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ON LINE MONITORING FOR DEFECTS IN ELECTRIC ARC STUD WELDING

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ABSTRACT
The application of on-line monitoring system for recording main welding parameters during electric arc stud welding process at different electric arc stability changes is described in this paper. In the first part of the paper, the basics of electric arc stud welding process, and equipment for stud welding and process monitoring used in experimental part is described. In the second part of the paper the analysis of process parameters during welding with purposely induced instabilities is analyzed.
Keywords: electric arc stud welding, process stability, on-line monitoring

1. INTRODUCTION
The application of electric arc stud welding process is well known in different production areas, like boiler production, motor vehicle industry, bridge construction and shipbuilding, due to fact that this process has high efficiency.

There are several versions of arc stud welding process, like Capacitor Discharge Stud Welding and Drawn Arc Welding. The types of Drawn Arc Welding technique can be: drawn arc stud welding with ceramic ferrule or shielding gas, short-cycle drawn arc stud welding, capacitor discharge drawn arc stud welding and drawn arc stud welding with fusible collar. [1]

In this paper welded joints were made by arc stud welding with ceramic ferrule (ceramic ferrule is used for protection of electric arc during welding process) because that type of arc stud welding process is very often used in steam boiler production. The basic property of this welding process is that the welded zone is compound of melted stud and base plate metal (there is no another separate filler metal in this welding process). At the beginning of the welding process, stud and ceramic ferrule are loaded into the gun and than set on the welding position. With gun trigger button depression electric arc is initiated and the stud tip and base plate are being melted. After arc termination, the melted stud tip is plunged in to the base plate and homogeneous joint is created (figure 1).

As it is in other welding processes the quality of welded joint is dependent of proper selection of welding parameters and literal application of those parameters during welding process.

To demonstrate influence purposely induced deviations in welding process on stability and quality of arc stud welding process, this paper presents approach to welding parameters record with On-line monitoring system and off line analyses of those results.

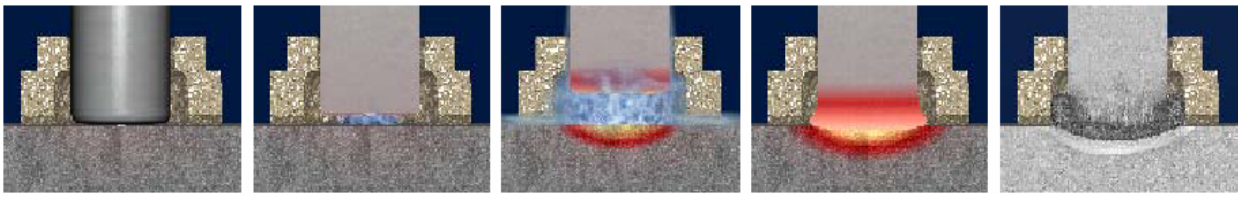

Figure 1. Sequence of welded joint creation during arc stud welding process [2,3]

2. WELDING PARAMETERS AND EXPERIMENTAL SETUP

Main welding parameters of Drawn Arc Welding process with ceramic ferule are: plunge *P*, mm; lift *L*, mm; time *t*, s and welding current *I*, A.[2] Scheme of arc stud welding parameters setup is shown on figure 2.

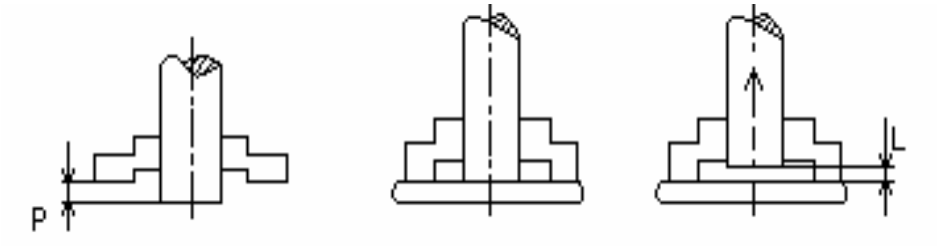

Figure 2. Scheme of arc stud welding parameters – Stud Plunge P and Stud Lift L

During experimental stud welding with ceramic ferrule (with semiautomatic equipment Nelson Stud Welding, Inc., Oh, USA; power source: ALPHA 850; stud welding gun NS 40 B) welding parameters were recorded with On-line monitoring system for acquisition and analysis of main arc welding parameters. Sampling frequency from welding process was 5 kHz (on each channel). Scheme of on-line monitoring system during arc stud welding is shown on figure 3.

