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Verba volant, littera scripta manet. [In English: Words fly away; written letters remain.]



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Who is in the field, and not in the DAAAM he/she does not exist.
(Jyri Papstel¹1996)

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COMPREHENSIVE STUDY OF STRIP SELECTION AND WELD ERRORS IN A STEEL TUBE ERW WELDING PROCESS

KRSULJA, M[arko]; BARISIC, B[ranimir] & KUDLACEK, J[an]

Abstract: Objective of this paper was to analyse production process at Histria Tube factory of welded tubes and give optimal production parameter recommendations. A comprehensive optimisation of the welded tube production process included optimisation of strip length planning and control of losses due to welding frequency. Calculations were proposed in order to reduce the coil strip width and achieve material savings. Optimal frequencies were experimentally tested during several production runs and according to the results main causes of errors were determined. Impeder position was also tested.

Key words: coil, slitting, forming, tube, weld

1. INTRODUCTION

Shaped steel tubes are used in automobile and construction industry. Current problem is the increase of the raw material and energy costs, together with the competition in form of the imported tubes. Furthermore tube producers are constantly under pressure by the edge buckling and spring-back especially with the increase of ratio outside diameter/wall thickness. In order to produce coil strip savings very precise rules for strip allowance and cutting must be followed. For this reason the tube production process is under investigation for further improvements. Welded circular tubes are produced by continuously forming of a flat strip around its longitudinal axis to produce a round tube. Tube production takes in consideration coil slitting, forming, welding/scarfing, sizing/calibration, cut off and various testing depending on the final use. Other research is concentrated on understanding of the stretch reducing at the operating temperature and then the mastering of these processes in individual passes as well as during the entire processing line. Also (Abrinia & Farahmand, 2007) researched reshaping of thick tubes and gave a new upper bound formulation for shaping thick tubes into square tubes. Computer optimisation with response surface method (Zeng et al., 2009) is being done in order to determine desired angles of the final product. Further research investigated more strip deformation through the whole cage roll forming (Jinmao et al., 2009) by elastic-plastic finite element model use of tooling in three sections pre-forming, linear forming and fin pass. Objective of this paper is to analyse welded tubes and give optimal production parameter recommendations. Some calculations such as coil width are proposed in order to shorten times and reduce expenses for manufacturing setup. Also the most common errors are discussed in order to help contain stability of the process.

2. FORMING AND COIL STRIP

The strip of required dimensions is moved through a progressive set of rolls in order to produce a round tube. Conventional forming consists of strip flattening, breakdown stage and a set of rolls for finishing stage. Together with a high frequency induction the tube edges are heated and by a continuous pressure pushed into contact so that a continuous longitudinal weld is formed.

Elastic M...	200000 N/m...
Poissons ...	0.29
Density	0.00787 g/...
Tensile S...	356.901 N/...
Yield Str...	203.943 N/...

Fig. 1. Material properties of tested tubes

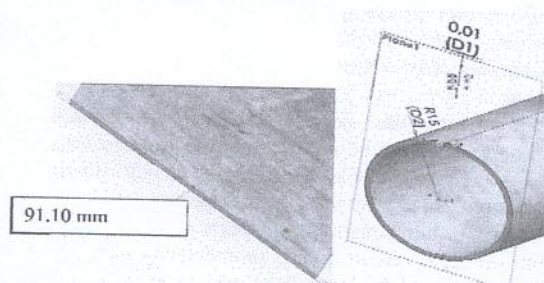


Fig. 2. Selection of the ideal initial length of the flat strip

In this weld procedure there is no filler metal and the weld seam reaches temperatures of 1300 °C. The final shape is given by the final sizing/shaping rolls that can be round, square or rectangular and there are also some special shapes. During the shape manipulation the tube is under continuous bending therefore a mixture of SHELL Adrana D 2215.04 oil 2,5-3 % in water is used (Histria tube, 2009) in order to facilitate friction during the longitudinal travel of the pipe. But it is mainly used for cooling of the seam and it ranges from 18-22 °C.

