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ADVANCED ADHESIVES REPORT
Your corrugating newsletter from Harper/Love Adhesives Corporation

Nineteenth-century fashion sowed the seeds of modern corrugating equipment

by Bill Kahn

In the mid-to-late 1800s, in both England and the United States, ruffles or flutes were very popular as decorations for women's and children's clothing, especially for collars, cuffs and petticoats.

This concept was also adapted to generate unfaced corrugated paper to replace plain paper in the cylindrical liners used to form the shape of top hats worn by gentlemen. The new fluted cylinder was stronger and its flutes provided cushioning in the sweatband. This process was patented in England in 1856 by Healey and Allen.

Demand for an efficient method to form and press flutes led to the development of several different types of fluting irons. The industry saw over 40 patents issued for various fluting irons between 1873 and 1878 in the United States.

Evolution of the fluting iron

Development of fluting irons advanced through three basic types:

The earliest models consisted of a flat, fluted plate and a fluted rocker. The rocker was heated and used to iron the cloth on the flat base plate (photo, left).

Second-generation fluters employed a fluted roll and a matching flat plate. In this design, heat was provided by heated metal plate placed inside a cavity in the fluted plate (photo, right).

The ultimate pattern consisted of two fluted rolls operated by a hand crank (photo, upper right). This approach is obviously the precursor to our modern single facer. Both rolls were hollow, which allowed for the insertion of heated metal rods (inset). The pressure between

the upper and lower fluted rolls was controlled by spring tension or other mechanical devices. The flute size of these rolls closely resembled the flute size we know as B flute. It is easy to see in this design the beginnings of modern corrugating equipment.

Early packaging applications

Unfaced corrugated paper made on a fluting iron proved to be an excellent cushioning material for packaging glass products. In 1871, A.L. Jones won a patent for using unlined fluting material to protect vials and bottles.

While the first corrugated box was made in 1894, the material was not used for freight shipment until 1897, when lamp chimneys were shipped wrapped in the Climax corrugated wrapper, produced by the Hinde and Dauch plant in Sandusky, Ohio.

Corrugated boxes were approved for rail shipment of cereal boxes in 1903 and this jump-started the market for corrugated production. By 1910 there were at least 50 companies in business making either corrugated or solid fiber boxes.

A short history of paper making

The history of paper is a story of continuous innovation, discovery, and improvement

by John Kohl

In 3000 BCE, the Egyptians created writing materials by mashing wet papyrus reeds and layering them into mats. The mats were pounded thin and allowed to dry in the sun, forming a good surface for recording information. These papyrus sheets were laminated mats and not really what we would call paper.

In 105 CE, a Chinese court official named Ts'ai Lun claims to have invented paper making from textile waste using rags and plants as a source of fiber. This is considered the birth of paper making as we know it. He developed the process of cooking the materials together in a vat and then lifting a screen through the mixture to catch the fibers. The thin layer of fiber was allowed to dry into what we would recognize as paper.

Later Chinese papermakers developed a number of other innovations that include sized, coated, and dyed papers. They also developed paper treated to protect it from insect infestation, and a method to use bamboo fiber that was extracted from the stalks by cooking with lye.

By 610 CE, the Chinese method of paper making eventually spread to Korea and Japan. The knowledge gradually spread to Central Asia and India where small paper mills quickly sprang up. The use of old rags for raw material gave this so called "Arabian" paper very poor quality.

Currently, paper machines are running over 2000 m/minute—a long way from the few sheets per day made by hand 2000 years ago.

Paper comes to Europe

The craft eventually spread to Italy where the Italian papermakers improved the techniques and processes while still using rags as the primary stock. In the 13th Century the Italians were the first to develop the use of water power for stamping mills, wire mesh molds, the paper press, dip sizing, and drying the sheets on a rope like spaghetti. All these Italian innovations were precursors to modern paper machines.

During the 14th Century, the craft spread to Europe where the first papermill was opened in Germany in 1390 by Ulmann Stromer.

