Assessment of Radiation Dose to Workers by Potassium Compound in NORM Industries in Korea

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Background

❖ The use of potassium compound in Korea

- In Korea, more than 30 potassium compounds such as KCl, K_2CO_3 have been registered by the act on safety management against natural radiation environment and used as industrial raw materials.
- Potassium compounds are used as a raw material for various products such as fertilizers, food additives, metal flux and potassium based products.
- Potassium compounds are also used as a catalyst in industries such as the semiconductors, plastic resins, synthetic rubber.

❖ Characteristics of exposure to potassium compound

- A radioactive isotope of potassium, K-40, has a natural abundance of 0.012% in potassium (K).
- Radioactivity concentration of K-40 in potassium compounds is always less than 30.6 Bq/g, this being the radioactivity concentration of K-40 in pure potassium.
- The compounds with a high ratio of potassium may have radioactivity concentration of K-40 exceeding 10 Bq/g.
- It is necessary to assess the exposure level of workers processing high-purity potassium compound in large quantities.

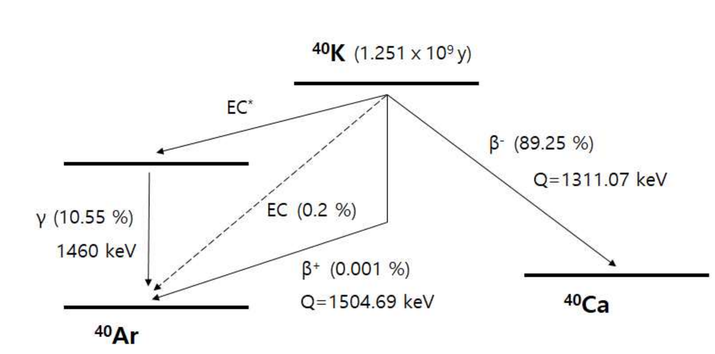

Figure. 1. Decay scheme of K-40

Objective

❖ To assess the annual radiation dose to workers in workplaces processing potassium compounds in Korea.

Materials and Methods

❖ Survey of potassium compound facilities

- In survey, a total of 29 facilities processing potassium compounds were assessed for radiation dose to workers.
- Annual processing amounts of potassium compounds, main exposure pathway, and working time at main processing areas were surveyed.
- The main exposure pathways for work with potassium compounds are external exposure due to gamma radiation and internal exposure from inhalation of particulates.

Figure. 2. Handling of potassium compound

❖ Measurement of radioactivity concentration

- Radioactivity concentration of K-40 was analyzed for 9 types of potassium compounds such as KCl, K_2CO_3 and KOH.
- Radioactivity concentrations were measured by gamma-spectroscopy using HPGE detector.

❖ Assessment of external dose to worker

- Radiation dose to workers resulting from external exposure was assessed using the directly measured ambient dose equivalent rates (H*(10)) and hypothetical exposure scenarios.
- Dose rates were measured at the specific positions of selected workers who were expected to receive a relatively high radiation dose.

❖ Assessment of inhalation dose to workers

- Inhalation dose coefficients were derived based on the ICRP-66 human respiratory tract model (HRTM) and actual measurement data of airborne particulates.
- Inhalation dose to workers were calculated using dose coefficient and hypothetical exposure scenario at potassium compounds facilities.

Table. 1. Example for interview results at processing areas.

Facility	Work type	(working time)
Facility A	- Transportation of potassium compounds - Packing products	(1 hours/day) (30 min/day)
Facility B	- Input of potassium compounds - Packing products	(2 hours/day) (4 hours/day)
Facility C	- Input of potassium compounds	(30 min/day)
Facility D	- Input of potassium compounds - Packing products	(30 min/day) (6 hours/day)

Result and Discussion

❖ Radioactivity concentrations and amounts

- Radioactivity concentration of K-40 were analyzed in the range of 6.3 - 21.7 Bq/g for 9 types of potassium compound.
- Radioactivity concentration of more than 70% of the potassium compound exceeded 10 Bq/g.
- Annual processing amounts of potassium compound range from 65 MBq to 4,200,000 MBq.
- Fertilizer and potassium compound products manufacturers showed relatively high processing amounts of 300,000 - 4,200,000 MBq/yr.