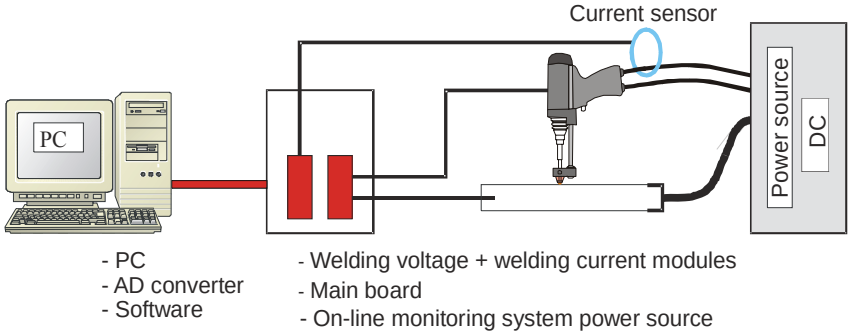

Figure 3. Scheme of On-line monitoring system for acquisition of arc welding process main parameters

Welding was performed on studs “Nelson KS 10,0×50” with ceramic ferrule “Nelson KW 10/5.5”: stud was made from X10CrAl18 (EN 10095), and base metal of plate was steel type 16 Mo 3 (EN 10028-2). The setup of selected welding variables is shown in table 1.

Table 1. Stud welding parameters

Trial No.	**Welding current *I*, A**	**Welding time *t*, s**	**Plunge *P*, mm**	**Lift *H*, mm**	**Welding condition**
1	600	0,4	2,9	2,5	Clean surface
2	600	0,4	2,9	2,5	Oil on surface
3	600	0,4	2,9	2,5	Surface with rust
4	600	0,4	2,9	2,5	Wet ceramic ring and surface

