TELSONIC
ULTRASONICS

Ultrasonic cutting and welding

Coffee pods that pack a punch

PLASTIC WELDING | METAL WELDING | CUTTING | CLEANING | SCREENING

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Coffee pods are on trend. They are particularly popular with consumers due to their full-bodied flavour and the ease with which they allow drinks to be prepared (Fig. 1). These major benefits are derived from the types of coffee used, how easy the pods are to use, grinding fineness, precise portioning, the sealing in of the flavour inside the pod and, above all, the brewing pressure in the coffee machine. Coffee machines that use pods are unlike "normal" coffee machines. Instead of the hot water dripping through the ground coffee, it is pressed through under pressure and can thus absorb the full flavour of the coffee. The filter felt inside the pods plays a very important role in the quality of the finished product. Cutting and welding systems that work with ultrasonics lend themselves to the precise cutting of the small filters and their fastening inside the pod. They are the perfect choice for these applications based on reasons of cost, technology and, last but not least, aesthetic and culinary considerations.

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01 Coffee pods with filter felt
02 Ultrasonic cutting and welding systems

The term "ultrasonics" is used to describe sound frequencies above the hearing threshold, i.e. above around 20 kHz. Frequencies in the range of 35 kHz are used for cutting and welding in this context. They are produced by a piezo-converter that causes a sonotrode to vibrate at high frequency, which is particularly effective in resonance yet requires little power at the same time. Clean cuts and high-strength bonded joints can be produced without exposing either the product or its environment to high thermal stress. To create high-strength bonded joints, acoustic vibration sets the molecules of the parts to be connected in vibration, generating heat that "breaks" the material boundaries at the points of contact and fuses the materials together.

Technically and economically impressive

Ultrasonics offers a whole host of further benefits, meaning that this technology can often provide a more cost-effective alternative to established processing technologies. Packaging specialist TME SpA, for example, which also produces

packaging for coffee pods (including for coffee manufacturer Sara Lee, whose Dolce Gusto pods have captured the global market) has been able to reap these benefits.
Today, the manufacturing of nonwovens for the filters in the base of the coffee pods in high unit quantities demands a process that is both cost-effective and reliable. Mechanical cutting and joining processes have proved to be as impractical as laser technologies. Cutting, for example, would often produce filter edges that were frayed or melted on. Although this did not impair the function of the filters, it did affect aesthetics and in some cases even taste. Furthermore, the short cycle times were virtually impossible to achieve. Laser cutting and joining techniques in particular were far too cost-intensive, as additional extraction hoods had to be installed for the combustion gases. By contrast, the ultrasonic systems used for cutting and joining today (Fig. 2) are impressing from the point of view of technology and cost:

Quick and clean: Cut'n'seal

The filter felt has several layers. First, the individual layers of the felt are joined together and the filter is cut out using ultrasonics. This process, which is known as cut'n'seal, is performed by 14 sonotrodes from Telsonic AG which, like the welding anvils located underneath them, are perfect for the application. The cut'n'seal process takes just 200 ms. As it uses no cutting media, it is both clean and eco-friendly. By contrast with laser cutting, there is no loss of material, no chips and no combustion gases. The cut edges are smooth and clean, so there is no need to rework the product. To top it off, ultrasonic cutting is also quiet, eliminating the need for any noise protection measures.
As part of the cut'n'seal process, the filters are placed inside the pods, creating the perfect fit, before being joined to the pod – also with the help of ultrasonics. At this station too, 14 welding sonotrodes work in parallel at a similar speed to the cut'n'seal process, delivering equally clean results. The system is able to produce 800 coffee pods every minute. The ultrasonics process is reliable and safe as it depends on only a few parameters that can be easily adjusted and monitored. These parameters include the welding energy, force and time, as well as the maximum power (P_{max}).

Easy to integrate into the system

The ultrasonic equipment consists of four components that can be easily integrated into coffee pod production lines: the ultrasonic generator that generates the high-frequency electrical vibrations, the converter that converts them into mechanical oscillations, a booster for amplification and the sonotrode. The latter introduces mechanical oscillation into the workpiece. Converter, booster and sonotrode have a fixed mechanical coupling and their acoustic resonances are tuned to one another.
The generator has a key function, as it not only generates the high-frequency electrical vibrations, but also provides the connection to the higher-level automation technology. State-of-the-art bus systems enable welding parameters to be adapted and results to be read out in real time, for example. In the production equipment for coffee pods, for example, this is achieved via EtherCAT and the data is used for statistical evaluations. The external setpoint defaults for amplitude, time, energy and maximum power, as well as soft start for large sonotrodes and frequency autotuning, are just some of the additional features that maximise process stability.
The cut'n'seal process provides the ideal technology for punching out the filter felt and joining it to the coffee pods, enabling high unit quantities to produced cost-effectively and with absolute precision. Weld and punch quality is constant and all process parameters can be monitored seamlessly during production and statistically evaluated if necessary.

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