Development of Hand-Held Equipment for Safeguards Applications On-Site

In-Jung Chang, Jung Youn Choi and Heejun Chung*
Korea Institute of Nuclear Nonproliferation and Control, 1534 Yuseong-daero, Yuseong-gu, Daejeon, 34054
**Corresponding author: hjchung2@kinac.re.kr*

1. Introduction

The international society, including IAEA, is promoting to develop techniques for timely detection and verification of undeclared nuclear activities. Those undeclared activities can be found by environmental sampling analysis in air, soil, or water. Typically, the samples are obtained by an inspector and transferred to the Network of Analytical Laboratories (NWAL). It generally takes about one to six months for detailed analysis of samples in the lab.

Therefore, the demand exists for developing portable hand-held equipment for safeguards applications on-site in order to quickly and timely detect suspicious activities [1]. Korea Institute of Nuclear Non-proliferation and Control (KINAC) has developed new hand-held equipment for airborne sampling, radiochemical preparation, measurement, and analysis on-site.

2. Air Sampler

A high volume air sampler is generally used to collect airborne uranium particles, but it is difficult to rapidly deal with some surprised actions like atomic bombing due to its heavy size. Thus, a portable air sampler has been developed, but another problem came out, analysis accuracy and limited run-time to operate since captured volume and battery capacity are insufficient.

Therefore, KINAC has developed portable large volume air sampler (*air sampler*), which can capture more volume of air (600~1,000 L/min) than other portable samplers (70~100 L/min). The external lithium battery (1390 Wh) was designed for longer operation.

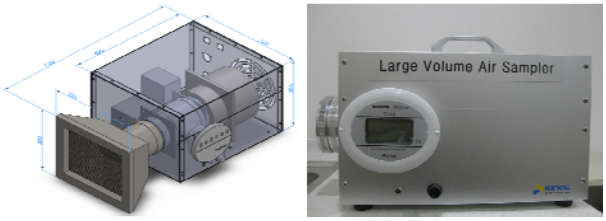

Fig.1. *Air Sampler* developed by KINAC

Air sampler [Fig.1] has been designed and built with a size of 346(W) mm × 625(D) mm × 254(H) mm and a weight of 13 kg. In order to analyze the airborne particles captured by a filter (TFA 810), some radiochemical pretreatment steps have to be required [2]. The steps are usually complicated and require longer time. Accordingly, KINAC has developed two types of portable radiochemical preparation equipment.

3. Portable Radiochemical Preparation Equipment

Typically, alpha spectrometry is applied for the assessment of uranium particle concentrations, but some notorious pretreatment steps [Fig.2] have to be required since the particle concentration in environmental samples is low. For that reason, the analysis of the environmental samples is generally carrying out in the qualified laboratory like NWAL, and takes a long time.

Therefore, KINAC has developed two pretreatment systems, *automated uranium separator* and *nuclear material sampler*, with the purpose of timely detection of undeclared nuclear activities.

