Laser Cutting Performances of Thick Stainless Steel Plates With a High-Power Fiber Laser for Dismantling of Nuclear Power Plants

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1. Introduction

Laser cutting is a widely used technology in industry. Recent advances in laser technology have led to the development of a laser capable of optical fiber delivery up to a power level of ~100 kW, and attempts have been made to apply it to facility dismantling. Particularly, in the dismantling of nuclear power plants, laser cutting has been considered as a next generation technology with many advantages. The reason for this is that since the laser is delivered by the optical fiber the small head is placed in the work space. Moreover, it is a non-contact type cutting, so that there is no reaction force. Thus, it is very advantageous for cutting through remote control which is essential because the core facilities of nuclear power plants cannot be accessed by human workers because they have high radiation. In addition to the advantage of remote cutting, the laser cutting has a narrower kerf width compared to other cutting techniques. Thus, the laser cutting can reduce the amount of secondary waste. It is very important to minimize the amount of secondary waste in dismantling nuclear facilities.

For this reason, researchers have been progressing worldwide to develop laser cutting technology. Dismantling of nuclear power plants requires cutting capability for steels with a thickness of 100 mm or more. Therefore, researchers in this field are making efforts to improve the cutting capability [1-5]. Our group has also developed the laser cutting technology. A laser cutting head capable of cutting thick steel was developed. It succeeded in cutting a stainless steel plate up to 100 mm by cutting performance test using a 6-kW fiber laser [4, 5].

In this work, a further cutting study was performed using a higher power laser of 10 kW. Stainless steel plates were cut up to a thickness of 100 mm based on the generally 10-mm cut capability per kW, and the maximum cutting speeds against the thicknesses were obtained.

2. Laser cutting experiment

2.1 Experimental setup

Fig. 1 shows the view of the laser cutting experiment. The cutting started from the side of the specimen and proceeded with the cutting head moving from the right to the left. When the laser was irradiated on the specimen, the assisting gas was supplied simultaneously. A compressed air was used as an assisting gas for blowing off the melt. The gauge pressure was ~1MPa and the gas flow rate was measured to be 470 L/min expressed under ANR (Atmosphère Normale de Référence) condition (20°C, 101.3 kPa, 65% relative humidity).

As specimens, 60-, 80-, 100-mm thick stainless steel plates (SUS304L) were used. Cutting was performed until each line was not cut while changing the cutting speed, thereby obtaining the maximum cutting speed.

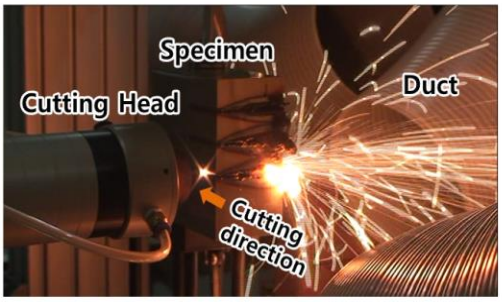

Fig. 1. View of the laser cutting experiment. The cutting started from the side of the specimen and proceeded with the cutting head moving from the right to the left.

2.2 Results and Discussions

Fig. 2 shows the maximum speeds against the thicknesses. For a thickness of 100 mm, the maximum cutting speed was measured to be 30 mm/min. Although a power of 6 kW was able to cut a thickness of 100 mm in our previous work [5], the cutting speed was very low. The maximum cutting speed was measured to be 7 mm/min for a 6-kW laser cutting. Compared to the result of 6-kW laser cutting, the maximum cutting speed was ~4.3 times higher.

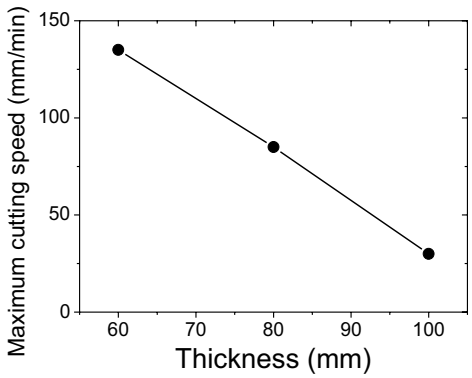

Fig. 2. Maximum cutting speeds against the thicknesses for cutting of stainless steel plates with a 10-kW fiber laser.

3. Conclusion

A cutting study was performed using a higher power laser of 10 kW. As specimens, 60-, 80-, 100-mm thick stainless steel plates were cut. And the maximum speeds against the thicknesses were obtained. For a thickness of 100 mm, the maximum cutting speed was measured to be 30 mm/min. This result can be used as a basic data for laser cutting application to dismantling of nuclear power plants.

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