Decontamination of Steam Generator tube using Abrasive Blasting Technology

B.Y. Min [a*], G.N. Kim [a], W.K. Choi [a], K.W. Lee [a], D.H. Kim [b], K.H. Kim [b], B.T. Kim [b]
[a]*Korea Atomic Energy Research Institute D&D Technology Development Dept., 1045 Daedeok-daero, Daejeon*
[b]*Sunkwang Atomic Energy Safety Co., Ltd., 553-2, Yongsan-Dong, Yousung-Gu, Daejeon*
[*]*Corresponding author: bymin@kaeri.re.kr*

1. Introduction

As a part of a technology development of volume reduction and self disposal for large metal waste project, We at KAERI and our Sunkwang Atomic Energy Safety (KAES) subcontractor colleagues are demonstrating radioactively contaminated steam generator tube by abrasive blasting technology at Kori-1 NPP. A steam generator is a crucial component in a PWR (pressurized Water Reactor). It is the crossing between the primary, contaminated, circuit and the secondary waste-steam circuit. The heat from the primary reactor coolant loop is transferred to the secondary side in thousands of small tubes. Due to several problems in the material of those tube, like SCC (Stress Corrosion Cracking), insufficient control in water chemistry, which can be cause of tube leakage, more and more steam generators are replaced today. Only in Korea, already 2 of them are replaced and will be replaced in the near future. The retired 300 ton heavy Steam generator was stored at the storage waste building of Kori NPP site. The steam generator waste has a large volume, so that it is necessary to reduce its volume by decontamination. A waste reduction effect can be obtained through decontamination of the inner surface of a steam generator. Therefore, it is necessary to develop an optimum method for decontamination of the inner surface of bundle tubes.

The dry abrasive blasting is a very interesting technology for the realization of three-dimensional microstructures in brittle materials like glass or silicon. Dry abrasive blasting is applicable to most surface materials except those that might be shattered by the abrasive. It is most effective on flat surface and because the abrasive is sprayed and can also applicable on 'hard to reach' areas such as inner tube ceilings or behind equipment. Abrasive decontamination techniques have been applied in several countries, including Belgium [1], the CIS [2], France [3] Germany [4], Japan [5], the UK [6] and the USA [7]

2. Methods and Results

In this section some of the techniques used to model the detector channel are described. The channel model includes a SiC detector, cable, preamplifier, amplifier, and discriminator models.

2.1 Material

A steam generator tube withdraw from Young-kwang NPP site. A bundle tube has been cut in slice of about 20mm length. The inner surface of steam generators has been contaminated by cobalt etc. Bundle tubes were made of inconel alloy. The outside shell is completely free released with a minimal follow up treatment (grinding of the contaminated surface). Fig.1 shows the specimen of SG's tube. Alumina #80 was used as an abrasive particle for dry abrasive blasting experiment. As an abrasive blasting media, it is harder than most common dry abrasive media and will cut even the hardest metals and surfaces.

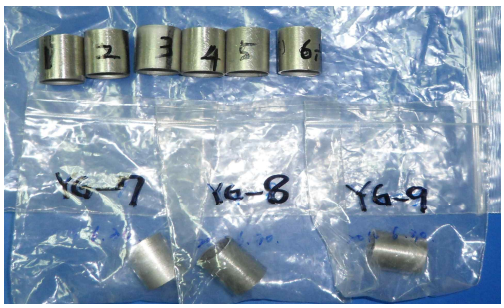

Fig. 1. Specimen of S/G tube

2.2 Experimental

The abrasive blasting technique, which uses abrasive materials suspended in a medium that is projected ion the surface being treated, results in a uniform removal of surface contamination. The dry abrasive blasting equipment consists of nozzle, protection room, cyclone, dust collector, air compressor shown in Fig. 2. The inner surface of a contaminated inconel tube can be decontaminated by abrasive particles from nozzle. Abrasive particles hit the back wall in a protection room, and fall into its bottom, and were collected in a temporary container. Compressed-air is normally used to carry the abrasive. Removal surface material and abrasive are collected and placed in appropriate container for treatment and/or disposal. The total length of inconel hot tube for the experiment is 10m, which could be separated into 5 pieces. A 20mm of inconel hot tube specimen was inserted between two pieces at 1m, 3m, 5m, 7m and 9m point, which were able to be separated after the experiment finished to measure specific activity. Experiments were executed for 3min, 6min and 7min 40sec.

