Big Splice ultrasonic welding
Large pipe connections enable new applications

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01 The Telsonic system for welding thick cable cross-sections using ultrasound utilises a combination of different technical approaches: PowerWheel technology, measurement of the actual welding force applied, a generator output of 14.4 kW for short cycle times, special masks and tools that prevent cables from slipping, and much more.
Combinations realised to date: up to five copper cables with a total cross-section of up to 280 mm².

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Making splices with ultrasound – basically welding cables together – is now pretty common for low-voltage stuff and cables with small cross-sections. But high-voltage applications with individual cable cross-sections from 16 to 95 mm² could also benefit from this tech. Various research projects and further developments are therefore currently underway. Initial projects with cross-sections of up to 280 mm², known as big splices, have already been successful. This article highlights the challenges along the way, possible solutions, the advantages that can be exploited and what will be possible in the future.

Big splice applications

There are many applications in which ultrasonic welding of large cable cross-sections is required. The automotive sector, for example, could benefit greatly from this, both for passenger cars and for vans and trucks. This is because splices can save on expensive connectors, for example.

Here are two examples:

Electric vehicles today usually have a charging socket on the left or right side. Due to the length of charging cables, it is important to approach the charging station correctly so that the cable reaches from the charging station to the car's charging socket. A charging socket on each side of the car would be a significant improvement in convenience. Until now, however, this has required the manufacture of a cable for each side, each with a plug at the beginning and end, i.e. one for the connection to the charging socket and one for the connection to the battery.

If, on the other hand, the cables coming from the charging sockets on the left and right could be welded together in the middle using ultrasound and then routed to the battery with a single cable, one plug and one piece of cable could be saved. The same applies to the power distribution from the battery to the drive systems with multiple motors. Here, too, a splice could save on connectors and cables. However, for ultrasonic welding of thick cables to work reliably, a number of challenges must be overcome.

02 Shimaalsadat Mostafavi, Head of Metal Lab & Application Architect at Telsonic: 'We will soon be able to weld aluminium cables as well. And even with cross-sections of 280 mm², we are still a long way from reaching the limits of what is possible.'

Challenges in ultrasonic welding of large cross-sections

In typical applications, three to five wires are welded together during strand welding. One challenge here is to ensure that the connections are welded reliably. The wires must always be positioned identically in the longitudinal and transverse directions at the node. It is also important to avoid 'side splices', i.e. wires that slip and are welded side by side instead of on top of each other.

The optimal entry of wires into the node when wires are positioned on top of each other is also relevant. Another challenge is the high power required for thick wires in order to completely penetrate the weld node and produce a consistently high-quality connection. At the same time, however, heat pockets must be avoided so that no individual wires are damaged. When very different cable cross-sections come together in a node, it is not trivial to determine the optimal welding parameters. The insulation of cables should also be protected from heat and spreading in the entry zone to prevent tears.

Splicing up to five cables with a total cross-section of 280 mm² using ultrasound

The list of challenges is therefore long. Nevertheless, the ultrasound experts have succeeded in developing a system for their TelsoTerminal TT7 ultrasonic welding machine (Figure 1) that reliably welds together various combinations of large cable cross-sections.

The projects realised include, for example, welding four cables with a cross-section of 70 mm² each (i.e. 280 mm² in total, see Figure 1), four cables of 50 mm² each (200 mm² in total) and one 75 mm² cable in combination with three 25 mm² cables (150 mm² in total) (Figure 3). 'These are just a few specific examples,' reports Shimaalsadat Mostafavi (Figure 2), Head of Metal Lab & Application Architect at Telsonic. 'In general, we can currently weld any combination of up to five different copper cables with a total cross-section of 280 mm² using ultrasound. Soon, we will also be able to weld aluminium cables of this size as splices. And we are still a long way from reaching the limits of what is possible in terms of cross-sections.'

The Swiss have achieved this by combining various technologies. A key factor is the use of PowerWheel technology, which applies amplitude and force centrally in the middle of the splices. Welding is carried out in a rocking rolling motion directly above the joint area. This ensures that the maximum amplitude is always in the middle of the welding surface and that the power is applied precisely within the welding zone.

This not only ensures ideal penetration of different cable cross-sections, it also protects the cable insulation. An integrated displacement and force measurement system also monitors the accuracy of the joining process. To ensure that the process is completed quickly even with large cable cross-sections, a generator output of 14.4 kW ensures short welding and cycle times. With the ultrasonic welding machine, cables can be fed into the welding area from the left and right. This makes handling much easier, especially with large diameters. To prevent cables from slipping, they are held in position with special tools and masks. The entire process is made easier for the user by a user-friendly interface and various digital process supports. And because the data from the process is also relevant for its optimisation and the quality of the respective products, it is not only stored in the machine, but also transferred to the MES or automation systems via a standardised data interface.

As described at the beginning, numerous applications already benefit from the splicing of large cable cross-sections using ultrasonic welding. Nevertheless, Telsonic employees are very interested in finding out which other applications could benefit from this new technology. They therefore welcome feedback and further pilot customers who would like to test the system for their specific application. Interested parties are welcome to get in touch. It will certainly be exciting to see what other areas of application ultrasonic welding of large cable cross-sections will open up in the coming years.

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