
<td>7,062</td>
<td>172.8</td>
<td>4,791.9</td>
<td>1,038.1</td>
</tr>
</tbody>
</table>

*N.E.C. = Not Elsewhere Classified

frequency. Mergers, acquisitions, and consolidations have become commonplace. Despite the prevalence of mergers, the dyeing and finishing industry remains diverse. Several large companies exist, but hundreds of smaller firms are active in dyeing and finishing on a commission basis. Some of the major players in this industry are shown in Table 2.

Most states have some textile mill operations, including dyeing and finishing operations to convert the greige goods to finished products. The dyeing and finishing industry, however, is concentrated in the southeastern and mid-atlantic states such as North Carolina, South Carolina and Georgia (see Figure 1). Some northeastern states, such as New York, New Jersey and Massachusetts also have sizeable dyeing and finishing operations.

Dyeing and finishing firms are highly dependent on suppliers of greige fabrics and yarn as well as raw materials suppliers, e.g., chemical firms. Small, single-operation establishments that dye yarns or fabrics on a commission basis are heavily affected by the success of the firms for which they dye and finish. Firms often buy dyestuffs and chemical additives and then combine these to achieve the desired shades and appearances, which makes quality and specifications of incoming dyestuffs and chemicals critical.

Employment in SIC 226 has been in a long-term downward trend, but production employment has remained constant in the last half of the 1980's. Production employment in this industry has dropped since 1982 as firms seek to become less labor intensive. (See Figure 2.)

Imports continue to be a leading problem in the U.S. textile industry group. U.S. Department of Commerce figures show that textile and apparel imports for 1989 may be 13 percent above the record breaking level of 1987. Imports are a concern because imported fabrics and apparel are often dyed and finished in the foreign country of origin. Firms primarily engaged in yarn dyeing may not be affected as much since few foreign countries export yarn to the U.S. However, foreign fabrics and apparel may contain foreign-produced and dyed yarns which then indirectly affects U.S. producers of dyed and finished yarns.

The outlook for the dyeing and finishing industry is heavily dependent on the outlook for the U.S. textile industry as a whole. The forecast for the textile industry continues to be one of uncertainty. The large 5 percent increase in output that occurred in 1989 does not seem likely in 1990. Analysts again project a modest 1-2 percent gain in mill output, which should keep this industry solid.

Table 2

Leading Dyeing and Finishing Industry Firms

<table>
<thead>
<tr>
<th>Firm</th>
<th>Headquarters</th>
<th>Sales ($000)</th>
<th>Primary SIC</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cranston Print Works</td>
<td>New York, NY</td>
<td>215,000</td>
<td>2261</td>
</tr>
<tr>
<td>Hanes Companies</td>
<td>Winston-Salem, NC</td>
<td>118,000</td>
<td>2261</td>
</tr>
<tr>
<td>Duro Industries</td>
<td>Fall River, MA</td>
<td>70,000</td>
<td>2262</td>
</tr>
<tr>
<td>Spectrum Fibers</td>
<td>Woonsocket, RI</td>
<td>69,300</td>
<td>2269</td>
</tr>
<tr>
<td>Ideal Textiles</td>
<td>Los Angeles, CA</td>
<td>60,000</td>
<td>2261</td>
</tr>
</tbody>
</table>
MANUFACTURING METHODS AND ENERGY USE

Fabric dyeing and finishing is one of the final textile production steps. Typically, after dyeing and finishing, fabrics only need to be cut and sewn before being sold to consumers. Dyeing and finishing imparts the color, feel, and performance properties that consumers desire for a variety of end uses in the apparel, industrial, or home furnishings market. Yarns may be dyed or finished before being used in the production of woven and knitted fabrics, nonwoven goods, and carpet. In many complex fabrics, yarn dyeing is needed to allow the desired pattern and appearance to be achieved. Dyeing and finishing processes are interrelated, and the specific processes used vary with the intended fabric or product end use.

