# Advanced quality assurance in drawn-arc stud welding

For many years, drawn-arc stud welding has been a well-established process for welding shear connectors in composite construction and for producing steel components in solid construction. The outstanding advantages are high efficiency and safety. One basic rule is that the load-bearing capacity of a good stud weld is higher than that of either the stud or the work piece material.
The rules for inspection and testing of stud welds are laid down in the relevant norms and leaflets (DIN EN ISO 14555, DVS leaflet 0902, DVS leaflet 0904). However, most of these tests (bend test, radiographic test, macro examination) are destructive, and can therefore only be carried out on random samples. A complete proof of weld quality for each individual stud is not possible by these methods.

The quality of each weld first depends on the correct choice of parameters. Also, the welding equipment must be in perfect order, so that the set values are consistently reached. Finally, the work piece must be adequately prepared, for example by the complete removal of rust, scale and moisture.
Where any one of these requirements is not met, unacceptable irregularities in the welding zone cannot be excluded. Inadequate maintenance of the welding gun regularly leads to a growing inconsistency in the welding quality, involving the risk of operators getting accustomed to gradually deteriorating results. When the faults become obvious, costly reworking is necessary, at the worst a total failure of the weld will occur. Unfortunately, untrained personnel or operators not familiar with the details of stud welding are increasingly jeopardizing the reliability of the production process.

To provide manufacturers of welded joints with complete documentation of their stud welds, KÖCO offers an in-production process monitoring and documentation system with its INOTOP stud welding equipment. This does not by any means make destructive tests dispendable. On the contrary, the storage and evaluation of all actual values increases the transparency of process documentation, as is also stated in DIN EN ISO 14555, section10.5.3 under the heading ”Continuous process monitoring“.

First of all, the process monitoring system includes a measuring device that records the developing of welding current and welding voltage throughout the welding time with high-resolution graphics. After the welding time has elapsed, the welding energy and average values of welding current and welding voltage are calculated. By evalu-

ating the form of the curve, the calculation is adjusted to exclude the effect of voltage drop in the welding cables, so that only the energy of the drawn arc is shown, regardless of variations in the configuration.

An analysis of actual values measured following each weld for quality assessment purposes would certainly be beyond the capacity of any operator.

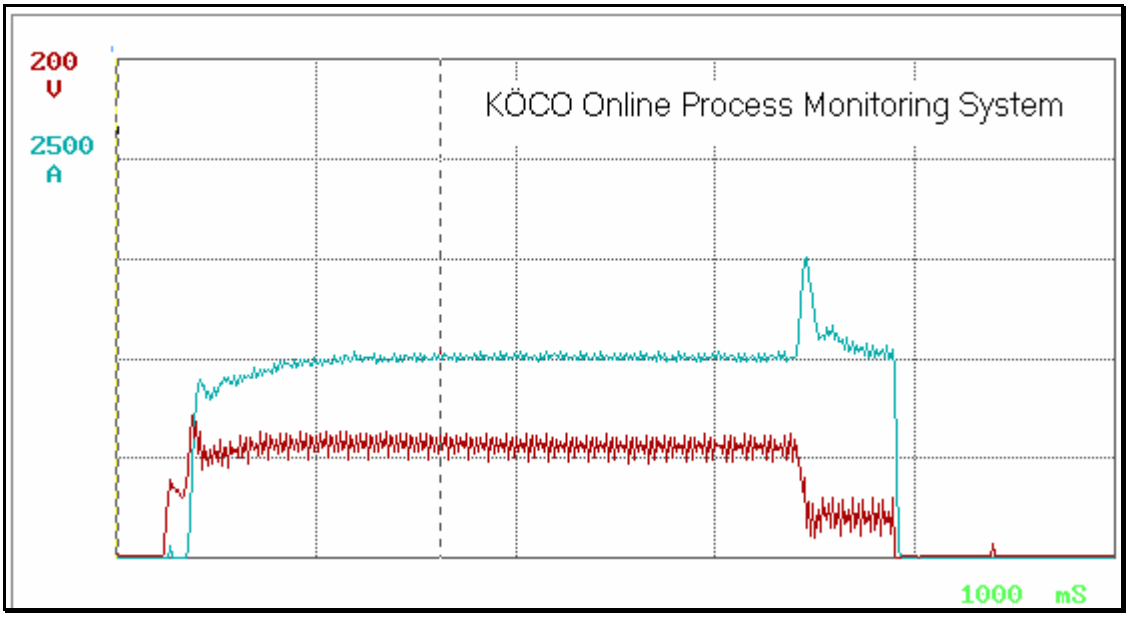
Therefore an evaluation unit is included in the process monitoring system which compares the actual values reached with stored reference values. If any one of the actual values deviates beyond the defined tolerance margin, the operator receives an immediate error signal, and continuation of work is only possible after acknowledgement of the signal. Thus the possibility of inadvertenly overlooking faults is excluded, even for operators working at a considerable distance from the power source.

Possible causes of faulty results are, for example, a lift that is too short (thus producing a drawn arc that is too short, leading to droplet short-circuiting, insufficient welding energy and faulty connections); failure of a mains phase due to capacity overload (resulting in a substantial drop in welding energy, destabilization of the welding process, splashing) and impediments to the movements of the piston (cold plunge, faulty connections, formation of pores).

The process monitoring system is of special interest in connection with the calibration of stud welding appliances, which is necessary on a regular basis according to DIN EN ISO 17662 (currently only drafted). The welding supervisor thus obtains information about the conformity of actual values with set values with virtually no additional effort on his part. Gradual deterioration of results caused by wear becomes visible as soon as it sets in.

For precise evaluation by statistical methods all parameters can be stored on one chip card. It is even possible to obtain a graphic record of the development curves of current, voltage and the movement of the stud.

Summary: The KÖCO stud welding process monitoring system enables processors to obtain a complete record of welding results achieved and to take immediate corrective action in the case of deviations beyond tolerance. Signs of wear are recognized at an early stage, the necessary calibration is easy to implement, and operation faults trigger error signals. Thus, the process monitoring system increases the reliability of the stud welding process.




Graphics of a stud welding process with 16 mm shear connectors. Current, time and voltage are instantaneous values at the position of the cursor; welding time and energy are valid for the whole cycle.

| 27.04.2004 | No. | Channel/set | Current | Time | Arc/volt. | Lift | Energy | Error code |
|---|---|---|---|---|---|---|---|---|
| 10:31:51 | | | /A | /ms | /V | /mm | /Ws | |
| 10:31:51 | 33362 | 1:19 | 1620 | 884 | 30,2 | 3,6 | 43249 | |
| 10:32:14 | 33363 | 1:19 | 1617 | 876 | 29,8 | 3,7 | 42211 | |
| 10:35:27 | 33364 | 1:19 | 1619 | 888 | 31,9 | 3,5 | 45862 | |
| 10:35:45 | 33365 | 1:19 | 1620 | 891 | 34,1 | 3,7 | 49221 | |
| 10:36:05 | 33366 | 1:19 | 1618 | 868 | 30,7 | 3,8 | 43116 | |
| 10:36:27 | 33367 | 1:19 | 1619 | 884 | 30,1 | 3,8 | 43079 | |
| 10:36:57 | 33368 | 1:19 | 1620 | 887 | 32,7 | 3,8 | 46988 | |

Sample printout of process monitoring for welding of 19 mm shear connectors. No deviations outside of tolerances have been found.