TELSONIC
ULTRASONICS

Rapid cooling reduces production cycle times

Automotive industry benefits from ultrasonic welding tools

PLASTIC WELDING | METAL WELDING | CUTTING | CLEANING | SCREENING

Bronschhofen (Switzerland), 10/2019

In the automotive industry, ultrasonic welding has proven itself to be a gentle and financially sound method of joining plastic and metal parts to one another, and assembling them. What helps it stand out is the lack of adhesives, connection elements, or solvents it uses, making it a highly eco-friendly and efficient process – even in applications that require short cycle times, such as robotics. In these cases, innovative cooling concepts allow for cycle times of less than two seconds within fast production lines.

Ultrasonic riveting is usually the method of choice in automotive industry tasks that combine individual components to create larger modules. The plastic becomes plasticized through the conversion of ultrasonic energy into heat specifically at the contact point. It then has pressure applied in order to shape and press it. Once the welding points have cooled down, what remains are strong bonded joints without either the product or its environment having been exposed to high thermal stress. To accelerate the process and shorten cycle times as a result, riveting tools are commonly used to cool the parts known as sonotrodes. There are several ways of doing this, but they offer varying degrees of efficiency.

Boosting efficiency when cooling sonotrodes

One option is to blow compressed air at the sonotrode, but this method takes a long time – and with the sheer amount of compressed air it uses, it cannot be called efficient. As a remedy, we have seen the emergence of sonotrodes with built-in cavities that convey the compressed air toward a specific point; in other words, the cooling air goes exactly where it needs to. This speeds up

01 Vortex booster with riveting sonotrode
02 Interior door paneling
03 Interior door paneling with multiple welding points

the cooling process and results in less compressed air being used. This solution does require a lot of structural work, however, especially if the sonotrodes are mounted on a robot. The compressed air connection needs to be secured directly to the sonotrode, which prevents the sonotrode from being replaced easily and therefore makes this an inflexible option. Whenever a product is changed, for instance, the compressed air lines need to be detached and reconnected each time. It is also important to remember that sonotrodes, although hard-wearing, are ultimately wear parts that will need to be replaced at some point.

The vortex booster

These drawbacks led ultrasonic specialist Telsonic AG to develop a different concept for sonotrode cooling: In its patented solution, the compressed air connection is on the booster rather than the sonotrode. An ultrasonic welding system essentially consists of a generator that produces the ultrasonic source and a converter that uses piezo-ceramic components to convert the ultrasonic source into mechanical vibrations. These vibrations are then amplified by the booster and transmitted to the sonotrode.

There are two benefits to using the booster for cooling purposes: Not only is there no need to detach the compressed air connection when replacing the sonotrode, but cooling is also more efficient. These are exactly the advantages that the vortex booster offers. In this solution, the compressed air (measuring a maximum of 10 bar) is conveyed to the booster and precooled. It is then decompressed and the Joule-Thomson effect is harnessed to reduce the air temperature even further (see separate box). Excellent examples of this technique can be found in everyday life – like the process of cooling soda water, soft ice cream, or whipped cream exiting a pressurized container, or snow cannons blasting artificial snow on to pistes.

The sonotrodes that are compatible with the booster feature specially designed cavities that create an equivalent effect to a Ranque-Hilsch vortex tube. Here, low-pressure zones with fast vortex circulation separate the cool air in the middle from the warmer air on the wall surfaces of the sonotrode. The cool air stream from the middle of the sonotrode is then directed immediately at the tip, cooling the riveting point faster and making the process more efficient. Practical applications have demonstrated that this patented cooling process reduces cycle times in robot-assisted ultrasonic riveting by almost half – and in some cases makes them less than two seconds long.

by Andreas Hutterli, Product Manager at Telsonic AG

Intelligently harnessing physical effects

The Telsonic patent is based on a temperature gradient in the compressed air developing inside the cavities in the vortex booster and the sonotrode. First, the compressed air that enters the vortex generator is cooled by means of the Joule-Thomson effect. The air then flows through the custom-designed cavity in the vortex booster and sonotrode, as it would in a vortex. This creates results such as the air remaining in place for longer. The Telsonic method therefore cools much more efficiently than other established sonotrode systems, which only work with compressed air that has not been cooled.