Dyes can be applied to textile products at various stages in their manufacture. Natural fibers may be dyed as separate fibers (loose stock dyeing) in sliver form (top dyeing), in yarn form (yarn dyeing) and in final fabric form (piece dyeing). Manmade fibers may be dyed in the same way, and also dyed in solution state (mass pigmentation or solution dyeing) or in gel state where the fibers have begun to form but have not been set. Another stage for dyeing manmade fibers is in the tow form where many parallel filaments are dyed before being cut into staple length.

When fabrics contain thermoplastic fibers such as polyester, they are generally heat set to give a permanent flat memory. Singeing is used to remove undesirable surface fuzz that could cloud the clean appearance of a finished fabric. The size, which is applied to yarns before weaving to add strength, is removed in desizing either by using enzymes or oxidative chemicals. Scouring removes waxes, fats and oils thereby improving wettability during further wet processing. Bleaching is used primarily for those fabrics intended for market whites and pastel shades. Mercerization swells cotton fibers, giving improved luster and dye absorbency.

Once these steps are completed, the fibers are highly absorbent and ready to uniformly accept dye. In continuous dyeing, the dye solution is applied uniformly across the flat fabric and carefully predried to quickly evaporate excess surface moisture. This aids in dye migration. Washing stages that follow serve to oxidize certain cotton dyes and remove any unfixed dyes. Dyed fabrics are then dried and, where necessary, printed. Drying follows to complete the dyeing operation. Printing can be carried out to give several colored patterns using a separate process (see Figure 3).

Finishing covers any of several wet or dry unit processes that are used to impart the final functional and aesthetic characteristics. Permanent press resin finishes and soil-release finishes are typically applied from an aqueous solution to open-width fabric which is subsequently dried and cured. Sometimes mechanical finishing operations are used to raise surface fibers (napping), cut the raised fibers to a uniform height (shearing), or impart luster (polishing). Often, calenders are used to flatten and impart a desired sheen.

The dyeing and finishing industry consumes a relatively small amount of electricity when compared with other industries within the textile industry group (see Figure 4). This industry relies on fossil fuels to meet most of its energy needs. Fossil fuels account for about 89 percent of energy used.
**INFORMATION SOURCES**


*Dun's Business Rankings 1989*, Dun and Bradstreet Corp., Parsippany, N. J.


**ABOUT INDUSTRY BRIEFS**

Basic funding for this Brief is provided by the Electric Power Research Institute (EPRI), a nonprofit organization that conducts research and development on behalf of the electric utility industry. Industry Briefs are designed to provide the utility marketing representative with an overview of industry trends, manufacturing methods and energy use characteristics of each industry. Such information will enable utilities to identify, evaluate and implement industrial DSM options suitable for specific process industry groups.

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For technical information, contact
EPRI Textile Office
College of Textiles
North Carolina State University
P.O. Box 8301
Raleigh, N.C. 27695-8301
(919) 737-7550

For ordering information, call
EPRI's Affiliate Member Program
1-800-4320-AMP

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in dyeing and finishing while electricity accounts for only 11 percent (see Table 3).

**DEMAND-SIDE MANAGEMENT OPPORTUNITIES**

The success of firms in SIC 226 is very much dependent on the success of weaving, knitting and yarn production firms. If these firms run near capacity, then firms in SIC 226 also remain busy. Like other segments of the textile industry, SIC 226 is very cyclical in nature. Typical firms in this industry operate on three 8-hour or two 12-hour shift schedules during prosperous economic times. Based on these operating characteristics, four DSM strategies are applicable.

*Load shifting* can apply to plants operating at less than maximum production capacity. Yarn dyeing has decreased in popularity, and many greige mills have small yarn dyeing operations that could handle all their production during off-peak hours. Scheduled maintenance could be done during peak hours to keep the maximum amount of production during off-peak hours.

However, the large fossil fuel requirement and the low amounts of electricity used in many dyeing and finishing operations, may not support much cost savings with this strategy.

