Torque strength of an endplate welding due to process parameters using a fuel assembling welder

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1. Introduction

As fuel bundles in a PHWR core irradiated, inner pressure in the claddings of the fuel rods increases owing to the outer pressure and fission products of the nuclear fissions. Because of a leak possibility from a welding between a cladding and endplug, this welding part is connected with the safety of nuclear fuel rods. Endplug-cladding welding of nuclear fuel rods in a PHWR takes advantage of a resistance upset butt welding. The weldment between a cladding and endplug is to be sound to prevent a leakage of fission products from a cladding as a UO2 pellet is irradiated[1-2]. Weld flash was made from a deformation due to a welding heat and increasing the pressure of the resistivity and resistance from a cladding and endplug. Weld line of a welding interface, microstructure of a weldment and a crystallographic structure change were sources of an iodine induced SCC in a reactor. The soundness of a weldment is important because a weld line connects the leakage of fission products from an operational reactor[3]. In this study, welding specimens were fabricated by a resistance welding method using a bundle fuel welder to measure and analyze the torque of an endplug-endplate welding. The torque of a weldment between an endplug and endplate was measured and analyzed with the welding time. The weldability of a weldment between an endplug and endplate was investigated by a metallographic examination.

2. Specimens Fabrication and Torque Measurements

The welder consists of a power supply unit, two welding electrodes and a header unit, a x-y storage and a jig plate exchanger unit, an endplate inserting and transfering unit, and a rotation of a fuel bundle unit. The location of the weldment from the outer rod array and intermediate rod array is 31, 37, 12, 16 on the endplate, respectively. Weldment specimens were fabricated with a welding current(3,600, 3,800, 4,000 A), a main electrode pressure(4bar), a branch electrode pressure(2.5bar) and a weldment time(2, 3, 4, 5cycles). Figure 1 indicates the fabricated welding specimen. The torque of the weldment between the outer rod and intermediate rod array on the endplate was measured and analyzed by cutting the welding specimens and using a torque measuring device.

Figure 1.The fabricated welding specimen.

3. Results Analysis and Discussion

Figure 2 shows the torque of the weldment between the endplug and endplate from the outer rod and intermediate rod array with a welding current of 4,000A, a pressure of 4 bar from the main electrode, a pressure of 2.5 bar from the branch electrode and the welding time(2,3,4,5cycles). As the welding time(2,3,4cycles) increases, the torque of the weldment between the endplug and endplate of the intermediate rod array indicates an increasing trend. As the welding time (3,4,5cycles) increases, the torque of the weldment between the endplug and endplate of the outer rod array indicates a similar trend. As the welding time increases, the torque of the weldment between the endplug and endplate of the outer rod and intermediate rod array indicates 10-13 N· m.

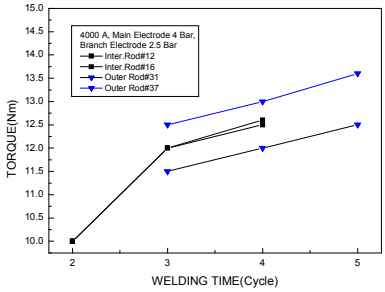

Figure 2.Torque of weldments between endplug and endplate due to welding current 4,000A and welding time.

Figure 3 shows the torque of the weldment between the endplug and endplate from the outer rod and intermediate rod array with a welding current of 3,800A, a pressure of 4 bar from the main electrode, a pressure 2.5 bar from the branch electrode and the welding time. As the welding time(2, 3, 4 cycles) increases, the torque of the weldment between the endplug and endplate of the intermediate rod array indicates an increasing trend. As the welding time increases, the torque of the weldment between the endplug and endplate of the outer rod and intermediate rod array indicates 9-12 N· m.

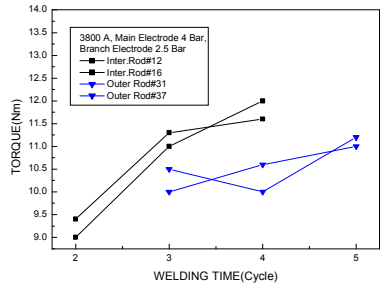

Figure 3.Torque of weldments between endplug and endplate due to welding current 3,800A and welding time.

Figure 4 indicates the torque of the weldments between the endplug and endplate from the outer rod and intermediate rod array with a welding current of 3,600A, a pressure of 4 bar from the main electrode, a pressure of 2.5 bar from the branch electrode and the welding time. As the welding time(2,3,4 cycles) increases, the torque of the weldment between the endplug and endplate of the intermediate rod array indicates an increasing trend. As the welding time (3, 4, 5 cycles) increases, the torque of the weldment between the endplug and endplate of the outer rod array also indicates an increasing trend. As the welding time increases, the torque of the weldment between the endplug and endplate of the outer rod and intermediate rod array indicates 8-11 N·m. Thus, as the welding current(3,600, 3,800, 4,000 A) increases, the torque of the weldment between the endplug and endplate of the intermediate rod and the outer rod array with a pressure of 4 bar from the main electrode, a pressure of 2.5 bar from the branch electrode and the welding time(2,3,4,5cycles) gradually shows an increasing trend.

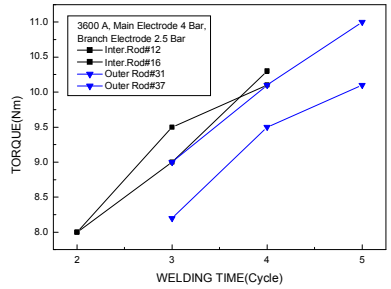

Figure 4.Torque of weldments between endplug and endplate due to welding current 3,600A and welding time.

Figure 5 shows a photograph of the longitudinal cross section of a welding between the endplug and endplate. It is confirmed that the center weldment interface is not melted , yet filled adequately. The torque of the weldment between the endplug and endplate is determined by its weldability. The torque of the weldment the between endplug and endplate will increase with a sound weldability of the welding interface due to a removal of the weld line at the welding interface.

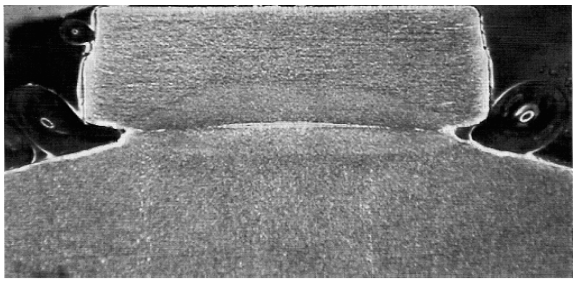

Figure 5. Photograph of cross section of weldment between endplug and endplate(magnification 50).

4. Conclusions

1. The torque of the weldment between the endplug and endplate was measured, and analyzed with the welding current, electrode pressure and welding time.
2. As the welding time(2,3,4,5cycles) increased, the torque of the weldment between the endplug and endplate indicated an increasing trend.
3. The additional examination will be performed for a confirmation of the torque control of a weldment between an endplug and endplate.

REFERENCES

[1] C. J. Park, et al., “A Study on the Characteristics of Zr-4 End Cap Welded Joints Using Resistance Upset Welding”, J. of the Korean Welding Society, Vol. 10, No. 4, p. 241, 1992.
[2] J. W. Lee et al., “An Investigation of Welding Variables on Resistance Upset Welding for End Capping of HWR Fuel Elements”, J. KWS, Vol.7, No.2, p.61, 1989.
[3] J. W. Lee et al., “Mechanical Strength and Ultrasonic Testing of End Cap Welds in Pressurized Heavy Water Reactor Fuel”, J. KWS, Vol.9, No.4, p.61, 1991.