# Characteristics of SCC Defects of Retired Steam Generator

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## 1. Introduction

Since a commercial operation in 1978, steam generators(SG) of a Korean nuclear power plant were replaced in 1998 with a new one. The steam generators have many types of corrosion defect in the tubes such as pitting, stress corrosion cracking. Since they have corrosion environments such as tube expansion region, crevices, the SG tube is a main concerning part from the viewpoint of corrosion problem. A metallographic examination on the defected tubes could be utilized for setting up a guide line for a safe operation of the steam generators. In this work, a destructive analysis on 50 tubes was addressed, and a relationship among SCC defect location, defect depth, and sludge height was obtained.
The objective of this work is to evaluate the SCC location in terms of the row and column number of the SG and to seek a relationship between crack location and TTS or TSP region.

## 2. Experimental

Tubes extracted from a retired steam generator based on ECT at the site were transferred to the hot laboratory of KAERI. Detailed nondestructive analysis examinations for marking of the defects were taken, and metallographic examinations were carried out in a hot cell. Types and sizes of the defects were characterized by using a high magnification contact camera and scanning electron microscope(SEM), and chemical compositions out side of the tubes was also measured by using EDS. All the crack information was compiled in a database, and a relationship among SCC defect location, defect depth, and sludge height was obtained. Fig 1 shows the analysis procedure on the SG tubes.

## 3. Results and discussion

Though the retired steam generator has a lot of pitting defect, only the SCC defect was considered in this analysis. Types of defect primary water stress corrosion cracking(PWSCC) and outside diameter stress corrosion cracking(ODSCC) at the top of tube sheet(TTS) ot near the tube support plate(TSP). Some cracks were observed at a free span region, At the TTS, circumferential cracks were mainly observed, the maximum depth was near 90% of the tube wall thickness. At the TSP region, axial cracks were mainly detected, a penetration depth was similar to the circumferential ones. A relationship between defect depth and sludge height/location should be analyzed in the next step.

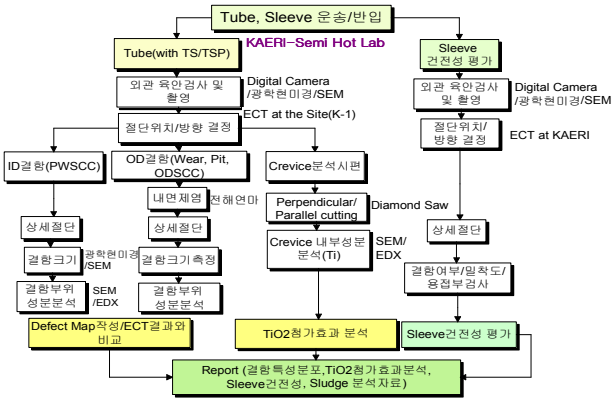


Fig.1 Flow chart of defect analysis

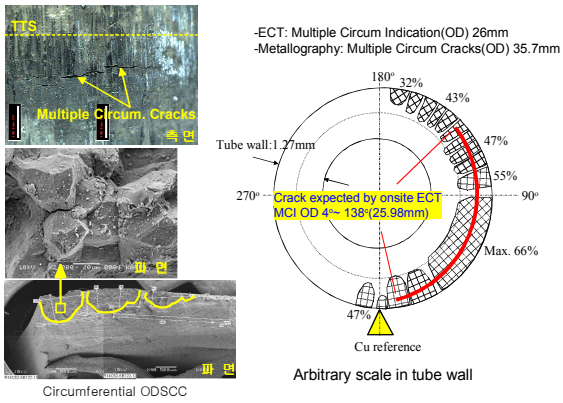


Fig. 2 A representative of a destructive analysis

Fig. 2 is a representative of defect analysis result. Circumferential cracks, of which maximum penetration depth is 60%, were distributed along the half of the circumference.

A relationship between axial cracks height and sludge height is depicted in Fig. 3. Most axial cracks were located at a sludge region. On the other hand, circumferential cracks are in the sludge pile and below TTS as shown in Fig. 4.

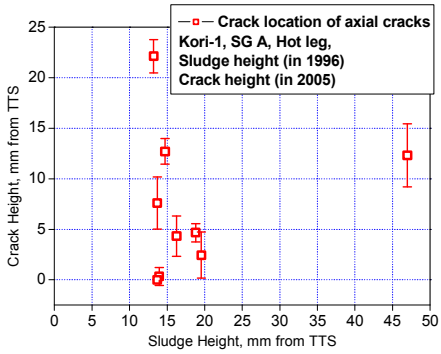


Fig. 3 Relationship between height of axial cracks and sludge height

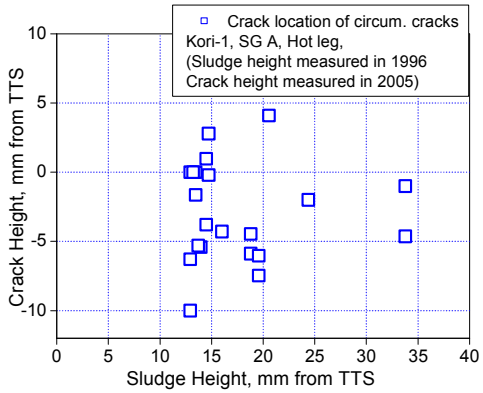


Fig. 4 Relationship between height of circumferential cracks and sludge height

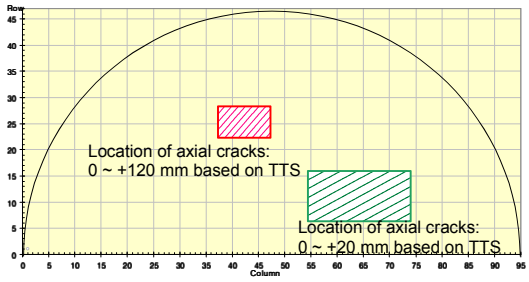


Fig. 5 Distribution of Location of axial cracks.

A SCC location in terms of row and column number was presented in Fig. 5 and Fig. 6. There is a specific region of observed area of axial cracks and circumferential cracks. The location seems to be related to the sludge location and tube expansion region(TTS).

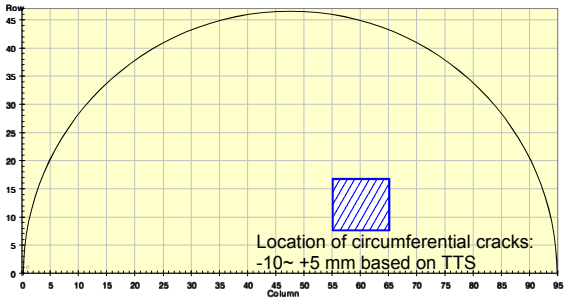


Fig. 6 Distribution of Location of circumferential cracks.

## 4. Conclusions

(1) Many types of corrosion in steam generator at Korean NPPs (Pitting, PWSCC, ODSCC, IGA, Denting) were reported.

(2) Most axial cracks were in sludge pile, whereas circumferential ones were around TTS or below TTS.

(3) No measurable indication between circumferential crack and sludge height was shown.

(4) Cracks were found in various length in a specific zone.

(5) Average defect depth of axial cracks was higher than that of circumferential ones.

(6) No relationship was observed between crack depth and row/column number.

## REFERENCES

[1] Kim, J.S, Hwang, S.S., et al., 'Destructive analysis on pulled tubes from Kori-1 ' Korea Atomic Energy Research Institute, 1989.