During the 15th and 16th Centuries, paper making spread throughout Europe. These mills could produce up to 4,500 sheets of paper in a normal 13-hour work day with the use of water power and mass labor in 4-four- man teams per vat.

Technical innovations and progress continued in the 17th century. The method for smoothing the sheets by hand with a creasing knife or stone was replaced with a smoothing hammer.

At the end of the 17th Century, a more efficient beater for fiber extraction was developed called a Hollander Beater. This would replace the stamping mills which had been used for more than a hundred years to pound and shred the raw materials for fiber extraction in the vats.

Printing spurs demand

The invention of printing with movable type soon led to a huge demand for paper and caused a shortage of raw materials to produce it. The search for substitutes for the rags that were used for paper making would last decades. The invention of ground-wood pulp by Saxon Keller in 1843 would be the first step toward solving the problem. Then in 1854 the method of chemical pulping was patented by Mellier Watt. Together these two methods would replace the rags as raw materials permanently.

During the 18th Century there was a push to step up production and to have more work performed by machines. This industrialization culminated with the design and construction of the first paper machines. The initial model was the vat that was used by J.N.L. Robert, who is credited with building the first flat screen paper making machine, in 1798. This was further improved on in England by Donking and the Fourdrinier brothers.

Soon other types of machines were developed, such as the Dickinson's cylinder machine. This type of machine transported the moulds on an endless chain and transferred or couched the sheets onto a continuous felt belt. These flat-screen and cylinder machines were further improved to include a dryer section. This led to increasing the width of the web that was produced and higher production speeds.

This modernization led to the end of lower-performing paper mill operations that could not compete with the quality and efficiency of the new equipment.

Technical advances in modern times

The paper industry in the 19th and 20th Centuries evolved through five partly overlapping periods, each marked by definite trends.

In the first stage, from about 1800 to 1860, all the work previously performed by hand was now done by machines. This included rag preparation, the use of fillers, and pulp beating. This period was the further development of the paper machine with all of its various parts, and the

machines required for finishing the paper.

During the second period, from 1840 to 1880, efforts were made to develop rag substitutes on an industrial scale. The first ground wood pulp and chemical pulp methods were developed and industrial ground wood and chemical pulp mills were built.

The third stage, from 1860 to 1950 was marked by increased web width and higher working speeds. The use of electric drive motors and improvements to other machine parts occurred. Machines designed for the production of specific paper and board grades (for example the Yankee cylinder and multi-cylinder machines) were also developed. The web width grew from 85 cm (1830) to 770 cm (1930), and production speeds rose from 5 m/min. (1820) to over 500 m/min. (1930).

The fourth stage, from 1950 to 1980, brought further increases in web width and working speeds. There was also the use of new materials (thermo-mechanical pulp, de-inked recovered paper, new fillers, processed chemicals and dyes). There was new sheet forming options with twin-wire formers, neutral sizing, and automation. This led to mills specializing in certain types of paper and the development of new paper grades.

The fifth stage, from 1980 to 2000 and beyond, sees the evolution of new sheet-forming principles with the use of fluid boundaries between paper and non-woven fabrics, and the chemical pulp processes seeing improvements. Currently, paper machines are running over 2000 m/minute, a long way from the few sheets per day made by hand 2000 years ago. ■

Two additions to Harper/Love technical field staff

Skip Gatrell has joined Harper/Love as a technical service representative. Skip has over 45 years of industry experience, having worked for St. Regis/Georgia Pacific in a variety of positions over his lengthy career. He has also been a Technical Service Representative for a specialty adhesive company for the past 10 years. Skip will continue to live in Akron, Ohio, and will service Harper/Love customers primarily in the Ohio, Indiana, and Michigan areas.

Mark Parrett joins the Harper/Love technical staff to help service customers in the Illinois, Iowa and Minnesota areas. Mark has almost 20 years of industry experience with Menasha, Inland and also a recent stint with a specialty adhesives company in the Midwest. Mark will continue to live in the greater Chicago area.

Milestones in corrugating history

1871 Patent issued to Albert L. Jones for fluting a single thickness of paperboard to afford cushioning for bottle wraps.

