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Analysis of spot arc welding with a covered electrode

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The paper treats spot plunged arc welding with a covered electrode. A diagram shows movement of the cold and hot electrode ends during welding. The welding process is described in seven phases by the covered-electrode movement. Several macro specimens of spot welds in lap joints made on plates of different thicknesses are shown.

1. INTRODUCTION

In fusion arc welding there is always a question how to obtain as deep penetration as possible and as high strength as possible with as low energy input as possible. One of possibility of achieving a deeper penetration is offered by the characteristics of some elements introduced into the coating of a covered electrode in order to increase arc power. For the spot welding is very important that the welding arc melts a large volume of the parent metal and a very small volume of the filler material, which can be attained by an appropriate chemical composition and fabrication of the core and the coating of the covered electrode.

2. SPOT PLUNGED ARC WELDING PROCESS USING A COVERED ELECTRODE

In the experimental work was used a covered electrode which contains elements increasing the arc power to such a degree that the arc can burn under the workpiece surface. An approximate composition of the coating of the covered electrode is given in Table 1.

Table 1.
Composition of the coating including the most important elements and their content

Element	Ca	SiO_2	TiO_2	Ni	Cr	Mo	Mn
%	2.5 – 5.0	12 - 16	10 - 14	8 - 12	24 – 30	2.5 – 5.0	2.5 – 5.0

In the experimental work, profiles and plates of low-alloy steel and of different thicknesses were welded together. A conventional power source having a drooping characteristic and permitting a high-frequency arc ignition was used for welding. Welding was carried out with covered electrodes with 2.5 mm, 3.25 mm, and 4.0 mm in diameter. The welding current was adapted to the electrode diameter used and varied between 120 A and 210 A. The welding time depended on the electrode diameter, the welding current, and the workpiece thickness,

i.e., lap-joint thickness. It ranged between 12.5 s and 30 s. In addition to the parameters mentioned, in spot plunged arc welding with the covered electrode, the velocity of electrode movement down into the workpiece and up to the surface, the velocity and direction of the hot electrode-end, jointly with the arc, at the end of welding were very important too.

The diagram in figure 1 schematically shows the movement of the cold and hot ends of the covered electrode during welding with regard to the workpiece surface as a function of time. The precise variation of both curves, however, depends on all the above-mentioned parameters. The diagram permits readings of the welding time, the length of the electrode consumed, and an approximate penetration depth.

