IN·TOUCH®

Published by the Polyurethane Foam Association www.pfa.org

Volume 9 | No. 1 | August 2001 (Revised 2019)

Flexible Polyurethane Foam Fabrication: Equipment and Capabilities

This issue serves as a companion piece to INTOUCH® Volume 1, Number 5, entitled *Foam Fabrication* and INTOUCH Volume 10, Number 1, entitled *Foam Fabrication: Adhesives.*

In the first issue of INTOUCH, *Flexible Polyurethane Foam: A Primer,* (Vol. 1, No. 1) we discuss the complex chemical processes that result in buns of slabstock foam. Once slabstock foam is cured, it is typically fabricated in various ways to make it commercially useful. Foam fabrication may may simply be cutting the foam to the proper size, or it may involve bonding and shaping several layers of foam and other materials together to get a composite that will provide a specific level of performance.

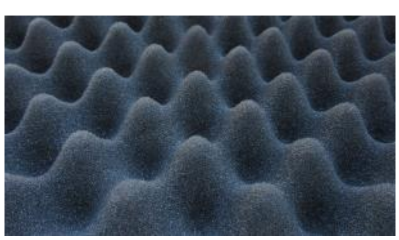
The role of foam fabrication in the business model is not the same for all foam producers.

As fabrication machinery and techniques advance, FPF producers are continuously adopting new fabrication technologies to meet their customers' needs for quality, economics, ease of use and design versatility of the finished product.

Suppliers of fabrication machinery have in turn developed mechanical means efficiently producing a great variety of shapes and forms with close tolerances. Some slabstock producers perform fabrication themselves. Others prefer to concentrate on product development, foam production and inventory management, and distribute to companies that supply fabricated forms to customers in the furniture, mattress, auto, packaging and household goods sectors.

It is also important to keep in mind that the simplest way to create a shape is usually the most economical and best way to serve customers.

Traditional cutting and shaping methods using vertical bandsaws, horizontal slitters, convoluters and basic hot wire cutters continue to serve the majority of customer needs. And it is within these machinery categories that the most significant advancements have occurred.



Loopers speed up the process of splitting long blocks of foam.

Loopers

Loopers split long blocks of foam into smaller, more manageable sections by feeding through a cutting portal using a looped transport system. The cutting unit is lowered to the required foam thickness after each block circulation. A swiveling cutting unit ensures the ideal cutting angle.

CAD-CNC vertical saws are able to cut buns or sheets and a variety of materials such as FPF, bonded foam and fiber.

Vertical Cutters

Computer assisted automation is common in FPF production facilities. CAD-CNC controlled fabrication equipment makes it possible to perform repetitive cutting patterns using high-speed vertical saws without the aid of an operator. Further advancements include the possibility of adding a movable saw head to allow a piece of FPF bunstock to be cut from several directions and angles to further speed the fabrication process. With sawing capability of up to five vertical feet, FPF buns can be efficiently reduced with automated equipment to desired part sizes within tolerances that are difficult to consistently achieve using manual operation techniques.

Horizontal slitters allow fabricators to reduce large FPF blocks to sheets for applications such as mattress toppers.

Horizontal Slitters

Semi-automated and fully-automated horizontal slitters and splitting equipment enable users to quickly process large foam blocks into sheets of varying thicknesses. CAD-CNC capability enables operators to store multiple cutting programs and the machinery allows execution of multiple cuts of different thicknesses. Processing speed and accuracy of the cuts is enhanced with auto sensing devices that identify block edges and allow the knife blade, bandsaw or wire to reverse itself in an optimum fashion for best yield, minimizing waste. Vacuum rotary tables hold the foam in place, allow the FPF to be cut efficiently and leave the cut sheets in a manageable stack.

Hot Wire Cutters

For intricate shapes, a hot wire cutter is often used to cut and shape some types of FPF. Hot wire cutters are available as manually operated tools or can be electronically computer controlled. For contoured, 3-dimensional shapes, there are automated machines with multiple heated wire harps. A very fine nickel-chromium cutting wire is heated with electricity. The heat from the wire melts the foam without actually touching it. Because of the melting process, finished edges are generally very smooth. Hot wire cutting is not appropriate for all types of FPF and a ventilation hood should be used to exhaust fumes.

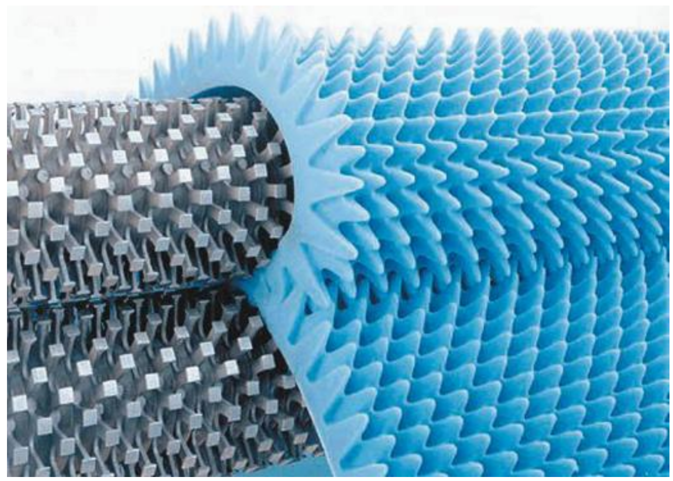
Compression cutting is an efficient alternative to foam molding to produce smooth, contoured shapes.

