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# A Welding Challenge

## *High Tightness for Plastics that Strongly Dampen Ultrasound*

If several unfavorable conditions come together, the demands on joining technology grow, especially for medical technology products. Not only do they have to be leak-proof, but also satisfy requirements for validated and traceable welding processes.

Polyethylene (PE) is a very soft plastic that has a high dampening effect to ultrasonic vibrations. As a result, welding amplitudes have to be bigger than 40 µm in order to melt the material. Before there were ultrasonic generators capable of delivering such high power with long-term reliability, it was not possible to handle such welding applications by ultrasound. Besides the power request, the size of the part also plays an important role because the larger and more complex the dimensions, the harder it is to achieve an uniform amplitude distribution across the sonotrode surface to initiate ultrasonic waves correctly in the joining zone. A specific case involved PE secretion containers of the type used for collecting body fluids in hospitals (**Fig. 1**).

Specifically, the task faced by the Colombian medical equipment manufacturer Bioplast was to weld a high density polyethylene (HDPE) cap to a body made of a HDPE and LDPE mixture. Difficult jobs of this type are often realized utilizing hot plate welding. However, this technology does not provide sufficient quality-relevant processing data to satisfy the high production requirements in branches such as medical technology. In this case, the execution was achieved successfully by ultrasonic welding. The specifications were as follows:

- Cap and container have to be welded tightly enough for the bottle to withstand a drop from 1.5 m and pressure shocks up to 0.8 bar.
- The size of the circumferential weld seam (**Fig. 2**) requires a sonotrode design that evenly provides the high amplitude needed.
- The welded parts must not have any marks, thus the welding tool contact surface must be carefully finished.
- The height of the fixture has to be adjustable to handle different heights in the product line (**Fig. 3**).
- The process must ensure validability and traceability.

**Fig. 1.** Secretion bottle with cap: Welding the materials used (HDPE and LDPE) tightly proved a challenge (© Herrmann Ultraschall)

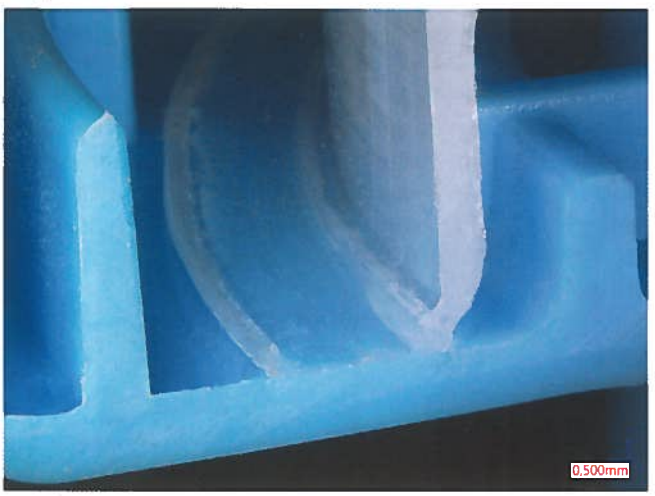


**Fig. 2.** Circumferential weld seam: a round blue cap is welded onto a transparent secretion bottle (© Herrmann Ultraschall)

In essence, three factors were decisive in determining whether the application could ultimately be realized. The following sections take a closer look at the details.

### *Weld Force Profiling and Graphical Representation of the Parameters*

Advantages of ultrasonic welding are the extensive parameterization options and their visual representation. The capability to vary welding force during the process helps at challenging materials and geometries. The HiQ Dialog 6200 ultrasonic welding machine from Herrmann Ultraschalltechnik used also offers weld force profiling for up to three weld force levels: at the low welding force F1, the material was softened slowly, and at welding forces F2 and F3, a welding ramp was created to reach the full force required to achieve the required tightness and strength.

