Development of Eddy Current Analysis Program for Steam Generator Tubing Data

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1. Introduction

The eddy current testing is widely used for the inspection of steam generator tubes in the nuclear power plant due to high inspection speed and detectability for discontinuities on non-magnetic tubes. The integrity of steam generator tubing is identified by analyzing eddy current data every outage. The Eddynet® system that is currently used in Korea was developed by ZETEC. The Eddynet® is based on the UNIX-based program and it operates on the workstation. In general, the UNIX operating system is unfamiliar to the eddy current analysts and the workstation is relatively heavy and cumbersome. Therefore the Korea Hydro & Nuclear Power Co., Ltd. (KHNP) is developing the new eddy current analysis system which is user friendly and easy to manage. The newly developed program is window-based and operated on the PC platform including laptop computer. The bobbin and rotating pancake coil data from steam generator tubes can be analyzed using this system. This paper describes the characteristics of the newly developed system in detail and the future work.

2. Eddy Current Analysis System

2.1 Current Analysis System

There are some analysis softwares for eddy current data such as Eddynet®, ANSER®, EddyVision®, etc. The Eddynet® developed by ZETEC is currently used for analysis of eddy current data from steam generator tubes in Korea. The Eddynet® software is based on the Unix-based operating system and operates only on properly configured HP workstation [1].

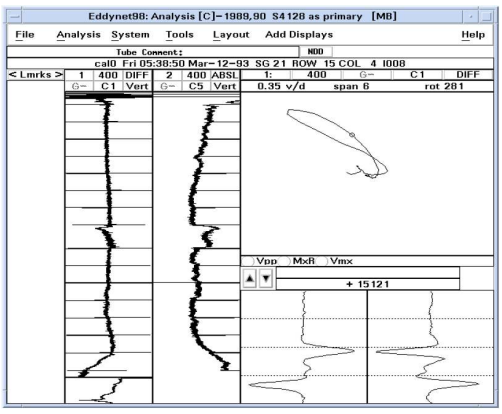

Fig. 1. Analysis window for bobbin data of the Eddynet® system

It is not easy to use the system because the UNIX commands are unfamiliar to eddy current analysts. Also, it is inconvenient for field inspection because it is relatively heavy and large volume. The Eddynet® software is somewhat complex and has many functions. This is because new modules have been added on the original program when a new function was required from the eddy current analysts. Fig. 1 shows the analysis window for bobbin data of the Eddynet® system. The Eddynet® analysis software includes not only the analysis of bobbin and rotating probe data but also the bobbin and multi-coil profile. The additional functions to analyze eddy current data such as calibration, measurement, analyst performance tracking and resolution process are also included.

2.2 Newly Developed Analysis System

The new system which is being developed by KHNP allows multiple users to access to the system as shown in Fig. 2 [2]. Each analyst may log in the system by user specific log-in name and should select an analysis group as specified. A resolution analyst should select the step from the first to the fifth pass.

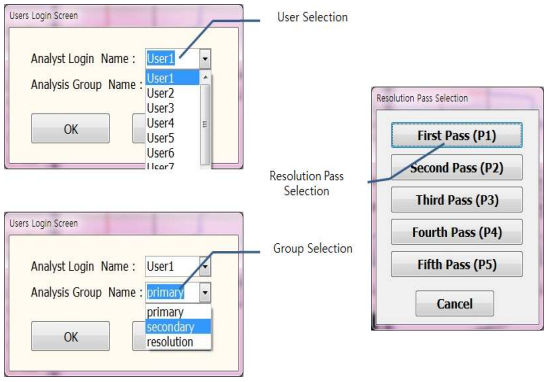

Fig. 2. Multi log-in window in the new system

In the bobbin data analysis, analysts should calibrate data using the ASME standard. The wear scar standards can also be used to construct the calibration curve for the sizing of wear depth in steam generator tubes. The voltage or phase angle setup is required for the measurement of flaw depths as the tube degradation mechanism. In general, the amplitude calibration curve is used for large volume degradation such as tube wear, whereas the phase angle curve is used for pinhole type flaw such as pitting. Calibration curve editors for both of the amplitude and phase angle are shown in Fig. 3.

