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Laser welding process specification base on welding theories

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Abstract

The laser welding technology expansiveness is growing rapidly nowadays. The laser welding technology process isn't well known yet. Laser machining development is the base of this technology. From the welding technologies the fusion welding technology causes small heat affected zone (HAZ). The quality of the welded joint depends on the heat effect and the metal heat transfer. In case of this technology design the knowledge of the effect of the used parameters is important. We can acquire this knowledge by the way of practice.

The problem of laser welding technology is the setting of the parameters. The used welding gas (Ar, CO_2, He, etc. and their mixes, and percentages), the welding speed, the focus point and the used power rate are also important. The welded materials (chemical composition), the sheet thickness and the joint type also influence the welded joint quality.

Welding tests will be done with different welding parameters (gas, speed, focus, power), in case of a metal with constant chemical composition, and welding setup.

Optimal welding process will be specified based on the quality control results (destructive and nondestructive inspections).

The used technology is a new technology and the effect of the parameters is not well known yet. In this work we wanted to show the relationship between preheating temperature and the Vickers hardness (HV_{10}).

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Keywords: Laser welding; process specification; HAZ; laser beam; plasma effect.

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1. Introduction

To create a quality welded joint we need to find and use the suitable parameters for the used welding technology and also the necessary preheating temperature. During the technology process planning we need to calculate the carbon equivalent by finding alloy chemical composition with the appropriate steel group equivalent equation.

We know more than 40 different carbon equivalent equations from the literature. With the carbon equivalent, the combined sheet thickness and the welding process heat input in mind we can calculate the welding parameters. This calculation isn't a sample method because the process heat input depend on the welding process and the welding speed. Also it is very important to know the heat transfer type (2D or 3D) and the used gas or gases.

The laser technology is a high energy beam fusion welding process with low heat effect. The welding process specification is the base of the joint quality. The suitable preheating temperature calculation is also very important.

2. Laser technology

The word LASER is an English (Light Amplification by the Stimulated Emission of Radiation) acronym word [1].
In 1960 the first laser was developed by the American Theodore Maiman. The prototype's material was a ruby crystal (Al_2O_3 crystal with Cr_2O_3, which has an appropriate metastable energy level) in which the laser effect played out and for excitation it used a strobes light. The ruby crystals at the two ends had a semi reflective and a highly reflective mirror see Fig. 1.
When the strobes lights excite, the ruby crystal and the metastable energy level light is created which starts the laser emission that is reflected back and forth along the axis. Since there is no mirror on the side of the ruby, the multiple reflections clear out the divergent rays and only the strictly parallel rays with the axis of the crystal stays in the system.

When the lights energy surpasses the level which can escapes the semi reflective mirror, the laser lights up. The exiting rays are parallel because of the geometrical layout of the system and the divergent is negligibly small [2]. The laser beam has high energy therefore it's useful for fusion welding technology.

2.1. Laser welding

We know two different joint types in case of laser welding (Fig. 2.). Fig. 2 (a) shows the heat transferred joint and the Fig.2 (b) shows the keyhole joint.

The laser energy penetration depth is very small, about 1mm/ kW. Which means to use laser for welding application we need a high power source. In case of the keyhole joint welding the formation of the plasma influence the joining process and the quality of the welded joint. We can modify the laser beam energy during the welding process. The plasma effects depend on the used gases. The melted metal forms depend also on the welding speed, the laser power level and the focus position too. These laser parameters can determine by the empirical experiments results.

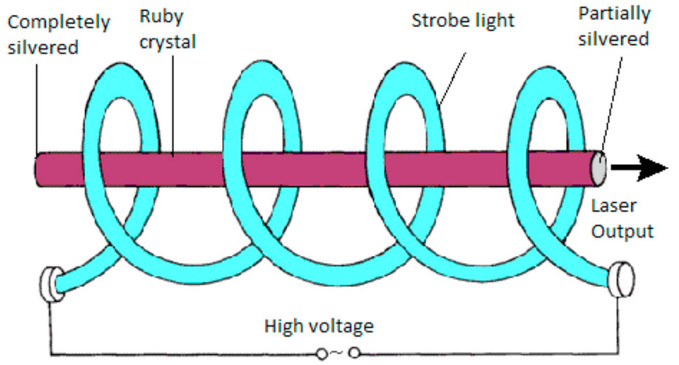

Fig. 1. Ruby Laser Schematics [1].