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A Relationship of the Torque Strength between Endplates and Endcaps due to the Welding Parameters

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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 an endcap, this welding part is connected with the safety of nuclear fuel rods. Endcap-cladding welding of nuclear fuel rods in a PHWR takes advantage of a resistance upset butt welding. The weldment between a cladding and an endcap is to be sound to prevent a leakage of fission products from a cladding as a UO_2 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 an endcap. 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 fuel bundle welder to measure and analyze the torque strength of an endplate-endcap welding. The torque strength between endplates and endcaps was measured and analyzed with the welding current and the welding time. The torque strength between endplates and endcaps was, on the whole, within 6.9~12.7 N·m in the range of fabrication specification of the fuel bundles. The weldability of between an endplate and an endcap was investigated by a metallographic examination.

2. Examinations 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, 17, 19 on the endplate, respectively. Weldment specimens were fabricated with a welding current(3,800, 4,000, 4,500A), a main electrode pressure(4bar), a branch electrode pressure(2.5bar) and a weldment time(2, 3, 5cycles). Figure 1 indicates a fuel bundle welder. The torque strength between the endplates and the endcaps was measured and analyzed using a torque measuring device.

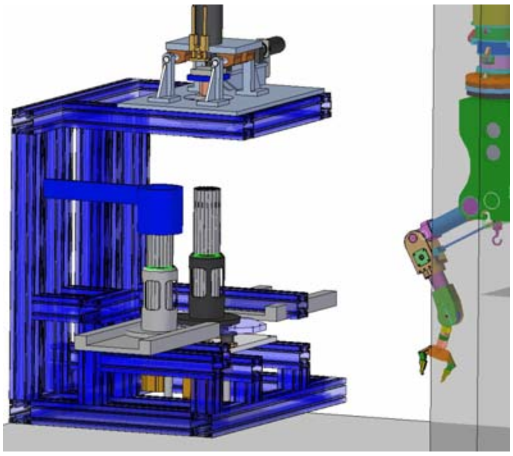

Figure 1. A fuel bundle welder.

3. Results Analysis and Discussion

Figure 2 shows the torque strength between the endplates and the endcaps with a welding current of 3,800A, a pressure of the main electrode of 4 bar, a pressure of the branch electrode of 2.5bar and the welding time 2cycles. The torque strength between the endplates and endcaps indicates 7~11 N·m. The torque strength between the endplates and endcaps was within 6.9~12.7 N·m in the range of fabrication specification of the fuel bundles .

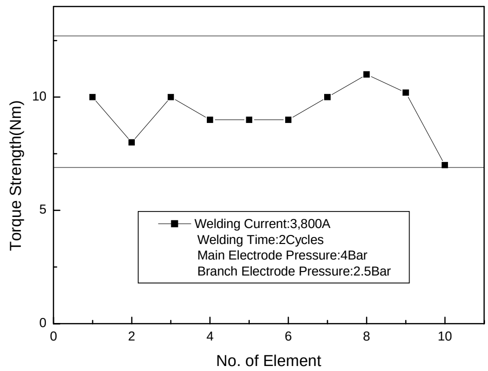

Figure 2.Torque strength between endplates and endcaps due to welding current 3,800A and welding time 2cycles.

Figure 3 shows the torque strength between the endplates and the endcaps with a welding current of 4,000A, a pressure of the main electrode of 4 bar, a pressure of the branch electrode of 2.5bar and the welding time 5cycles. The torque strength between the endplates and endcaps indicates 6.5~15 N·m. The torque strength between the endplates and endcaps was slightly within 6.9~12.7 N·m in the range of fabrication specification of the fuel bundles. The fluctuation of torque strength of the welding time 5cycles is bigger than that of torque strength of the welding time 2cycles.

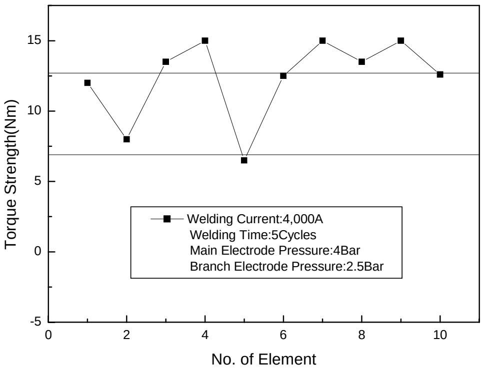

Figure 3. Torque strength between endplates and endcaps due to welding current 4,000A and welding time 5cycles.

Figure 4 shows the torque strength between the endplates and the endcaps with a welding current of 4,500A, a pressure of the main electrode of 4 bar, a pressure of the branch electrode of 2.5bar and the welding time 2~3cycles. The torque strength between the endplates and endcaps indicates 7~10.5 N·m. The torque strength between the endplates and endcaps was within 6.9~12.7 N·m in the range of fabrication specification of the fuel bundles.

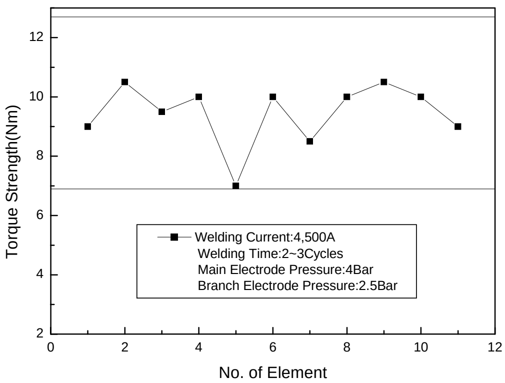

Figure 4. Torque strength between endplates and endcaps due to welding current 4,500A and welding time 2~3cycles.

Figure 5 shows a photograph of a longitudinal cross section between an endplate and an endcap. The torque strength between an endplate and an endplug is determined by its weldability. The torque strength between an endplate and an endcap will increase with a sound weldability of a welding interface.

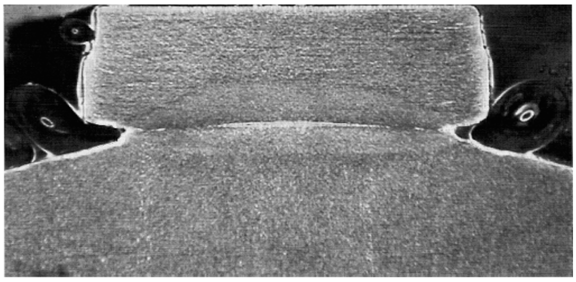

Figure 5. A photograph of a cross section of a weldment between an endplate and an endcap (magnification 50).

4. Conclusions

1. The torque strength between the endplates and the endcaps was measured, and analyzed.
2. The torque strength between the endplates and endcaps was, on the whole, within 6.9~12.7 N·m in the range of fabrication specification of the fuel bundles .
3. The fluctuation of torque strength of the welding time 5cycles is bigger than that of torque strength of the welding time 2cycles.

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.
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