Analysis of Inhalation Dose Rate to Workers in NORM Industries : Packing Area

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1. Introduction

Internal exposure to workers can occur in industries handling naturally occurring radioactive materials (NORM) due to inhalation of airborne particulates containing radioactive materials. International Atomic Energy Agency (IAEA) suggested industry sectors as being the most likely to require some form of regulation consideration [1].

Inhalation dose to workers varies with particulate properties including airborne particulate concentration and radioactive concentration. It means that necessity of safety management may vary with exposure situation. Analysis of inhalation dose to the workers according to industry sector and working type is necessary to implement safety management to NORM industry.

The objective of this study was to analyze inhalation dose rate to the workers in NORM industries. We focused on packing area because workers at the area are highly exposed to airborne particulates. Analysis of inhalation dose rate was implemented for monazite, zircon, and bauxite industries in Korea.

2. Materials and Methods

The major processing area expected to generate airborne particulates was selected as packing area based on previous studies. In this study, we selected six facilities to analyze inhalation dose rate to the workers at packing area (Table 1).

Table 1. Six industries for inhalation dose assessment

Facility	Materials treated in the packing area
A, B	Product containing monazite
C, D	Product containing zircon
E, F	Product contacting bauxite

Airborne particulates concentration was measured by using cascade impactor. Airborne particulate was collected at a flow rate of 28.3 L/min.

The measurement of the radioactive concentration of materials taken from the packing area was performed using HPGe detector. Radioactive equilibrium of uranium and thorium decay series for the materials treated at packing area was assumed. Fig. 1 shows cascade impactor and HPGe detector that used in this study.

Fig. 1. Cascade impactor (left) and HPGe detector (right).

Inhalation dose rate to workers was calculated based on actual measurement data. Breathing rate was used as 1.2 m^3/h suggested by International Commission on Radiological Protection (ICRP).

3. Results and Discussion

Fig. 2 shows airborne particulate concentrations collected from six NORM facilities. Airborne particulates concentration ranged 0.067-0.511 μg/L. Airborne particulate concentration was the highest for facility B. It was the reason that ventilation system was not operated at the packing area for facility B.

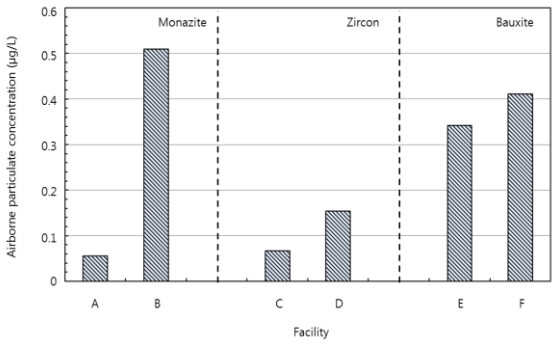

Fig. 2. Airborne particulate concentration in packing area for six NORM facilities.

Fig. 3 shows the radioactive concentrations. Radioactive concentration of material treated at packing area was 53.9-2,883 Bq/kg for uranium series and 145-11,900 Bq/kg for thorium series. Radioactive concentration of uranium decay series was the highest for zircon industry. In the case of thorium decay series, monazite treated in facility A was the highest.

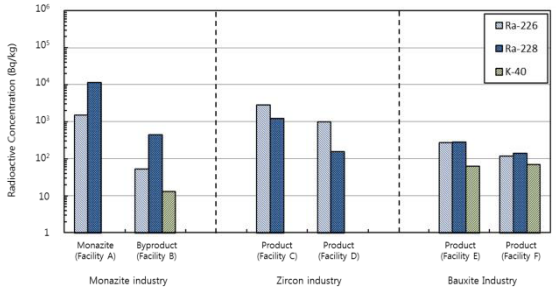

Fig. 3. Airborne particulate concentration in packing area for six NORM facilities.

Inhalation dose rate was calculated based on the particulates properties and exposure situation. Inhalation dose rate ranged 4.95×10^{-6} - 5.10×10^{-5} mSv/h. Inhalation dose rate was the highest at facility A as 5.15×10^{-5} mSv/h. It was reason that radioactive concentration of thorium decay series was up to 40 times higher than the other materials. The most difference of inhalation dose rate according to facilities was caused by airborne particulates concentration and radioactive concentration.

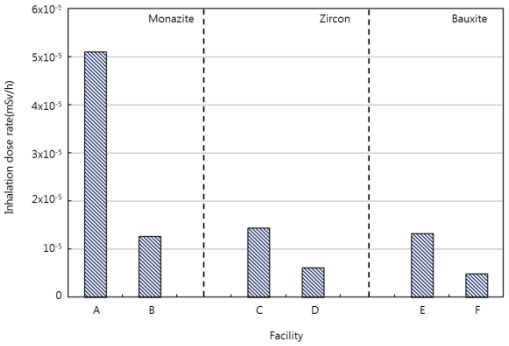

Fig. 4. Inhalation dose rate in packing area for six NORM facilities.

4. Conclusion

We analyzed the internal dose rate to the workers at packing area in NORM industries. Internal dose rate varied with airborne particulate properties. The results of this study can be used for characterizing radiation exposure at Korean NORM industries.

ACKNOWLEDGMENTS

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REFERENCES

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