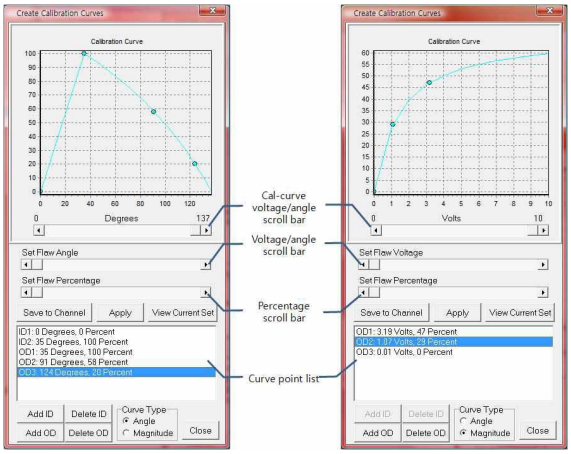

Fig. 3. Calibration curve editors for bobbin data

As shown in Fig. 3, the analyst can construct the calibration curves step by step so-called "manually". However, the calibration process can be established automatically for the consistency between analysts and the prevention of human error. For the automatic calibration, the analyst selects the calibration standard used for data acquisition in a given calibration group and edits the flaw information in the automatic calibration editor field. After editing the information, click the Auto Calibration button on the control panel and the automatic calibration window will appear as shown in Fig. 4. The analyst should choose the signal in the Lissajous window corresponding to the lists of the calibration standard and click the Apply button.

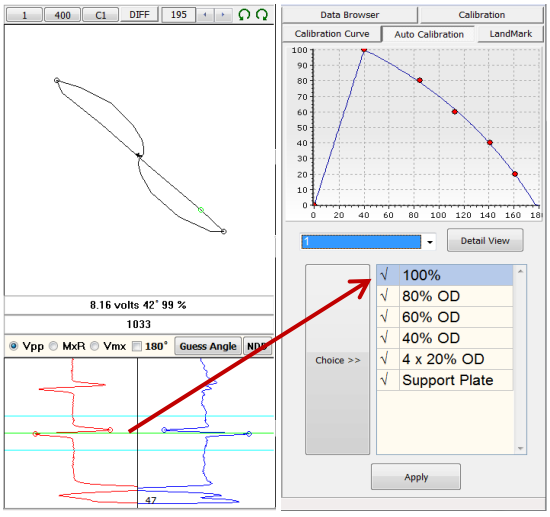

Fig. 4. Auto calibration window

In the data analysis for rotating pancake coil, the C-scan window is very useful for the detection of flaws as shown in Fig. 5. The C-scan window includes the axial and circumferential B-scan windows and some setting parameters. The proper information of the flaw can be shown by the appropriate selection of setting parameters. The selected signal range in the C-scan window is also able to be calibrated in the Lissajous window like bobbin data as shown in Fig. 6.

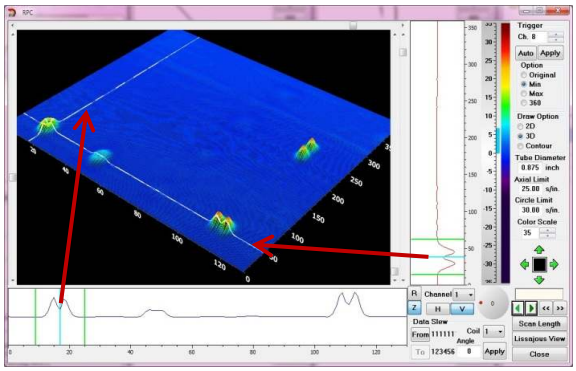

Fig. 5. C-scan window for rotating pancake coil data

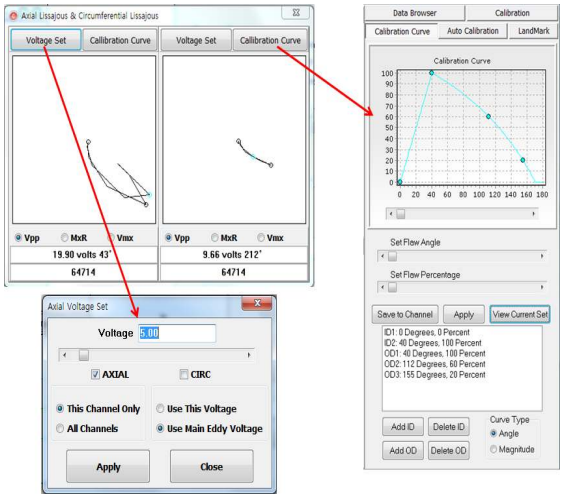

Fig. 6. Calibration process for rotating pancake coil data

3. Conclusion

The KHNP is developing the new eddy current analysis system for steam generator tubing data. The bobbin and rotating pancake coil data acquired from steam generator tubes in the nuclear power plant can be analyzed using this system. It is a window-based system and can be operated on the PC platform while the current system is Unix-based. The bobbin profile analysis and the analyst performance tracking system will be included in the new system through the future work.

REFERENCES

[1] Eddynet®98, Global Menu & Administrative Functions User Guide, ZETEC, 2002.
[2] H. J. Lee, M. W. Nam, C. H. Cho, Development of Advanced Eddy Current Testing System for Steam Generator in Nuclear Power Plants, KHNP, 2011.