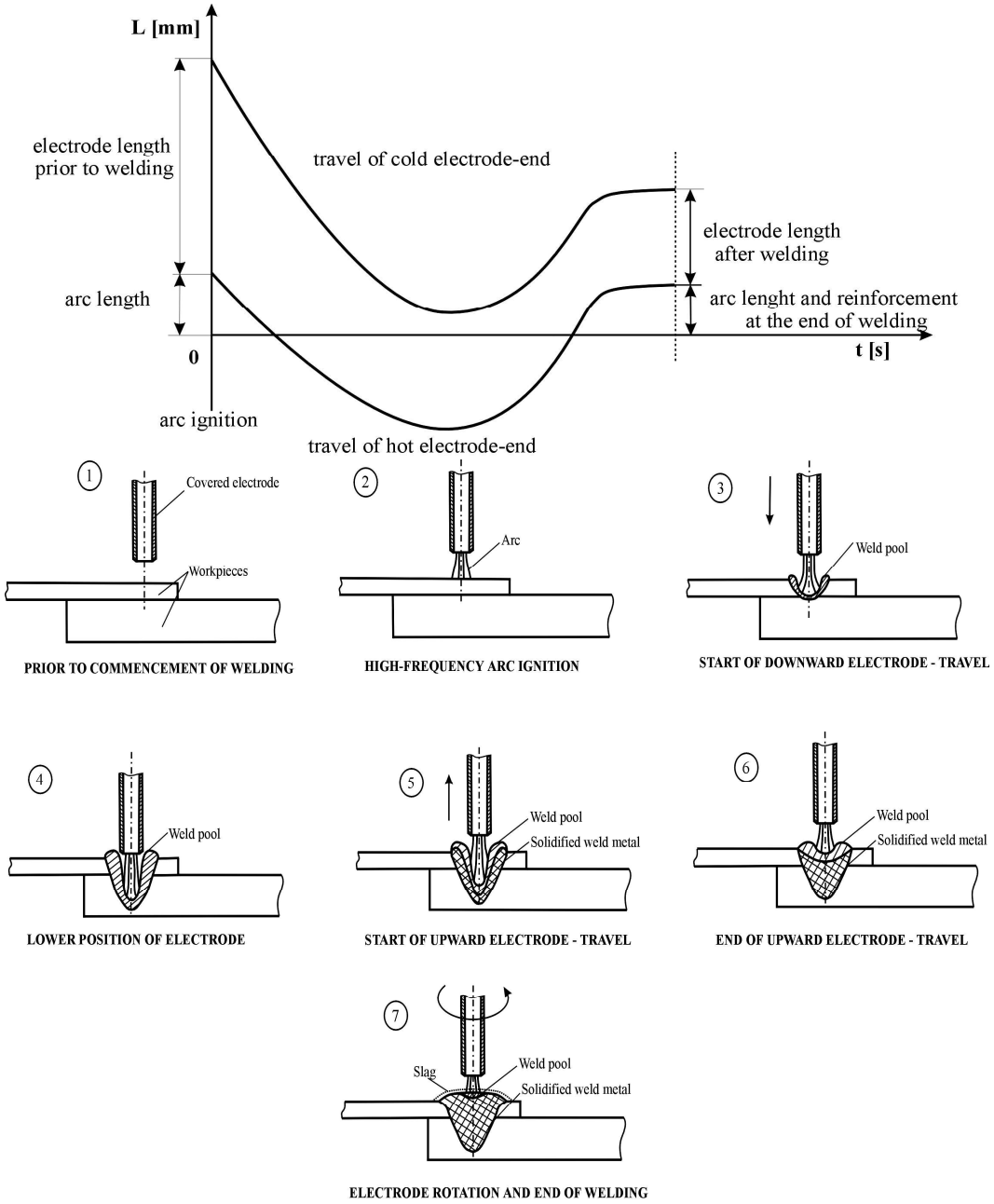

Figure 2. Schematic representation of spot plunged arc welding with a covered electrode when making a lap joint between two workpieces with different thicknesses

Figure 3 shows several macro specimens of lap joints including spot welds which were arc welded with the covered electrode. The first macro specimen (a) shows a spot weld between a 3 mm thick plate and a 22 mm thick plate without penetration. The second (b) macro specimen also shows a spot weld of plates with different thicknesses and with a relatively shallow penetration. The third (c) macro specimen shows the lap joint as a spot weld reaching through both plates. The three welds were made without any weld preparation prior to welding, which is to say that the weld location was not defined in advance. Prior to welding, it is necessary to clean the plates well so that the arc may ignite without difficulty and that oxides and other impurities may not reach the weld pool. In our investigations, a maximum penetration depth of 25 mm was attained. From the point view of strength, it may be thus concluded that a steel plate of up to 15 mm in thickness or a profile can be joined to another plate of optional thickness. If the latter is thinner than 10 mm, the spot weld may reach through the two plates; if it is thicker, the spot weld in the lower plate reaches only to a certain depth.

Final layers of the welds made with spot plunged arc welding with the covered electrode are shown in figures 3d. All the welds were made manually, i.e., a welder moved the electrode perpendicularly downward to the depth required, than upwards to the workpiece surface, and finally made the final layer by rotation.

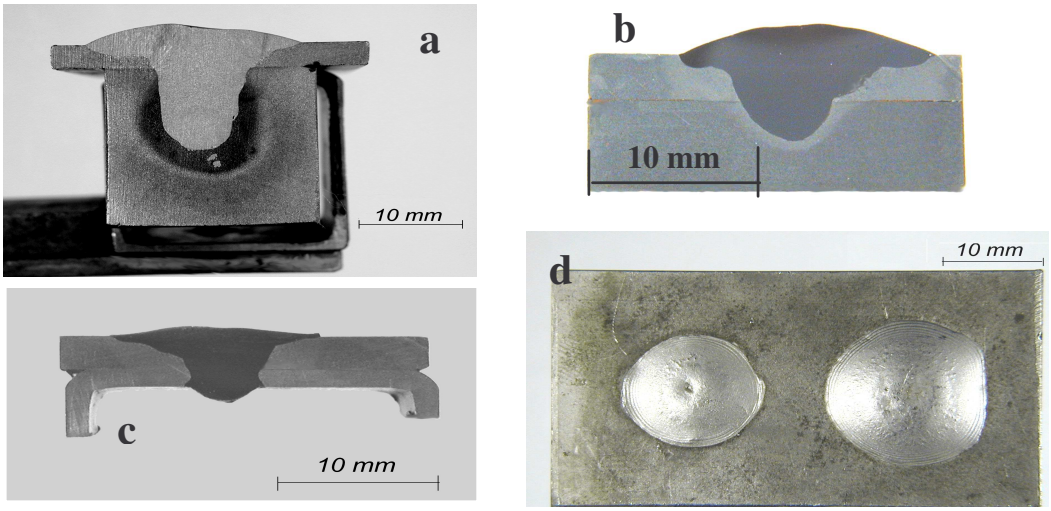

Figure 3. Lap joints including welds made with spot plunged arc welding with a covered electrode (a, b, c) and the shape of the final layers of two welds (d)

Similar welds but of a shape which can be anticipated and a size which is known in advance can be produced automatically by using the new, innovative device (a patent has been already applied for). The main component of the device is a step motor permitting programming of the velocity, the length of the downward electrode movement, the duration of dwell in the lower position, the velocity of upward movement, the duration of dwell in the upper position, the velocity of the rotation of the electrode and the arc when making the final run. The welding current required is supplied by a conventional power source with a drooping characteristic and supplemented by a device for high-frequency arc ignition. The housing of the device consists of a mounting plate and an adjusting plate, guiding pieces and an electrode holder which is connected to the main shaft.

3. CONCLUSION

Based on the results obtained the following conclusions can be drawn:

- spot plunged arc welding with a covered electrode can be carried out manually or automatically;
- spot weld on the overlap joint is possible to make without any preparation prior to welding
- the covered electrode should contain metal and non-metallic components ensuring arc constriction and its power,
- the majority of the activating elements is contained in the electrode coating;
- the electrode and arc travel downward into the worpiece and then upward again is not linear;
- the rotation of the hot electrode-end, jointly with the arc, determines the size and shape of the weld face.