1873 Second patent to Jones for a box made by folding the material described in initial patent. Corrugating was done on a pair of hand-crank driven fluting rolls.

1873 Jones sold both patents to Henry Norris whose firm Thompson and Norris was acquired by Hinde & Dauch.

1874 Patent issued to Oliver Long to glue a liner to one side of the fluted material to keep it from stretching out. This created the single face that we know today. Patent was sold to Robert Gair whose company was the predecessor of Continental Can's Container Division—now Smurfit-Stone.

1882 Robert Thompson issued a patent for a combination of two machines a single facer and a double facer. This was still a batch-type operation.

1895 First machine that would make single and double-faced board continuously was patented in Anderson, Indiana.

1895 C.F.Langston built the first commercially built single facer for David Weber in Philidelphia, Pennsylvania.

1900 An improved continuous machine with steam hot plates and steel chain belts for drying the double face was built. This machine speed was 10 feet per minute.

1903 Corrugated boxes approved for rail shipment of cereal and later (1905) for shipment of fruit jars.

1908 Typical Langston corrugator was 63" wide and had speeds of 20 to 30 feet per minute.

1908 Langston receives patent for the first double facer to utilize cotton belts to draw paper over steam chests.

1914 The "Pridham Decision" by the ICC removes the 10% penalty for shipping via corrugated and the industry surged.

1918 H.Krannert (now Temple-Inland) started making ventilated corrugated boxes for shipment of baby chicks.

1918 By the end of WWI corrugators were 63" wide and running at 75 feet per minute.

Leaders in the science of making good adhesives better™

Harper/Love Adhesives Corporation
11101 Westlake Drive
P.O. Box 410408
Charlotte, NC 28241-0408
800-438-3066 • www.harperlove.com
e-mail: salestech@harperlove.com

Use Calciban™ to keep your glue rolls clean and efficient.

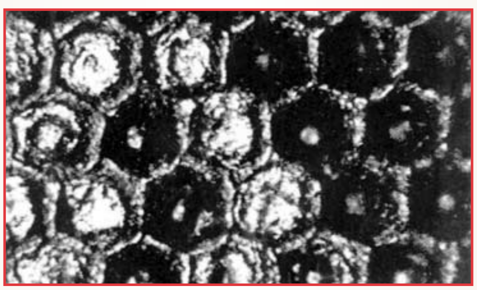
Calciban prevents calcium buildup that can cause adhesive transfer problems.

Inorganic compounds in your adhesive water can cause calcium buildup on your glue rolls. These deposits, which appear as a milky-white haze on the roll surface, clog cells and reduce the amount of adhesive the cells can carry. This creates a risk of bonding problems and increased waste.

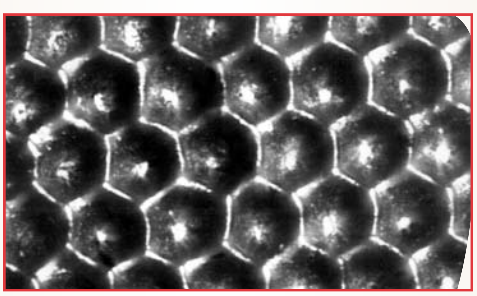
In also means lost productivity when you need to shut down for time-consuming cleaning operations.

Just 3 to 6 ounces of Calciban in a 700-gallon batch of adhesive can prevent this buildup and the problems it creates. It can be post-added to the batch, or to starch in a storage tank.

At an investment of only about $1.00 per batch, Calciban is low-cost insurance against the problems of calcium buildup.



***The problem:** Inorganic compounds in adhesive mix water can clog cells in your glue transfer rolls.*



***The solution:** Used regularly, Calciban keeps glue-roll cells clean and efficient, for proper adhesive transfer.*

Other uses for Calciban:

- **Add to cooling water in closed-loop systems**
- **Add to flexo wash water**
- **Add to boiler feed water**

To order, contact your local Harper/Love representative or call us toll free at 800-438-3066.