Study on monitoring top end plug resistance weldment of nuclear fuel rod

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1. Introduction

This process is required to get the integrity and obdurability because this part is the most possible radioactive substance spill when a nuclear fuel combusts in nuclear reactor.

Owing to the importance of weldments of the fuel rod, there has been any amount of research into the many welding processes. However the studies on the evaluation of weldments quality have not yet been gained.

Quality analysis methods in the nuclear fuel rod welding areas are an impact test and a structure test by sampling, and current, force, replacement is measured to display the value on indicator.

This study is to manage quality in real time on weldments of top end plug of the nuclear fuel rod. We observed the pattern when changing current and oxidizing the electrode using instantaneous dynamic resistance with the instantaneous value of current and the instantaneous value of volt of the secondary transformer.

2. Material and Methods

2.1 Used Material

Zircaloy, which is frequently used in the cladding material for the nuclear fuel rod, is pure zirconium based alloy with Sn, Fe, Cr, and the chemical composition of Zircaloy is shown in Table 1.

The cladding tube is diameter of 9.5mm, thickness of 0.6mm, length of 100mm (shown as Figure 1), and Fig.1(b) shows a schematic diagram of the welding between end plug and cladding tube.

Table 1: Chemical composition of ZIRLO and Zrrcaloy-4

	Sn	Fe	Cr	Ni	Fe +Cr	Nb	O
Zircaloy-4	1.20 -1.45	0.18 -0.24	0.07 -0.13	<0.0 07	0.28 -0.37	…	0.10 -0.15
ZIRLO	0.9 -1.3	0.8 -1.4	…	…	…	0.8 -1.4	0.1 -0.16

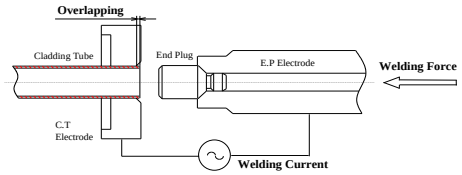


Fig.1 Specimen dimension of sheath and end plug

2.2 Welding Method

Welding machine, which is used in this experiment, is a single phase alternating current resistance welder with the miyachi transformer. To find the welding characteristics according to the condition of welding, we weld to increasing currents of 2kA at a time from shear fracture area to

To predict contamination of the electrode, we oxidized the electrode, and weld it.

When welding, measurement of current and volt is used to the resistance monitoring system(WEM-7000, Monitech)

3. Results and Discussion

3.1 Concept of the instantaneous dynamic resistance

It is difficult to observe the changes using average dynamic resistance (general measured frequency range of 1kHz to 3kHz), because weldments of top end plug of the nuclear fuel rod are welded at 1cycle of welding time. However it can be possible to analysis the amount of variation if the pattern of the precision measured instantaneous dynamic resistance is observed at measured frequency of 50kHz.

$$IDR_j = V_j / I_j, \ \Omega \qquad j = 1,2, \ldots, n$$

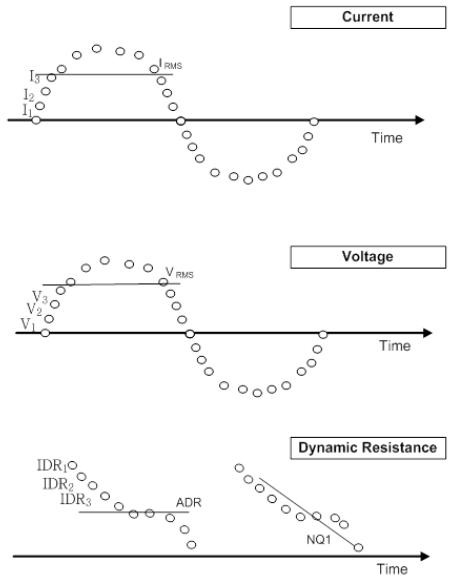


Fig. 2. The concept of IDR

3.2 Analysis of the instantaneous dynamic resistance wave form pattern according to increasing currents.

Figure 3 shows the changes of instantaneous dynamic resistance according to increasing currents. As currents increased, the time that instantaneous dynamic resistance reached to "0" is taken longer. Figure 4 shows that as currents increased, the value of average dynamic resistance per half cycle decreased, but the slope of instantaneous dynamic resistance has been slightly declined. Average dynamic resistance has been lower 2nd half cycle than 1st half cycle, and the slope of instantaneous dynamic resistance has been slightly declined.