Fig. 2. The dry abrasive blasting equipment

2.3 Results

The Fig. 3, 4 and 5 shows the test result of decontamination for radioactively contaminated steam generator tube by abrasive blasting technology at Kori-1 NPP. The removal efficiency of radionuclide was increased upon increasing the blasting time and distance. With respect to the decontamination factor, specimen of 9m point of the performed 2nd decontamination step was more effective than that of the other connected point owing to turbulence effect of pressured air with abrasive. Decontamination factor of 9m point was achieved about 15,000.

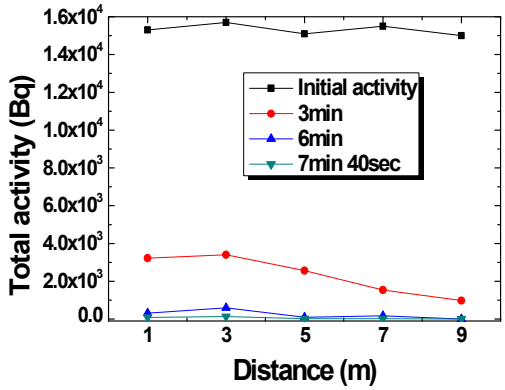

Fig. 3. The change of the total activity with blasting distance

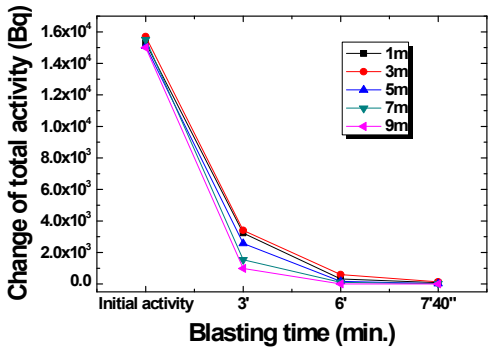

Fig. 4. The change of the total activity with blasting time

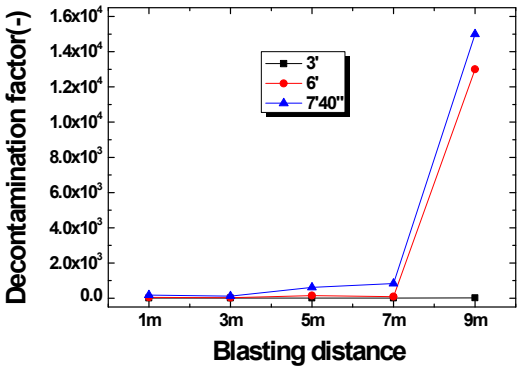

Fig. 5. Decontamination factor

3. Conclusions

A decontamination test was performed for a radioactively contaminated inconel tube with abrasive blasting system. The abrasive blasting techniques have proved effective and give result in a relatively short time. Decontamination factor of about above 15,000 was achieved at 9m (blasting time: 6min)

REFERENCES

[1] V. MASSAUT, M. KLEIN, and A. LEFEBVRE, Pilot dismantling of the BR3 pressurized water reactor, ICONE-3; Nuclear Engineering (Proc. 3rd JSME/ASME Joint Int. Conf. Kyoto, 1995), American Society of Mechanical Engineers, New York 1719-1724, 1995

[2] N.I. AMPELOGOVA, Y.M. SIMANOVSKY, and A. A. TRAPESNIKOV, Decontamination in Nuclear Power Engineering, Energoizdat, Moscow, 1982

[3] A. JUAN and S. ROUDIL, Innovative decontamination processes applied to an actual decommissioning operation, Decommissioning of Nuclear Installations (Proc, 3rd Int. Conf. Luxembourg, 1994), Office for Official Publications of the European Communities, Luxembourg, 370-373. 1995

[4] P. BORNER, et al., Decommissioning of the HOBEG fuel element fabrication plant in Germany, Decommissioning, Decontamination and Reutilization of Commercial and Government Facilities, American Nuclear Society, La Grange Park, IL 412, 1997

[5] T. ISHIKURA, Development of Decontamination and Decommissioning Techniques for Commercial NPPs in Japan, Nuclear Power Engineering, Tokyo, 1996

[6] G.D. JONES and D.J. LYALL, "Nuclear submarine prototype post-core removal decommissioning and life extension'', Nuclear Decommissioning – The Strategic, Practical, and Environmental Considerations (Proc. Int. Conf. London, 1995), Mechanical Engineering Publications, London 119-126, 1995

[7] L.E. BOING and M.J. COFFEY, Waste Minimization Handbook, Vol. 1, Rep. ANL/D&D/M-96/1, Argonne Natl Lab., Argonne, IL, 1995.