In order to obtain the strip of required profile dimensions certain parameters have to be taken into consideration like spring-back, weld supplement, dies geometry etc. Strip width is based on roll design, mill length and design and the forming method employed in the breakdown press. Ideal tube was designed in SolidWorks software and k factor of 0.5 was used in order to predict ideal strip length of a 30 Ø tube with -0.01 mm tolerance, the result was 91.10 mm for galvanised steel (Fig. 1 and 2). SolidWorks sheet metal module was used for determining tubes together with formula (1) from (Histria tube, 2009) a good approximation of 92.06 mm was obtained from where an addition of 0.96 mm for a secure welded seam has been added.

$$\text{Strip Width} = ((WD - t) \cdot 3,14) + t \quad (1)$$

From an 8 tone coil, for standard 6 m long pipes 4-5 % is wasted in the process for various reasons. The coil width is 1250 mm or 1000 mm. For ideal coil usage various combinations and planning of production process in advance is needed. When strip is cut 10 mm is wasted if the knife is ideal, coil length/strip approximation= ideal number of strip. For our case 1240/92.06=13.469 therefore the ideal number of strip would be 13 but the waste then grows up to 43.22 mm +10 mm. The solution is to use combinations and to plan production ahead; a strip of 43.2 mm could be used for production of a 12 mm diameter tube. Or twelve strip coils for 30 Ø and one for 26 Ø. Strip calculations represent a place where weight savings

can be done for example from an 8 tonne coil 12 strips coils for 30 Ø and 1 coil strip for 26 Ø give an ideal usage of efficiency.

3. WELD ERRORS

The high frequency welding is a forge weld without filler metal and a clean bond plane. During the forming operation all impurities are squeezed out of the weld. The edges of the tube are heated up due to resistance to flow of current and the edges are formed together in the weld rolls. The optimal approach angle for carbon steel is 3-4° while for stainless and most nonferrous metals 5-8° range. The requested impeder cross-section is calculated on the basis of Vee voltage and frequency. Both the energy input and necessary impeder cross-section can be reduced by one of the following setup changes reduced vee angle (a 1.5° reduction in Vee angle equals a 100 kHz step down in frequency (Asperheim & Grande, 2009), less spring-back, shorter distance from induction coil to weld point. The heat enters from the top and the bottom of the edge and the heat affected area is shaped like the hourglass (Fig. 3). Flow lines are high carbon discontinuous planes whose angle can be used to evaluate degree of upset during welding operation. Some of the common defects (Nicols, 2009): entrapments, pre-arcs, lack of fusion.

Entrapments (black penetrators) are result of bad melt rate of the approaching tube speed. Solution to entrapment is 4-6 degree Vee angle, stable Vee length, lowest possible weld temperature; Mn/Si ratio must be higher than 8:1.

Pre-arcs (white penetrators) happen when the Vee is robbed of heat; the short circuit diverts momentarily the current. (Fig. 4). Coolant should be kept clean and away from the coolant area, use good slicing to minimize slitting burs.

Lack of fusion (open seam) (Fig. 4 and 5) is failure of strip edges to form a sound weld.

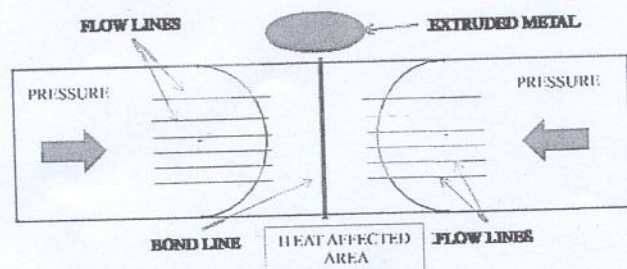


Fig. 3. Weld area demonstrates the influencing parameters

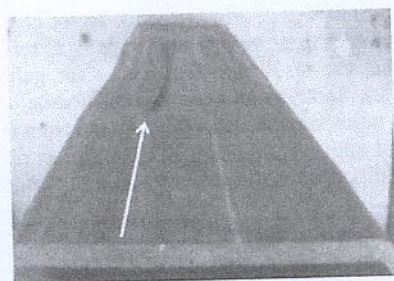


Fig. 4. Figure shows a lack of fusion at the edges



Fig. 5. Stitching, regularly spaced continuous errors, voltage consistency problems

