

# Analysis of Inlet Air Characteristics of Air Cleaning Unit in Nuclear Power Plants

Hak-Soo Kim\* and Cho-Rong Kim

KHNP Central Research Institute, 7, 1312-gil, Yuseong-daero, Yuseong-gu, Daejeon, Republic of Korea

\*hskim0071@khnp.co.kr

## 1. Introduction

Air Cleaning Unit (ACU) as an Engineering Safety Features (ESF) in Nuclear Power Plants (NPP) is adopted to remove radioactive waste as well as toxic materials from operation and accidents. ACU in NPP composed to various components to clean air such as pre-filter, HEPA and adsorber which is filled with TEDA (Tri-Ethylene-Di-Amine) impregnated activated carbons (TEDA-AC). The removal performance and shelf-life of TEDA-AC is affected by the operating environment such as temperature, humidity and toxic materials. This paper deals with the analysis results of inlet air characteristics into ACU to establish experimental variables for TEDA-AC aging evaluation

## 2. Inlet Air Characteristics Analysis

### 2.1 Representative Sampling

The NPP to collect the representative samples were selected for reactor type. The selected NPPs are Hanbit Unit-2, Shin Wolsong Unit-2, Hanul Unit-2 and Wolsong Unit-4. The representative samples are collected at full power, de-synchronizing, overhaul and synchronizing based on NPP operation modes, and the sample locations are Containment Building, Fuel Building and Auxiliary Building. Table 1 is shown the selected NPPs, sampling time and locations

Table 1. NPPs, Sampling Time and Location for Representative Sampling

NPPs	Sampling Time	Locations
Hanbit 2	Full Power	Containment Bldg.
Shin Wolsong 2	De-Synchronizing	
Hanul 2	Overhaul	Fuel Bldg.
Wolsong 4	Synchronizing	Auxiliary Bldg.

### 2.2 Analysis of Representative Sample

The representative sampling was carried out at the inlet of ACU using a commercial portable air sampler and a 5 liter Tedlar Bag. The analysis items of air samples were determined by type and concentration of volatile organic compounds, oxides (NOx, SOx) and aldehydes based on the related studies and organic solvents used in NPP. Typically, the analysis of aldehydes used the High Performance Liquid Chromatography (HPLC) and the analysis conditions are shown in Table 2.

Table 2. Analysis Conditions of HPLC

Parameters	Conditions
Column	Inno C <sub>18</sub> (250x4.6 mm, $\mu$ m)
Mobile Phase	ACN/H <sub>2</sub> O = 60/40 (v/v%)
Detector	UV 360 nm
Flow Rate	1.0 mL/min
Injection	20 $\mu$ l

### 2.3 Analysis Results of Representative Samples

#### ○ Analysis results of organic compounds

The analysis results of type and concentration of organic compounds are shown in Table 3 and Fig. 1.

Table 3. Type and Concentration of Organic Compounds

Organic compound	Molecular Formula	Concentration ( $\mu$ g/m <sup>3</sup> )
Formaldehyde	CH <sub>2</sub> O	95.91
Acetaldehyde	C <sub>2</sub> H <sub>4</sub> O	52.62
Benzene	C <sub>6</sub> H <sub>6</sub>	8.58
Toluene	C <sub>6</sub> H <sub>6</sub> -CH <sub>3</sub>	95.72
Ethylbenzene	C <sub>8</sub> H <sub>10</sub>	48.42
m, p-Xylene	C <sub>8</sub> H <sub>10</sub>	98.85
Stylene	C <sub>8</sub> H <sub>8</sub>	2.55
o-Xylene	C <sub>8</sub> H <sub>10</sub>	57.09

