Study for Improving an Accuracy of Portable Cable Aging Tester

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1. Introduction

Cables are one of the long life items that have not been considered for replacement during the design life of a nuclear power plant[(hereafter referred to simply as NPP)].

Since extending the lifetime of a NPP is one of most important concerns in the global nuclear industry, extending the cable life beyond the design life has become one of the major issues. To extend the cable life, it is first necessary to prove that the design life is too conservative compared with actual aging.

There are two kinds of method for determining install life of cable. One is conventional method which determines the install life by using experiment data. The other one is condition monitoring method which determines the lifetime by measuring the aging condition of plant cable[1]. Condition monitoring method is getting prevalent since it can make possible the extension of cable life.

KEPRI has developed new portable cable indenter which can be used for condition monitoring of cable aging. Indenting method and test results to find best accuracy of indenting is described herein.

2. Methods and Results

2.1 Principle of Cable Indenting

Cables exposed to a harsh environment in a NPP tend to show signs of aging degradation. One of these symptoms is the hardening of the cable material. An indenter was designed to measure the hardness of the cable jacket by EPRI[2]. It is a very convenient tool for condition monitoring of nuclear cables since it uses a non-destructive method for diagnosing the extent of cable aging. This tool uses the modulus value, which is calculated by dividing the force by the moving distance of the anvil, to detect aging degradation of the cable. Figure 1 shows a picture of a portable cable indenter developed by KEPRI[3,4]. Figure 2 shows "Force-distance" curve for the portable cable indenter. Figure 3 shows the operating flow of portable cable indenter.

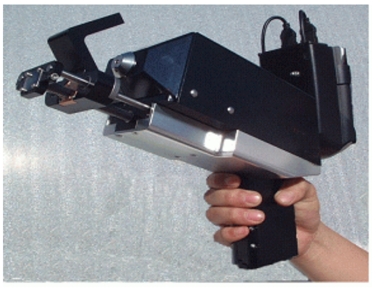

Figure 1. Portable Cable Indenter

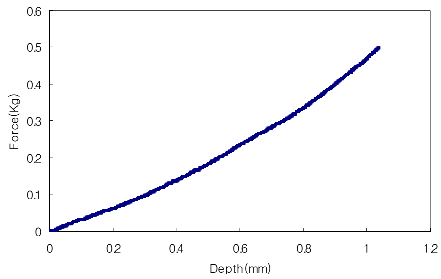

Figure 2. Force-Distance Curve of Cable Indenter

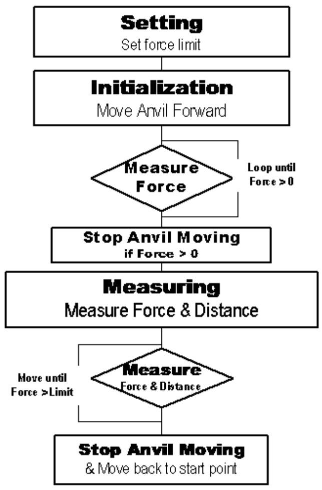

Figure 3. Operating Flow of Cable Indenter

2.2 Study for Optimizing the Indenting Accuracy

2.2.1 Clamping figure and indenting speed

Test specimen of Cable should be firmly fixed by clamp to optimize the indenting accuracy. Clamping force is limited at 2 Kg_f by using torque limiter. To find the best test condition of the indenter, several tests were performed by changing clamp types and probe speeds. I have tried the 10 times indent test with clamp of V-block type and truncated cone type as shown on Figure 4. Indenting probe consists of Φ 2mm bar and truncated cone of Φ 0.56mm end. As result of measuring deviation, clamp of truncated con type had less deviation than V-block clamp. For the indenting speed, 0.03mm/sec had lowest deviation as shown on Figure 5.

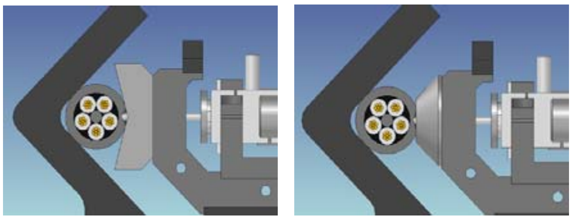

Figure 4. V-block and Truncated cone type clamp

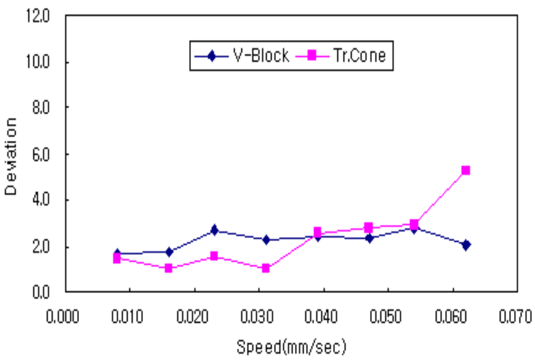

Figure 5. Measuring deviation for clamp type and probing speed

2.2.2 Indenting force and depth

To find the proper force and depth of indenting, I have monitored force and depth values during cable indenting. Indenting force is limited at 0.5Kg_f. Figure 6 shows the relations between modulus and indent depth for 116 ℃ accelerated aging of CSP cable. As shown on figure 6, modulus value had almost constant value during a cycle of indenting even an ignorable fluctuation is shown in the beginning of indenting. Since the indent force seems to not give an effect to modulus value, 0.5kgf, which does not give damage to cable jacket, is proper. For the indenting depth, most of indenting depths show below than 1mm. 2mm length of truncated cone probe is good enough to cover soft and hard materials.

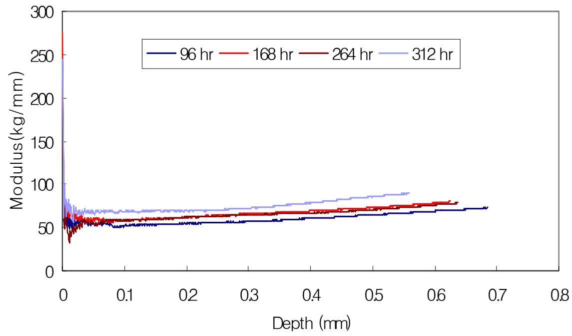

Figure 6. Relation between modulus and indent depth

3. Conclusion

New portable cable indenter is developed for non-destructive diagnosis of cable aging. As result of experiment, it is confirmed that the best accuracy of indenter can be achieved by using truncated con type clamp, indent speed of 0.03mm/sec, 0.56mm contact point and 2mm long truncated cone type probe, indenting force of 0.5Kg_f. Since extending the cable life beyond the design life has become one of the major issues in Korea NPPs, new portable cable indenter will be a useful tool for condition monitoring of cables in nuclear power plants.

REFERENCES

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