Compression Cutting

Compression cutting allows FPF bun stock to be fabricated into shapes normally associated with a foam molding process. This technology is sometimes appropriate when a large number of FPF parts must be contoured into a particular shape. To begin the process, an impression of the desired part is cast into an open cavity. Usually the cavity is manufactured from aluminum or a rigid composite material. The FPF product is positioned above the cavity and pressure is applied, forcing the foam to fill the cut-out. A horizontal knife is used to cut the foam flush with the surface of the cavity resulting in A and B parts. Part A is shaped as the cavity dictates and Part B is shaped as the negative image of the cut-out part. Compression cutting requires sophisticated tooling to shape the cavity and precise control of the force applied so that the foam properly fills the cut-out shape. This fabrication technology is particularly useful in the production of contoured cushions for automobile seating, armrests and headrest pads and for anatomically shaped office chairs. In these applications, large quantities of the specified parts help offset the compression cutting tooling costs.

Convoluting And Profiling

Most people are aware of the dimpled FPF pads used to add surface comfort to mattresses and pillows. These end products are produced using convoluting and profile cutting equipment. Convoluted pads result from passing a layer of foam between two opposing cutting rolls. As with compression cutting, A and B surfaces result, but in this case, the patterns on both surfaces are the same, only offset. Convoluting equipment can be set up to produce several different continuous patterns including waves, vertical channels, and dimples with a range of slopes and angles. A convoluting cutter is made up of a number of cutting wheels aligned side-by-side and fixed in place along the convoluting roller. Convoluting cutting wheels must nest on the top and bottom. However, wheels with differing patterns can be arranged across the same roller to create products such as a mattress pad channeled along the perimeter and having dimples in the center. Because convoluting wheels are relatively expensive and alignment is often difficult, your foam supplier must provide information on the availability of profile patterns.



Convoluters use cutting dies to efficiently produce profile shapes from sheets of foam.

Waterjet Cutting

One limitation to the various fabrication techniques above is the inability to cut a pattern inside another pattern, e.g., a doughnut with a hole inside. To do that, there must be a way to enter the foam, piercing it from inside the cutting pattern. One way to achieve intricate cut-outs inside patterns is to use a water jet cutter. To cut FPF, a very fine water stream is forced through a coherent jet nozzle under extremely high pressure. The resulting wire-like water stream has precise cutting capability. Because FPF is a soft, porous product, it tends to absorb energy very quickly causing the water jet to diffuse. As a result, water cutting is limited to a narrow range of flexible foam densities and firmnesses and is not usable with foams having more than about six-inch thickness. Another drawback is the fact that FPF products absorb moisture so drying time after cutting must be allowed.

Due to specialized nature of water jet cutting, this fabrication technology is practiced by a limited number of fabricating companies. If you require water cutting, your foam supplier can help you locate an appropriate resource.

Laser Cutting

Much like water cutting, laser fabrication supports the cutting of a pattern within a pattern. It is also a specialty technology and application with flexible foam products is limited. Since laser cutting burns the foam, care must be taken to properly exhaust resulting fumes.

Safety Procedures

Care should be taken when operating fabricating equipment. The American Standards Institute (ANSI) published B151.28-1995 to set forth mandatory safety requirements for machines that cut, slit or buff plastic foams, pertaining to their manufacture, care and use. The standards also apply to such fabrication equipment that has been modified or remanufactured.

If you are involved in FPF fabrication, you should be familiar with the specific requirements of this standard. **Note:** The standard does not apply to hot wire, laser or water jet cutting machines. Caution should be exercised in hot wire cutting, laser cutting, bonding, laminating or any other process that exposes FPF to significant heat sources. In such processes, potentially dangerous fumes are emitted which should be exhausted through properly engineered ventilation systems. FPF is flammable and will burn when exposed to open flames or other significant heat sources. Once ignited, FPF can burn rapidly, generating great heat and potentially toxic gases that can be harmful or fatal to people if inhaled in sufficient quantities. The fabricator should be guided by a Safety Data Sheet (SDS) from the foam supplier to determine the proper procedures for handling the foam and to be aware of any special requirements for handling fabrication steps.

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Summary

1. The simplest way to create a shape is usually the most economical and best way to serve customers.
2. Fabrication technology advancements make it possible to create a variety of shapes and forms with extremely close tolerances.
3. Computer assisted automation in now found in many FPF production facilities.
4. Vertical saws, horizontal slitters and hot wire serve most FPF fabrication needs.
5. Compression cutting, convoluting and profiling, water jet and laser cutting serve specialized fabrication needs.
6. A number of safety procedures must be followed in fabricating FPF including maintaining safety guards, performing proper maintenance and using care in machinery operation.
7. Caution should also be exercised when fumes are emitted and when FPF is exposed to a significant heat source.

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