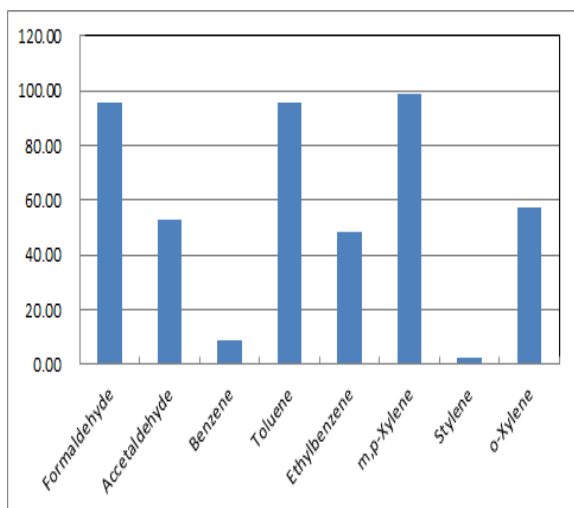


Fig. 1. Distribution of Organic Compounds in Inlet Air.

The total concentrations of organic compounds with NPPs are shown in Fig 2. The total organic compound concentration of Shin Wolseong Unit-2 is higher than that of other NPPs because its commercial operation is short and the large amount of organic compounds contained in the coating materials on the wall and equipment surface was continuously volatilized.

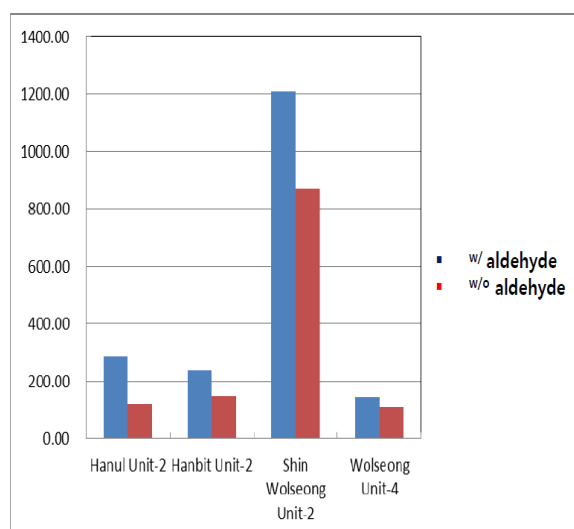


Fig. 2. Total Concentrations of Organic Compounds with NPPs.

### ○ Analysis results of oxides

The analysis results of type and concentration of oxides are shown in Fig. 3. As shown in Fig. 3, the concentrations of NO<sub>2</sub> and SO<sub>2</sub>, which are known to affect the shelf-life of TEDA-AC, are negligible as about 1/100 μg/m<sup>3</sup>, and there is no significant difference according to the NPPs.

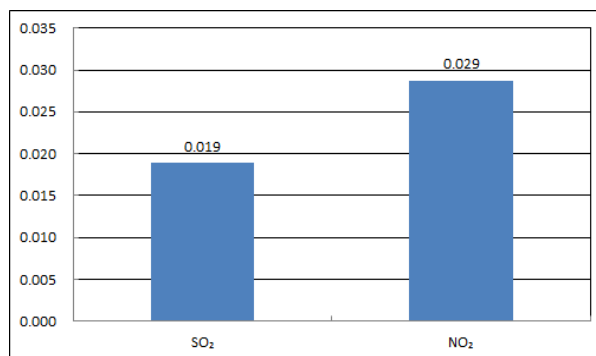


Fig. 3. Concentration of Oxides in Inlet Air.

### 3. Conclusion

The types and concentrations of organic compounds and oxides in inlet air into ACU were analyzed for representative nuclear power plant. The representative organic compounds were identified as Formaldehyde, Acetaldehyde, Benzene, Toluene, Ethylbenzene, m,p-Xylene, Styrene and o-Xylene, and the concentrations of Formaldehyde, Toluene and m,p-Xylene are relatively higher than that of other organic compounds. In addition, it was confirmed that NO<sub>2</sub> and SO<sub>2</sub> exist as oxides in inlet air and their concentrations were analyzed as 0.02 ppm. The results of organic compounds and oxides in inlet air into ACU will be used as the poisoning parameters in aging test of TEDA-AC.

### REFERENCES

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