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SURFACE TENSION TRANSFER (STT) WELDING

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ABSTRACT
The paper presents basic information of relatively new, modern and high efficiency welding process, STT process. This welding process is successfully used for performing of root passes at thick pipes, steam-boilers and chambers. The STT welding process is suitable for welding of thin plates, also. Very low heat input affect on residual stresses and deformations reduction point of view. The root pass is high quality and lack of fusion or other discontinuities are reduced to minimum.
Keywords: Welding, steel pipes, STT, root pass.

1. INTRODUCTION
Today this welding process is being used by every major pipe contractor in the world, yet it is still relatively unknown in many sectors.[1] Therefore we will explain this technology in the best way we can.
The STT welding technology is modern, high efficient and high quality welding process for joining thin wall materials and joining at root passes of thicker materials. The Lincoln Electric is the first welding company to hold a patent on a relatively new welding process called Surface Tension Transfer (STT). This technology is patented in 1988, it wasn’t use before 1994, which was the first commercial unit produced and sold. Power source of this process provide stabile main welding parameters during welding. Stabile parameters enable welding with so called, “short circuit arc”, which presents the way of transfer molten metal into the weld. The material transfer in electric arc is founded on surface tension force between weld pool and melted bead in electric arc.[1] STT unit monitors and controls, frequently and precisely, welding current during welding process which affects on the welding voltage. Because of that we can say that the STT unit controls both, welding current and welding voltage. Which welding processes is suitable for individual pipes joining and pipes joining in pipes systems? Production of steamboiler is a specific type of production due to different material types, thickness, diameters, weld joint shapes, and because of that quality welding technology is necessary but hard to achieve. Conventional approach for pipes joining in steam-boiler industry up to 88 mm diameter is TIG (Tungsten Inert Gas) welding process as a single bead or multi bead process. For joining bigger diameter pipes in steam-boiler industry, combination of welding processes TIG + SMAW (Shielded Metal Arc Welding) or TIG + SMAW + SAW (Submerged Arc Welding) is usually used, depending on available equipment and thickness of base material (number of passes). [1]
TIG welding process is used for root passes which are the most important and the most complex from the standpoint of weldability (welding in non accessible areas is the welder problem, imperfections in that joint area is the most evident, gap in weld joint root must be in rigid tolerance,...). According to some welding experts’ opinions [1], STT is process which will replace manual TIG (but not automatic

TIG) welding process in described situation. This paper explains how the process works and examines its advantages and disadvantages. [1, 2]

2. WELDING PROCESS

Major advantages of STT process are, lower heat input and better control of welding parameters than others. Short Arc welding process with solid wire is primarily selected for applications in manufacturing where are required medium or low heat input. The process will work in all welding positions and only requires average welder knowledge of the problem. The Short Arc process is characterized by its unwanted "explosion" of molten metal drops, known as spatter. In this process, welder sets the wire feed speed and average voltage, based upon the required heat input for the particular application. Spatter will occur when the electrode makes contact with the base metal (shorting out the arc), then a high current applied, known as ''Pinch Current" is applied to "blow" or separate this short. The molten metal (drop) contacting both, the electrode and work, acts like a fuse and "blows", depositing some of itself into the weld path and surrounding fixtures. During this, molten metal (drop) casting other molten parts into the air. This process repeats itself approximately a hundred times per second while the machine tries to maintain the set voltage. Better control of welding parameters is one of the essential advantages of STT welding. The STT process uses electronic technology to produce or combine the best variable characteristics of the Short Arc and TIG welding processes. ''The Surface Tension Transfer® process was named after the way this technology monitors and controls the surface tension of the weld droplet as it adheres to the weld puddle.''[1] To illustrate how this waveform technology works, Figure 1 contains the welding processes of STT and conventional source.

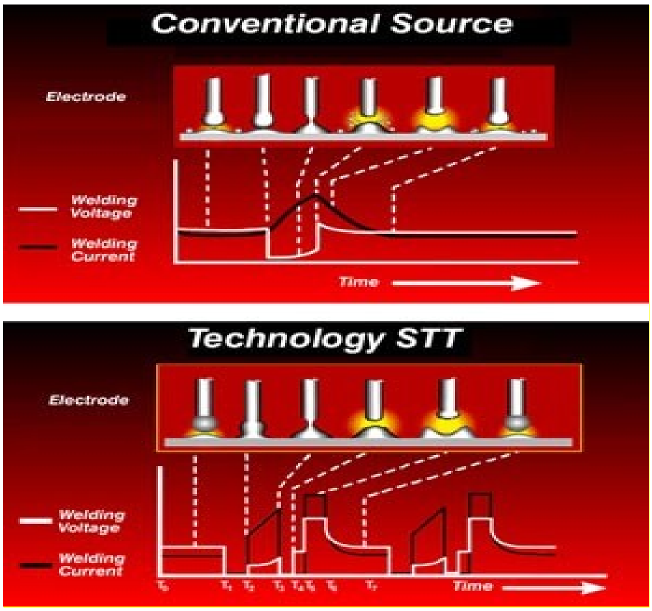


Figure 1. Comparison of STT and coventional technology in welding

Figure 1 represents the process during one STT waveform. The figure illustrates amperage over time, with the time being in milliseconds.

