Fundamental Study on Underwater Laser Cutting for Dismantling Nuclear Facilities

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1. Introduction

Laser cutting has many advantages when applied to dismantling of nuclear facilities. Since the laser can be delivered by an optical fiber, it is easy to work at a long distance with only a small cutting head. In addition, laser cutting is also advantageous to control the cutting head because it is a non-contact cutting so that there is little reaction force. Moreover, laser cutting has a narrower kerf width, so the amount of secondary waste is less than that of other cuttings.

To apply laser cutting to nuclear dismantling, it is necessary to be able to effectively cut thick steels. Therefore, many researchers in this field including our group have been developing laser cutting technology [1-7]. In addition, underwater cutting is also required for dismantling nuclear facilities. Therefore, underwater laser cutting technology has been also developed [3].

In this work, fundamental study on underwater laser cutting was performed for dismantling nuclear facilities. A waterproof laser cutting head was developed for use in underwater environment. And cutting tests on thick stainless steel plates were performed with this cutting head.

2. Experimental procedure

Fig. 1 shows the view of the underwater laser cutting experiment. A 6-kW fiber laser (YLS-6000, IPG Photonics) was used as a laser source. The laser beam was delivered by a process fiber and entered the developed underwater cutting head. A compressed air was used as an assisting gas. The gauge pressure of the assisting gas was set to be ~1 MPa and the gas flow rate was measured to be 880 L/min expressed under ANR (Atmosphère Normale de Référence) condition (20°C, 101.3 kPa, 65% relative humidity).

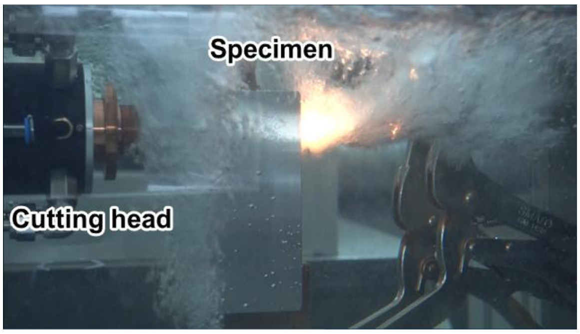

Fig. 1. View of the underwater laser cutting experiment.

50-, 60- mm thick stainless steel plates (SUS304L) were used as specimens. Some specimens were initially mechanically pierced to blow the melt easily near the start point. Cutting processes were started from the center of the hole for pierced specimens and from the side edge for non-pierced specimens. In order to evaluate the cutting performance, the maximum cutting speed of each specimen was measured by changing the cutting speeds by line-to-line.

3. Results and Discussions

When using the pierced specimens, the maximum speeds were measured to be 100 mm/min for 50 mm thickness and 40 mm/min for 60 mm thickness. In these cases, the stand-off distance were set to be 10 mm. When using the non-pierced specimens, the maximum cutting speed for 50 mm thickness was measured to be 80 mm/min. However, the 60 mm thick plates were not able to be cut. To cut the 60 mm thickness, a method of improving cutting near the start point was proposed. With this method, cutting of 60 mm thickness was also done well for the non-pierced specimen.

4. Conclusion

In conclusion, fundamental study on underwater laser cutting was performed for dismantling nuclear facilities. An underwater laser cutting head was developed and the cutting tests were performed. As results of the cutting tests, 50-, 60- mm thick stainless steel plates were effectively cut with this cutting head.

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