Available online at www.sciencedirect.com

ScienceDirect

Physics Procedia 89 (2017) 156 – 163

Physics Procedia

Nordic Laser Materials Processing Conference, NOLAMP_16, 22-24 August 2017, Aalborg University, Denmark

Hybrid Laser-Arc Welding of the High-Strength Shipbuilding Steels: Equipment and Technology

G. Turichin[a], M. Kuznetsov[b]*, I. Tsibulskiy[b], A. Firsova[a]

[a] *Saint Petersburg State Marine Technical University, Saint Petersburg,190121, Russia*
[b] *Institute of Laser and Welding Technologies, Peter the Great Saint Petersburg Polytechnic University, Saint Petersburg, 195251, Russia*

Abstract

Hybrid laser-arc welding (HLAW) allows getting weld joints with thickness up to 35 mm for one pass, provide good quality formation of joints, minimal thermal deformations, the productivity in 10 times more in comparison with arc welding. In addition, replacement arc welding to the HLAW allows economizing filler materials, shielding gas and consumable electricity more than 4 times. Therefore, HLAW is actually technology for basic engineering branches and especially for shipbuilding. The Institute of Laser and Welding Technologies (ILWT) developed laser and hybrid laser-arc welding technologies for different type of steels and alloys including high-strength shipbuilding steels. Also ILWT produced portal and robotic systems for HLAW process realization. Portal system for hybrid laser-arc welding of panels with dimensions 6x6 m using at the manufacturing of flat curvilinear sections in the shipbuilding is depicted in the article. Results of experimental researches of the hybrid laser-arc welding parameters influence on the formation and mechanical properties of weld joint are described at the publication also. Experimental part was made with using of the portal system.

Peer-review under responsibility of the scientific committee of the Nordic Laser Materials Processing Conference 2017

Keywords:Hybrid lase-arc welding, portal system for welding, panels of flat and curvilinear sections, high-strength shipbuilding steels

* Corresponding author. Tel.: +7-812-552-98-43; fax: +7-812-552-98-43.
E-mail address: kuznetsov_mich@ltc.ru

Peer-review under responsibility of the scientific committee of the Nordic Laser Materials Processing Conference 2017
doi:10.1016/j.phpro.2017.08.005

1. Introduction

Production of the ships is connected with using of the welding technologies (Eyres, 2001). The majority shipyards in the world are using arc welding at the production of ship constructions. Low power density and productivity, high consumption of the welding materials and electricity, significant welding stress and distortion are typically for arc welding. Welding works compose about 50% from total ship production work accordingly (Roland et al., 2004). Therefore implementation of the new high productivity welding methods in the shipbuilding is actual task.

One of the welding methods with high productivity is hybrid laser-arc welding (HLAW). HLAW consists from arc and laser components. Therefore HLAW possesses of the high power density provided deep penetration of the thick metal with high productivity (Jasnau et al., 2002), minimal heat input and welding deformation (Koga et al., 2010). Implementation of the HLAW instead of arc welding methods decreases up to 5 times consumption of the welding materials, schielding gas and electricity.

The first European researches of the laser welding at the production of ship constructions were carried out in 1980. Unified Guidelines for the Approval of CO_2 Laser Welding in Shipbuilding was formed by 1994 year using results of the researches. Thereafter active using of the laser welding technologies in the world shipbuilding was start. German shipyard "Meyer-Werft" applies CO_2-laser welding and HLAW at the productions of the cruise liner panel with length 20 m (Roland et. al., 1997). "Kvaerner Warnow Werft" (Rostock, Germany) is equipped by portal HLAW system on the base Nd:YAG laser. Shipyards Fincantieri (Italy), STX Finland Cruise Oy (Finland), Odense Steel Shipyard (Denmark) are equipped by laser and HLAW systems. Advance shipbuilding countries of the Asian region develop and actively implement of the laser and HLAW technologies in the shipbuilding also (Klæstrup Kristensen, 2013).

Institute of the Laser and Welding Technologies (ILWT) is developing laser technologies including laser welding and HLAW and producing portal (Turichin G. et. al. 2014), mobile and robotic (Zemlyakov E. et. al. 2016) systems for their realization more than 20 years. The processes of the laser and HLAW had described in the research works of the ILWT staff indifferently well. Processes of the plasma flame formation (Turichin et. al., 2006) and welding pool behaviour at the HLAW (Turichin et. al., 2011) are described also. Influence of the HLAW parameters including gap between welding samples (Turichin et. al., 2015) and attitude position on the welding seam geometry and HLAW efficiency (Tsibulskiy et. al., 2014) is studied. Staff of the ILWT have experience of the HLAW pipe steels X80, X100 (Turichin et. al., 2015), modern high strength steels Weldox, armor steels - Armox, wear-resistant steel - Hardox (Turichin et. al., 2016), titanium alloys, nickel alloys, aluminium alloys and other.

The portal system created by ILWT and intended for agglomeration of the panels at the ships building is described in the publication. Results of the experimental research HLAW of the butt joint, angle joint and T-joint from high strength steels using in the shipbuilding are described also.

2. Experimental procedure

2.1. Experimental equipment

HLAW of the high strength shipbuilding steels was realized on the Laser Arc Technological System (LATS). LATS intends for agglomeration of the panels with dimensions up to 6x6 m using at the serial building of the inland cruise and mixed cruise ships (Fig. 1).