High power fiber laser for hulls production in shipbuilding

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Abstract—Application of modern cost-effective laser technologies for the hulls production instead of existing techniques allows increasing productivity and manufacturing accuracy. A 16 kW fiber laser based complex of equipment for shipbuilding industry will be presented. The report describes the experimental work results on flat sections production using laser cutting and hybrid laser-arc welding technologies.

Keywords—hybrid laser-arc welding; laser cutting; flat sections

The realization of new state of art technologies on leading shipbuilding plants is a characteristic feature of modern shipbuilding. Metalwork in shipbuilding often suffers from a lot of deformations caused by high heat input of existing cutting and welding processes (automatic submerged arc welding with preliminary panels plasma cutting). The deformations need to be straightened to achieve flat sections. According to the European shipbuilder’s information distortions correction takes up to 30 percent of the man-hours used in hull production. Decreasing the heat input by using laser processing can reduce distortion.

One of the great interests for shipbuilding industries all over the world is the hybrid welding process. Hybrid welding permits significant time and cost savings by the elimination of multi-pass requirements, taking advantage of the deep penetration offered by this process. Hybrid laser–arc welding allows for the possibility of further modifying the weld bead shape, eliminating undercut, increasing gap bridgeability and reducing the propensity for cracking and porosity compared to autogenous laser welding.

Joint Stock Company "Shipbuilding and Shhiprepair Technology Center“ (SSTC) together with the Saint-Petersburg Polytechnic University conducted research of hybrid laser-arc butt welding of shipbuilding steels with laser cutting edges preparation. Experiments were carried out with the shipbuilding steel E36 with thickness from 7 to 20 mm. Researching work included mechanical testing of samples. Application perspectiveness of hybrid laser-arc welding technology for the production of butt joint of flat sections prepared with laser cutting for the domestic shipbuilding was proved on account of the experimental investigations results.

JSC "Shipbuilding and Shiprepair technology center“ in cooperation with IMG (Germany) have developed an experimental complex of equipment for the flat sections with dimensions up to 12x12 meters production using laser technologies. The complex is designed as a production line including position for assembling and welding of panels, profile mounting position and position for fixing and welding of stiffeners.

The multipoint application of one powerful laser was realized on developed complex. The complex based on 16 kW power fiber laser with four channels optical switcher allowed to transport laser radiation to different working positions. The laser is used for the plate’s edges preparation with laser cutting before welding, for the panel’s hybrid laser-arc butt welding and for the stiffeners hybrid fillet welding.

The obtained experimental and test’s results satisfy the requirements of Russian Maritime Register of Shipping (RS).

The concept of using laser technologies for the complete cycle of flat sections production is implemented for the first time in the world shipbuilding. The main advantages of using laser technologies for flat sections production comparing with traditional techniques are:

- Significantly higher productivity (up to 1.5 – 3.0 times);
- Lower (about 20 – 40 percent’s) material and energy consumption;
- A minimum level of residual welding stresses and strains of welded structures.