- Stage 1. The electrode approaches the work piece with steady amps and volts levels (conventional source); Background current: It is a steady-state level of amperes, between 50 and 100 amperes. The electrode approaches the work piece. (STT)
- Stage 2. As the electrode shorts (melting), the voltage drops drastically and the amperes begin to rise (conventional source); Ball period (forming a ball): Just before the electrode is about to complete the short (background current), the voltage sensing clip reads a decrease in voltage and

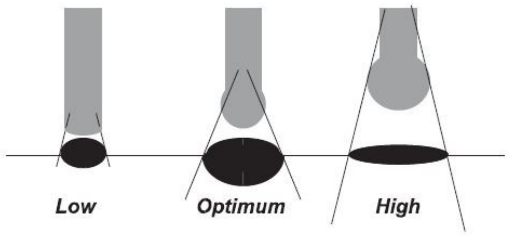
the machine drops the level of amperage. The background current is further reduced to 10 amperes for approximately 0.75 milliseconds. This time interval is referred to as the *ball time*. (STT)

- Stage 3. The electrode achieves contact with the work piece and is depositing the filler metal. At this point, the voltage is approximately zero, and the amperes have increased significantly (conventional source); Pinch mode (increase the amperes level): Wire is still being fed, therefore fusion is occurring between the electrode and the work piece. A high current is applied to the shorted electrode in a controlled manner, to transfer the molten drop. At this point the wire begins to “neck” down or melt from the outside in. (STT)
- Stage 4. The filler metal separate from the rest of the electrode (because of the high amperes) in an unpredictable manner, producing spatter and smoke (conventional source); The delta V calculation: This calculation indicates the moment before the wire completely detaches. The current is reduced again to 50 amperes in a few microseconds, this will prevent an explosion that would create spatter. (STT)
- Stage 5. After the separation between the weld deposit and the welding wire, the voltage and amperes decrease back to their preset levels (conventional source); Plasma boost: Amperage is increased and a controlled separation takes place creating the weld bead with little spatter. At this period high arc current quickly “melted back” the electrode. (The geometry of the melted electrode at this point is very irregular). (STT)
- Stage 6. Repeats the process as in step one (conventional source); Plasma: This is the period of the cycle where the arc current is reduced from plasma boost to the background current level. This is called “tail-out” period. In this period the current goes from this higher level down to its initial, background level. The cycle then repeats itself, with the time required for one waveform taking between 25-35 milliseconds. (STT) [3]

3. APPLICATION IN PRACTICE

For application in practice we used original Lincoln electric power source ‘’Invertec STT II’’ for welding steel pipe with diameter of 508 mm. Picture of power source is shown on Figure 2. In the Figure 2 we can see power source and wire supply source. The wire supply source is necessary because main power source does not have neither parameter adjustment neither place and mechanism for wire supplying the welded joint. On the main power source adjustable parameters are: background current, peak current, hot start, tailout, wire size select switch and wire type select switch. The output current is switched to the Background level at the conclusion of the preceding Peak Current pulse. This knob allows preset adjustment of the amplitude of the background current up to 125 amperes. The beginning portion of the welding arc is a pulse of current referred to as Peak Current. This knob allows preset adjustment of the amplitude of the peak current up to 450 amperes. The background current is for adjust bead shape. The optimal shape is shown on Figure 3.

Figure 2. Lincoln electric ‘’Invertec STT II’’



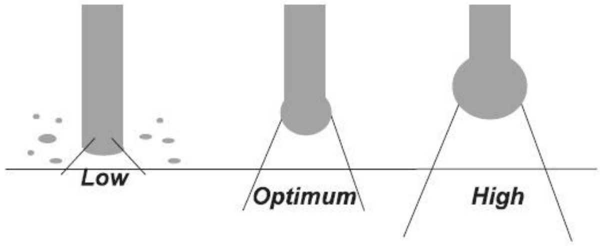


Figure 3. Adjust bead shape (background current) *Figure 4. Adjust Arc Length (Peak Current)*

When the parameters are on the optimal level, welding can start. We used one welder for welding the pipe, with technique of welding in vertical position, from the top to the bottom. Quality of the produced weld is high and inner side of the root pass is shown on Figure 5.

Figure 5. Inner surface of root pass (steel pipe)

On the Figure 5 we can see that the root pass is flat i.e., no excessive amounts of the welded metal. This is important from the standpoint of fluid flow. No crossing laminar in turbulent flow, which results with reduced amount of wear material. Edges of the weld area are well join with no lack of fusion.

4. SUMMARY AND CONCLUSIONS

Welding is the dominant mode of connection, ie joining the elements of a unit or structures in almost all branches of modern industry. Longer does not connect only metal to metal, there are more possible combinations of connecting different materials. Because of all the above, it is clear that the development of welding represents the development of the entire industry. Scientists and professors, as well as industrial workers participate every day and tend to this development, in different ways but with the same goal. STT process provides many advantages, primarily over the proces with Short Arc means of metal transfer. Up to 75% of the current short arc pipe welding applications could be justifiably replaced by STT due to its tangible benefits of improved quality, lower costs, and improved operating conditions. Within the next 5-10 years, it is very possible that STT will become the predominant steel alloy pipes welding process used in the global industry.

5. ACKNOWLEDGMENT

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