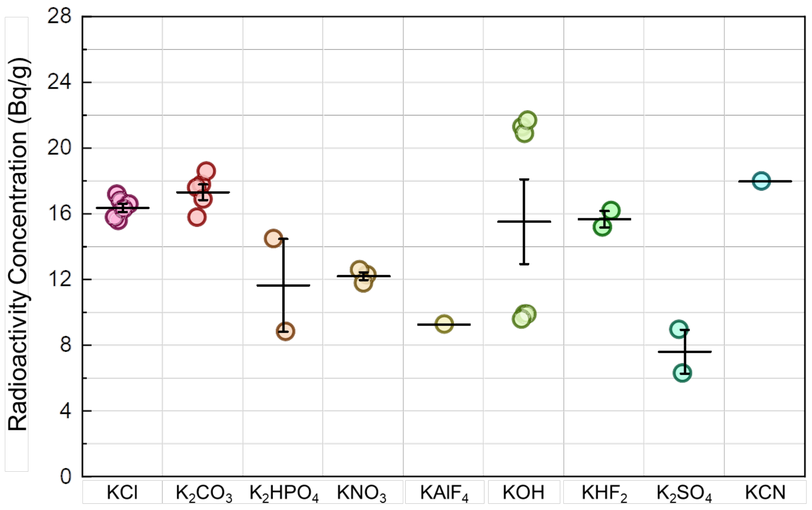

Figure. 3. Radioactivity concentration of potassium compound

❖ Radiation dose to workers

- Annual radiation dose to workers was assessed as an average of 0.11 mSv/yr and a maximum of 0.54 mSv/yr in the field of KNO_3 production.
- The effective dose of all workers, the radiation dose resulting from external exposure accounted for more than 99%, and inhalation dose was not significant at several nSv/yr.
- The effective dose to workers due to potassium compounds is expected to be almost less than 1 mSv/yr, the level for exemption of bulk NORM suggested in the IAEA GSG-7.
- The average of radiation dose to workers is similar to the K-40 exposure level (0.17 mSv/yr) due to potassium homeostasis in the human body.

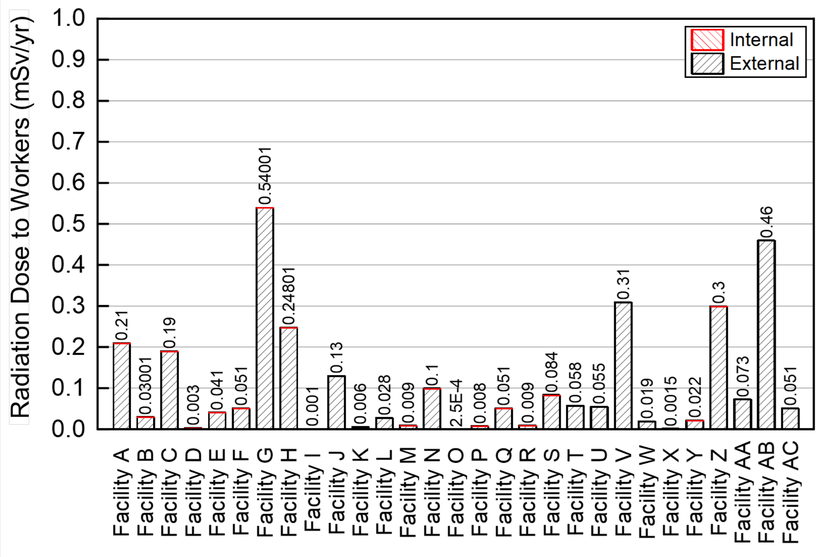

Figure. 4. Radiation dose to workers processing potassium compound

❖ Characteristics of workers processing large amounts of potassium compound

- In the process where a large amount of potassium compounds are processed, such as fertilizer manufacturing, heavy equipments (ex. shovel loaders or tank lorries) are mainly used or operated as a closed system.
- The radiation dose to workers processing a large amounts of potassium compound did not increase significantly because the workers were separated from the potassium compound by a certain distance (ex. heavy equipments) or the processing time was short (ex. closed system).

Conclusion

❖ We assessed the radiation dose to workers processing potassium compound in Korea.

❖ Radiation safety management for workers processing potassium compound needs to focus on external exposure.

❖ A graded apporoach with other NORM industries may be necessary in consideration of the level of exposure.

❖ The results from this study will contribute to the optimization of radiation protection in NORM industry.

Acknowledgement

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