Development of Milling Machine to Decontamination Radioactive Metal Waste

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1. Introduction

Decommissioning of nuclear power plant has become one of the most hot issues recently in Korea and abroad, so does the importance of technologies/techniques involved in dismantling and decontamination of materials and components of decommissioned nuclear power plant, especially for large component such as steam generator, reactor head, etc.

These large components for decontamination for disposal purposes, unlike decontamination of component in service in an operating nuclear power plant, selecting physical decontamination technique with a relatively high efficiency could be advantageous because decontamination process can be done aggressively without concerns for mechanical integrity of the component. However, in applying physical decontamination technique. many other factors should be considered such as the amount of secondary wastes, proper radiation protection and worker's radiation safety.

In this study, we developed milling decontamination equipment for metal surface decontamination with multiple radiation protection features.

2. Main subject

2.1 Milling

Water compartment channel head of replaced steam generator was chosen for decontamination by milling process. The specimen was taken for decontamination from the channel head which has a large curvature shape and it is quite a big specimen which dimension is 500x250x150 mm.

In consultation with IAEA report on decontamination technologies [1], target level of decontamination process was decided to remove its surface by milling operation sufficiently enough to cover 16 μm thickness of radioactive crud of steam generator.

Sequence of testing decontamination process as follows; The specimen is secured at the lathe properly. Then, the heights of its fine elements drawn on the surface are measured element by element through the work probe to numerically express the shape of the specimen. The result is loaded to the control unit of the lathe. Now, the measured value is the basis. Enter the thickness you want to milling here to complete the data setup. By making the first measurement with the work probe, this will secure uniformed milling operation on curved or various formed surface of the component, thus providing uniformed decontamination and preventing unwanted excessive production of secondary wastes, After the specimen setting is completed, milling cutter rotates and perform its milling operation along its path in accordance with numerical input data representing the specimen's shape.

Cutting surface is slightly overlapped to eliminate blind spots.

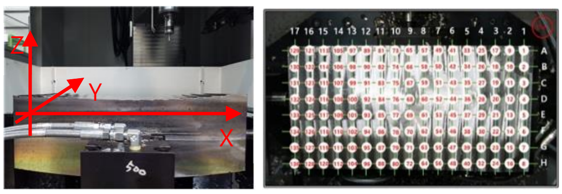

Fig. 1. Measurement [Work probe (left), point (right)].

2.2 Results of Decontamination process

Fig. 2 shows the average of each X-axis and showing the heights difference of each element before and after milling operation. Although there are some deviations due to overlapping operation, it is confirmed that cutting has been made more than the input value over all sections.

According to the above results, it was confirmed that the numerical curvature surface can be decontaminated almost uniformly through the curvature, with a range of the input values from 0.01 to 1 mm. Decontamination target can be reached without much difficulty.

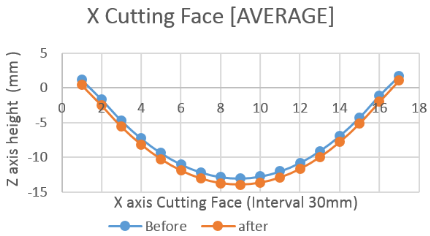

Fig. 2. Before / after X axis milling [Line 1 to 17].

2.3 Radiation protection

Radioactive dusts generated during milling operation cause worker and work space contaminated. Therefore, milling operation was done in a box-shaped closed structure. This container was equipped with ventilation system with HEPA filter on top of it and inside of the container was maintained negative pressure in order to prevent dust dispersal. Control of decontamination process by milling operation was performed outside of the container by remote control and radioactive chips from milling operation were not handled by worker but directly transferred to the waste drums through a conveyor belt.

Since cutting oil commonly used in milling operation generates a large amount of secondary wastes, misty-type oil injection was adopted. This type only needed a small amount of oil injecting to the cutting portion and most of it was vaporized due to heat generated during milling operation and was treated by HEPA filters, thus, significantly reduced the amount of secondary wastes.

In addition, the automatic tool changing system was adopted so that tools were changed automatically during a set of operation without worker's intervention, thereby reducing the risk of workers' exposure and contamination.

Fig. 3. Milling Equipment.

In consideration of radiation safety of the equipment operator, the process was controlled remotely by an operator at a distance of around 10 m. The whole process was fully monitored through internal CCTV, allowing the operator to easily watch and follow up if necessary without the risk of exposure.

3. Conclusion

We have developed milling equipment for decontaminating metal surface which enables to remove radioactive surface of large component of nuclear power plant such as steam generator, reactor head, etc. uniformly without being affected by curvature of the surface of the component. It can make it possible to reduce excessive amount of secondary wastes due to overcutting the metal surface. This milling machine can be set up in the range of 0.01 ~ 1 mm(1,000 μm), i.e.,_it can remove metal surface up to the thickness of 1,000 μm, far deeper than 16 μm known as the thickness of radioactive crud of steam generator. So, complete decontamination of metal surface of the component by milling machine we develop is possible.

In addition, by adopting various radiation protection features, minimum radiation exposure to workers can be expected.

In the future, this type of decontamination equipment with high-tech controllers to cope with various sizes and shapes in conjunction with various form of radiation protection features can handle decontamination process more effectively with minimum secondary wastes.

Acknowledgements

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REFERENCES

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[2] Final report on Application of Decontamination & Dismantling Technology for Old Steam Generator.