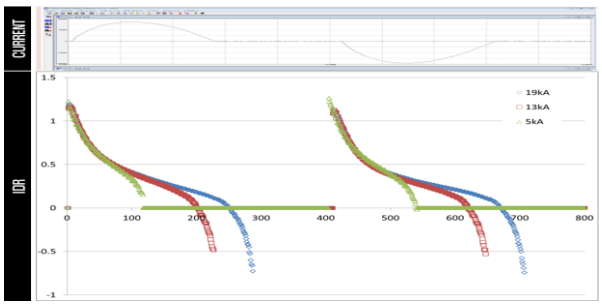
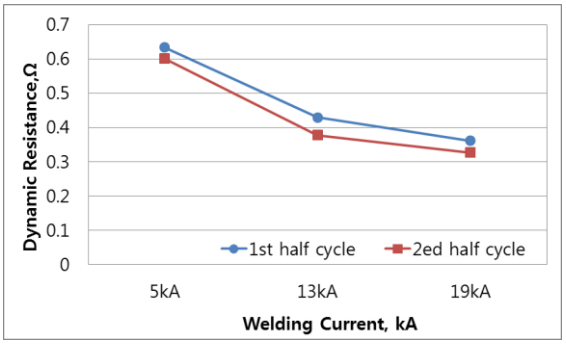
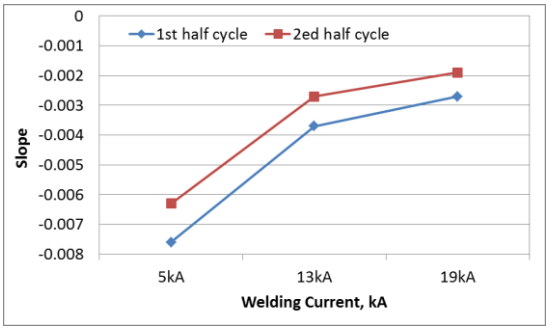


Fig. 3.Instantaneous dynamic resistance pattern according to current increase



(a) Average Dynamic Resistance



(b) Gradient of Instantaneous Dynamic Resistance

Fig.4 Gradient of the average dynamic resistance and Instantaneous dynamic resistance per half cycle according to current increase

3.3 Observation of the instantaneous dynamic resistance pattern according to contamination of the electrode

The experiment on contamination of the electrode is conducted by oxidizing the electrode with torch. Figure 5 shows the pattern of instantaneous dynamic resistance using oxidized electrode. At 1st half cycle, initial resistance value of instantaneous dynamic resistance is lower than the wave form of 13kA in Fig.3, and there is a curvy line at slope section. This phenomenon is estimated because current flow is not smooth due to the oxidized electrode

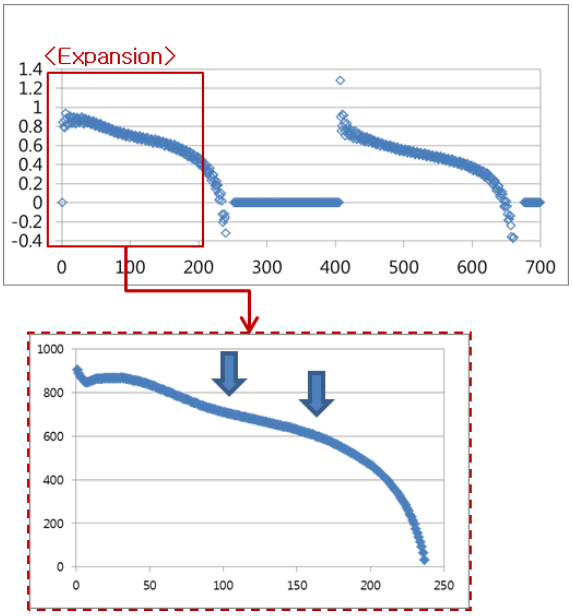


Fig.5 Instantaneous dynamic resistance pattern of oxidation electrode

3. Conclusions

1) Resistance weldments of top end plug of the nuclear fuel rod have a short welding speed of 1cycle, so it is better to increase measured frequency and use instantaneous dynamic resistance per half cycle.
2) In case of welding with the oxidized electrode, it can be judged that the flow of current have been disturbed by instantaneous dynamic resistance.

REFERENCES

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