*Strategic load growth* is driven by the application of process heating electrotechnologies. Dyeing, curing and other finishing processes require large quantities of thermal energy. Selected electrotechnologies can make inroads in finishing applications by providing the high temperatures required for direct-fired processes and also increase production, improve quality and prevent dye migration. The major opportunities for electrotechnologies are in the wet processing area of textiles. Wet processing includes the majority of processes that dye or finish the spun yarn or woven knit/greige fabric. Most of

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**Figure 3**

**Basic Steps in Dyeing and Finishing**

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**Figure 4**

**Dyeing and Finishing Industry Electricity Consumption (Million kWh)**

|------|------|------|------|------|------|

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**Applicable DSM Load Shape Objectives for SIC 226**

- Load Shifting
- Peak Clipping
- Valley Filling
- Strategic Load Growth
- Strategic Conservation
- Flexible Load Shape
Table 3

Dyeing and Finishing Industry: 1986 Energy Use Statistics

<table>
<thead>
<tr>
<th>SIC</th>
<th>Industry</th>
<th>Purch. Elec.</th>
<th>Purch. Fuels</th>
<th>Total Purch. Energy</th>
<th>Energy Costs ($ Million)</th>
<th>Electricity Consumption (Mil. kWh)</th>
<th>Intensity (kWh per $ Value Added)</th>
</tr>
</thead>
<tbody>
<tr>
<td>2261</td>
<td>Finishing Plants, Cotton</td>
<td>17.2</td>
<td>31.6</td>
<td>48.8</td>
<td>2261</td>
<td>313.1</td>
<td>1.07</td>
</tr>
<tr>
<td>2262</td>
<td>Finishing Plants, Manmade</td>
<td>57.3</td>
<td>110.6</td>
<td>167.9</td>
<td>2262</td>
<td>1,089.7</td>
<td>0.86</td>
</tr>
<tr>
<td>2269</td>
<td>Finishing Plants, N.E.C.*</td>
<td>22.7</td>
<td>22.8</td>
<td>45.5</td>
<td>2269</td>
<td>431.9</td>
<td>1.34</td>
</tr>
<tr>
<td>Total</td>
<td></td>
<td>97.2</td>
<td>165.0</td>
<td>262.2</td>
<td></td>
<td>1,834.7</td>
<td></td>
</tr>
</tbody>
</table>

*N.E.C. = Not Elsewhere Classified

Table 4

Applicable Electrotechnologies in the Dyeing and Finishing Industry

<table>
<thead>
<tr>
<th>ELECTROTECHNOLOGY</th>
<th>APPLICATIONS</th>
<th>ADVANTAGES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Infrared, Microwave, and Radio Frequency Drying</td>
<td>Fabric and Yarn Drying</td>
<td>• Higher Speeds</td>
</tr>
<tr>
<td>High Efficiency Motors</td>
<td>All Areas</td>
<td>• Machine efficiency, lower energy consumption</td>
</tr>
<tr>
<td>Robots/Automation</td>
<td>Materials Handling</td>
<td>• Reduced labor and increased efficiency and productivity</td>
</tr>
<tr>
<td>Heat Recovery Heat Pumps</td>
<td>Dryer Efficiency</td>
<td>• Reduced energy consumption, better use of available resources</td>
</tr>
<tr>
<td>Membrane Separation Processes</td>
<td>Dyebath Recovery</td>
<td>• Can recycle process water and recover dyes for reuse</td>
</tr>
<tr>
<td></td>
<td>Chemical Recovery for Reuse</td>
<td></td>
</tr>
<tr>
<td>Ultrasound</td>
<td>Fabric Dyeing</td>
<td>• Improved dye uptake</td>
</tr>
</tbody>
</table>

TRADE ASSOCIATIONS

American Textile Manufacturers Institute, Inc.
1801 K Street, N. W., Suite 900
Washington, D.C. 20036
(202) 862-0581

American Association of Textile Chemists and Colorists
P. O. Box 12215
Research Triangle Park, NC 27709
(919) 549-8141

the processes by firms operating in SIC 226 are wet processes, presenting opportunities for a broad range of electrotechnologies (see Table 4). Membrane separation is one of the more attractive options, offering potential significant cost savings advantages through the recovery and reuse of dyes.

Strategic load growth opportunities also include the use of robots and automation for materials handling and process monitoring. Automation should continue to play a key role in SIC 226 as the industry seeks to become less labor intensive.

Strategic conservation strategies center on the application of high efficiency motors and improved control systems to reduce electricity consumption. Industrial process heat pumps and extended process heat integration have broad applicability across this sector.