In addition, the course of the weld over time can be graphically displayed for various parameters. A 15-inch screen (**Fig. 4**) facil-

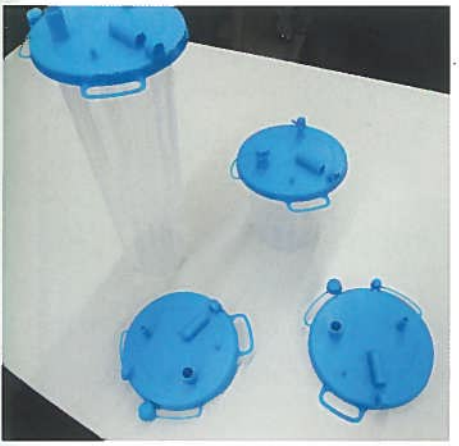

**Fig. 3.** Product line: a vertically adjustable fixture was required to compensate different heights (© Herrmann Ultraschall)

itates clarity. The display on the user interface shows any deviations within the process curve for further process optimization. A decisive indicator here is the course of the joining speed curve (distance over time). Via evaluation of the parameter graphics

- joining distance (RPN stands for the relative welding distance),
- amplitude,
- frequency,
- power, and
- force

the lab team at Herrmann Ultraschall determined the process setting (**Fig. 5**).

## The Ultrasonic Generator

The fully digital ultrasonic generator supplies 6200 W power and collects more than twenty measurement values periodically and discretely 10,000 times per second. This means that the welding process can be controlled quickly and sensitively. The ramping up and down of the ultrasonic signal can be modified, and planned sequences are precisely reproducible.

The output amplitude can be infinitely programmed from 1 to 100 % and adjusted precisely to a plastic material with a high dampening coefficient. The control electronics with a sampling rate in the megahertz range (approx. one value per microsecond) can maintain amplitude accurately under all operating conditions, including the present case of a circumferential weld seam with the desired weld seal and the high amplitude required by the material.

## Tracking Software for Traceability

Among the most important requirements in medical technology are process reliability and traceability. As additional software, the module FSC was integrated in the user interface of the ultrasonic welding machine HiQ Dialog. This software records any changes in system parameters and user actions in electronic auditing trails. In combination with the software module DataRecorder that can store process results from the ultrasonic generator directly to a PC, both the weldings and user actions (e.g. parameter changes) can be recorded completely in what amounts to a holistic production logbook.

For this, the FSC software offers user authentification by password and image, user management and control of user

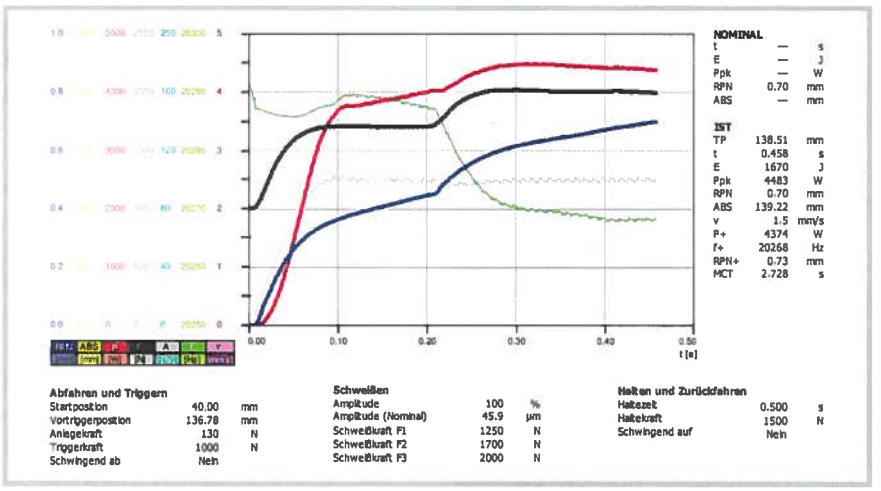


**Fig. 5.** The courses of the parameters joining distance (RPN), power (P), and force (F), as well as the correct selection of amplitude (here: 45.9 µm) and frequency (here: 20,268 Hz) are the keys to successful process settings (© Herrmann Ultraschall)

**Fig. 4.** HiQ Dialog 6200: The ultrasonic welding machine has a vertically adjustable tool holder and can display the weld course graphically on its 15-inch screen (© Herrmann Ultraschall)

permissions. When processing parameters are changed, previous values can be restored easily. The software also identifies unauthorized manipulations and corrupt data sets. All of these are prerequisites for fulfillment of the important global guideline CFR 21 Part 11 of the US-FDA (Food and Drug Administration) for the product development process in the pharmaceutical and medical sector. ■

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