If the edge isn't moulded, power setting, Vee angle and length, coil size, impeder placement and condition should be checked. Frequency of 400 kHz is commonly used for welding and the majority of the current flow is confined within 0.75 mm of the surface. Impeder is used to concentrate the magnetic flux created by the work coil and diverts more available energy into the weld Vee. Further more savings can be made by selecting proper impeder as it can affect the weld speeds up to 50 % without increase in weld power. The speed must be consistent with the speed and material. Impeder is most effective if placed under the faying edges, usually one strip thickness below the top inside of the tube. Impeder should extend from the centre of the coil to a point slightly past the apex. Minimum impeder length is determined by adding the weld roll diameter to the coil length. One of solutions if lack of fusion has occurred is placing impeder to 0.32 mm past the weld roll line and kept cool. The Vee angle should be smaller than 7 degrees also the inside coil diameter should not exceed the tube diameter by more than 6.35 mm. Lack of fusion at edges (Puckers) usually caused by non-metallic's on the bond plane. The edges are not parallel, more squeezes are needed or more heat is needed.

4. CONCLUSION

A comprehensive method for proper coil slitting of 8 tonne coil has been presented. Problems and solutions to strip selection and impeder positioning have been presented. From an 8 tone coil, 4-5 % is wasted in the paper an increase of the process stability by giving technical solutions has been done. New results are manifested in material weight savings and will give benefits to the tube producing company and tube industry as a whole. Further research should involve penetration of current in different materials and for different tube thicknesses and optimisation of impeder selection and positioning.

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6. REFERENCES

- Abrinia, K. & Farahmand, H. R. (2007). An upper bound analysis for the reshaping of thick tubes with experimental verification, *International Journal of Mechanical Sciences*, Elsevier, doi:10.1016/j.ijmecsci.2007.06.007
- Asperheim, J. I. & Grande B. (2009), *Factors Influencing Heavy Wall Tube Welding*, http://materials-welding.blogspot.com/2007_09_16_archive.html, Accessed on: 2009-05-05
- Jinmao, J.; Dayong, L.; Yinghong, P. & Jianxin, L. (2009). Research on strip deformation in the cage roll-forming process of ERW round pipes, *Journal of Materials Processing Technology* 209, 4850-4856, Elsevier, doi:10.1016/j.jmatprotec.2009.01.011
- Nicols, R. K.; *Common HF welding defects, thermatool welding and heating systems*, Available from: <http://www.thermatool.com/information/papers/quality/Common-HF-welding-defects.pdf>, Accessed on: 2009-05-21
- Zeng, G.; S. H. Li; Z.Q. Yu & X.M. Lai. (2008). Optimization design of roll profiles for cold roll forming based on response surface method, *Materials and Design*, doi: 10.1016/j.matdes.2008.09.018
- *** (2009) <http://www.histria-tube.hr>, *Histria Tube, Round tubes company documents*, Accessed on: 2009-05-05

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Teich, Tobias / Tieren, Mircea / Tkalic, Mladen / Tomas, Andrija / Tudjarov, Boris / Turkalj, Goran / Ujevic, Darko / Uricek, Juraj / Valter, Zdravko / Varga, Gyula / Vavrik, Ivan / Viducic, Ljiljana Vincze, Markus / Virkus, Uwe / Vitecek, Antonin / Vitez, Ivan / Vrdoljak Raguz, Ivona / Vrljicak, Zlatko / Vujasinovic, Edita / Vujica Herzog, Natasa / Vukmirovic, Srdan / Wantuch, Edward / Weigl, Karl Heinz / Zamfira, Constantin Sorin