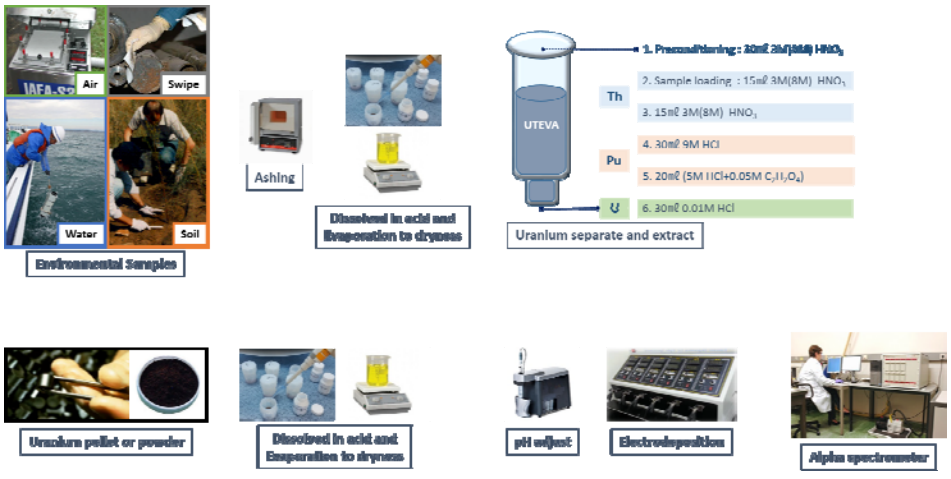

Fig.2. Radiochemical pretreatment steps for alpha spectrometry

3-1. Automated Uranium Separator

Automated uranium separator [Fig.3] has been designed and built with a size of 440(W) mm × 760(D) mm × 700(H) mm and a weight of 40 kg. An auto control program software was developed to separate and extract four samples independently or simultaneously. For user convenience, it was designed that all procedures can be displayed and controlled on a touch screen monitor.

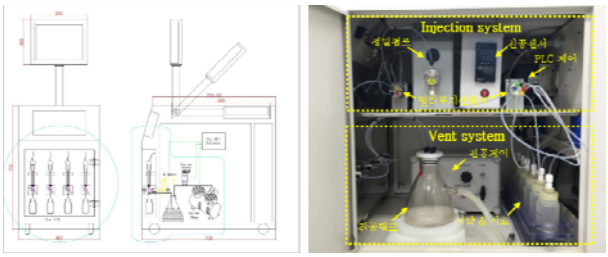

Fig.3. Developing *Automated uranium separator*

3-2. Automated Nuclear Material Sampler

Automated nuclear material sampler [Fig.4] consists of two cases. Each case was designed and built with a size of 450(W) mm × 400(D) mm × 300(H) mm and a weight of 15 kg.

Fig.4. Developing *automated nuclear material sampler*

- *Case 1* : Touch screen monitor, Hot plate and Device of reagent injection (syringe and stepping motor)
- *Case 2* : Electronic balance and Power supply

Some of steps for alpha source manufacture, such as reagent injection, evaporation and pH adjustment, are mechanically automated. Also, it can be displayed and controlled on a touch screen monitor.

4. A portable Alpha-particle Spectrometer

A portable alpha-particle spectrometer [Fig.5] has been developed with a size of 300(W) mm × 300(D) mm × 300(H) mm and a weight of 14 kg that can be operated a maximum pressure of 1.0 Torr. Also, KINAC has designed and built that combined a vacuum chamber, device part, and measuring part [3, 4].

Fig.5. *A portable alpha-particle spectrometer* developed by KINAC

The performance evaluation with a standard source (Eckert & Ziegler) was carried out. The *portable alpha-particle spectrometer* shows substantial similarity with the commercial alpha spectrometer, manufactured by CANBERRA Industries Inc. [Fig.6, Table.1].

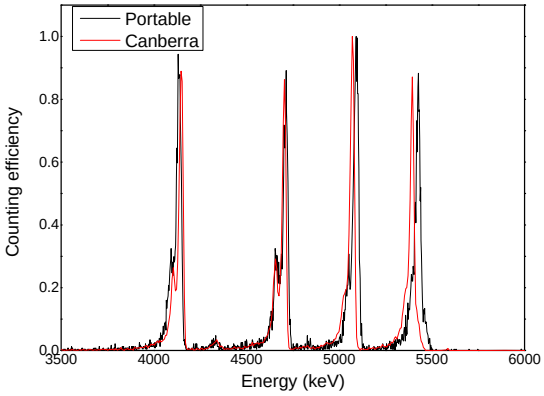

Fig.6. Comparing to commercial alpha spectrometer

Table.1. FWHM and efficiency of each alpha spectrometer

	FWHM (keV)		Detection efficiency (%)	
	Portable	Commercial	Portable	Commercial
238-U	30.33	22.45	12.09	12.60

5. Conclusions

The approach of this work was to develop new portable equipment, which is possible to timely analyze environmental samples or declared nuclear materials.

Employing four developed devices, airborne uranium concentration can be evaluated on-site. Declared nuclear activities can also be verified, quickly and easily.

The further steps will optimize the whole system and design, and be tested along with IAEA or national safeguards inspections.

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