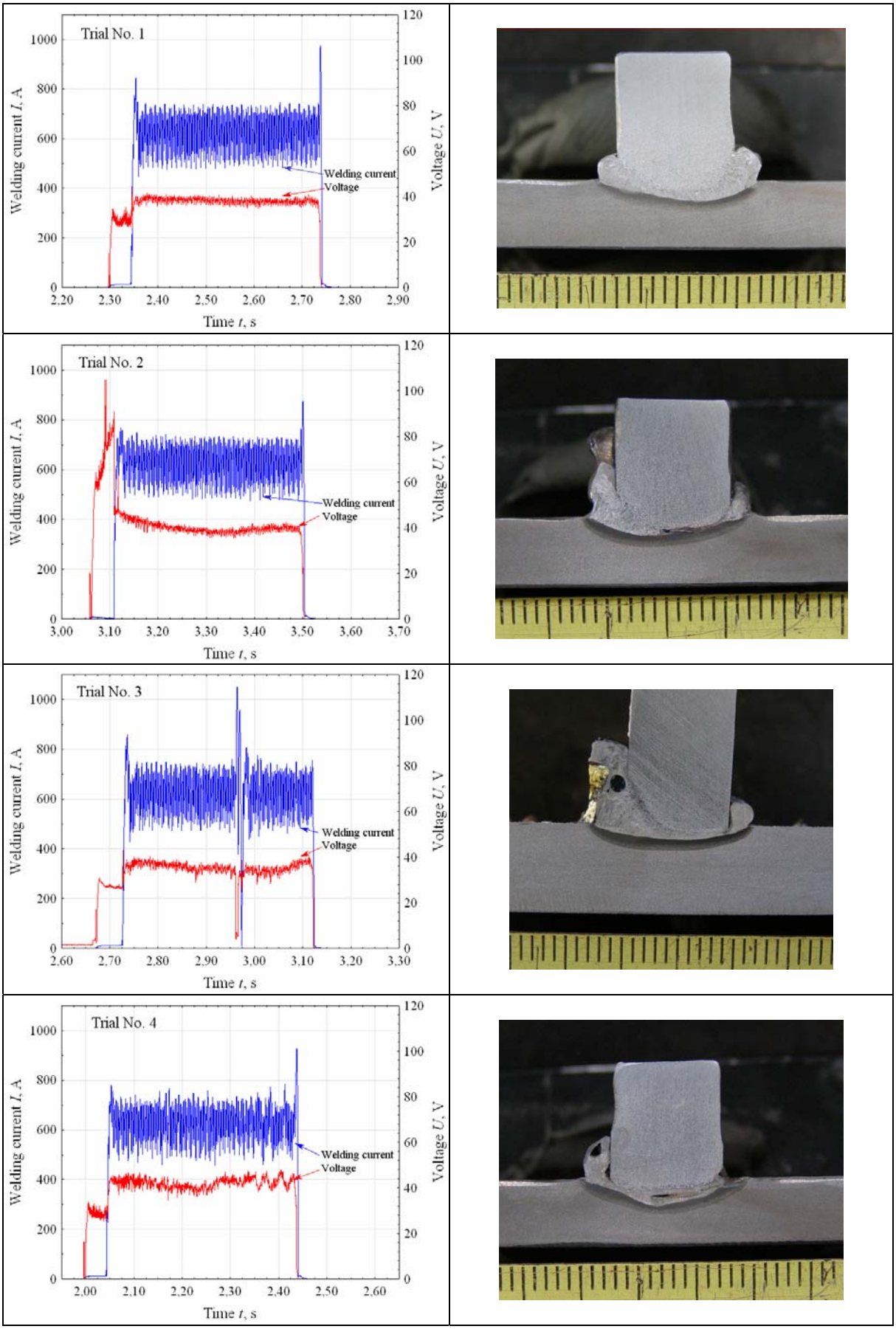

Figure 4. Welding current and voltage distribution during complete cycle of stud welding process and macro section of related weld joints.

3. DATA ANALYSIS

The changes of welding voltage and current were recorded trough whole stud welding cycle and shown in diagrams on figure 4. The insight of welding process stability is possible by analyzing of these diagrams, but visual evaluation of macro sections shown on figure 4 also is the quality index of weld joints.

From the weld process stability point of view it can be observed from the diagrams on the figure 4 that there is an evident parameter changes during welding with induced pollutions on the welding spot, especially there were obvious changes of welding voltage, due to fact that there is a specific CC welding power source.The distribution of the welding voltage on the weld process start for the trials no. 1 and 2 are shown on figure 5; the changes of the process stability are present in the voltage distribution even on the beginning of the arc start process

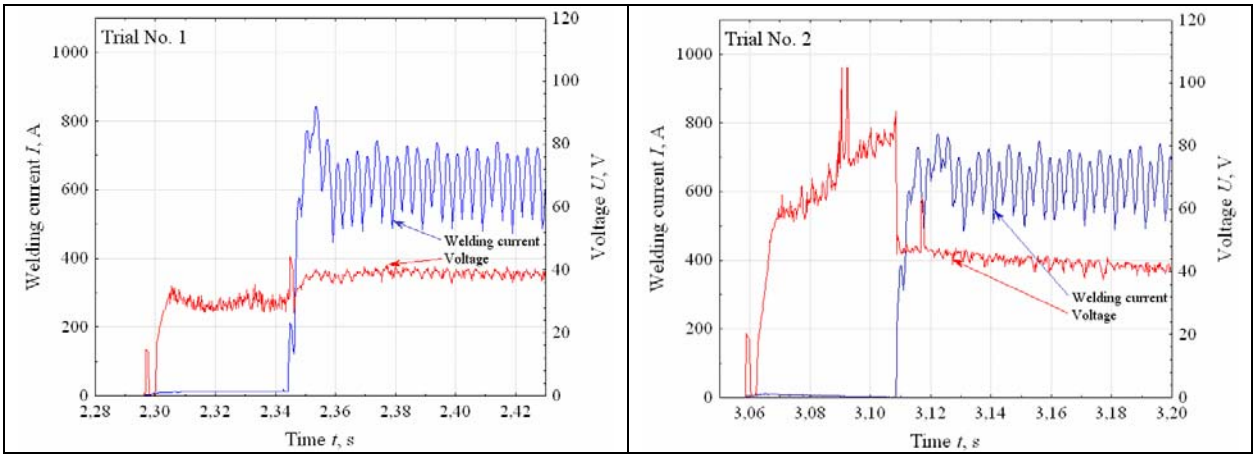

Figure 5. Welding voltage and current distribution at start of the welding process for the welding parameters shown in table 1

The changes of process stability manifested also on weld quality, what is evident from macro sections, also shown on the figure 4. The presence of the weld porosity is, as expected, evident on all processes with induced instabilities, and especially during welding with wet ceramic ferrule and on wet steel surface.

4. CONSLUSION

Conducted experimental research of the weld process stability have shown that there are explicit sensitivity of weld process stability due to purposely induced instabilities as is shown based on voltage distribution of stud welding process. Besides record of welding parameters distribution for the quality evaluation of welded joint, it is necessary to have some other indexes like macro sections of the welded joints. The following research will foresee different statistical methods for monitoring of arc stability in stud welding process.

5. REFERENCES

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