Study on the Calculating Method of Atmospheric Diffusion Coefficient Using Turbulence Observation Data on Field Experiments

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1. Introduction

According to the Nuclear Safety and Security Commission (NSSC), the dose of residues by released radioactive materials should be assessed.

At KHNP NPPs, a straight-line Gaussian plume model (e.g., PAVAN) based on U.S. NRC Regulatory Guide 1.145 is used to estimate the atmospheric dispersion and surface deposition of the released radioactive material from nuclear facilities. The Pasquill- Gifford (P-G) curve, which is function of distance and atmospheric stability classes, is used to evaluate the atmospheric dispersion. This method has been widely applied because it allows simple and conservative evaluation. Based on Notice of the NSSC No. 2017-26, feasibility analysis has been required to determine whether the method could be applied to the characteristics of domestic nuclear sites.

In this study, the atmospheric diffusion coefficient using the observed turbulence at Hanul NPP site was examined for the validity of the atmospheric diffusion coefficient by the P-G curve applied in Korea.

2. Materials and Methods

2.1 Monitoring and Equipment Installation

The three-dimensional ultrasonic anemometer was installed at Hanul NPP site. Atmospheric diffusion coefficient was calculated using the observed turbulence for 12 month (11.1.2017 ~10.31.2018).

2.2 Comparison of Methods for Assessing Atmospheric Diffusion Coefficients

Horizontal diffusion coefficient (σ_y) and vertical diffusion coefficient (σ_z) in Gaussian model are described by Taylor's turbulence hypothesis. (Equation 1).

$$\sigma_y = \sigma_v t f_y(t/T_{Ly})$$
$$\sigma_z = \sigma_w t f_z(t/T_{Lz}) \quad (1)$$

σ_v	:	horizontal standard deviation(m)
σ_w	:	vertical standard deviation(m)
f_y	:	non-dimensional horizontal diffusion function
f_z	:	non-dimensional vertical diffusion function
t	:	travel time of the diffusing material

There are several methods available to calculate the Lagrangian integral timescale, T_{Ly} and T_{Lz}. In this study, Draxler's method and Eulerian autocorrelation function were chosen for these calculations.

The atmospheric diffusion coefficients calculated by these two methods were classified by atmospheric stability and compared with P-G values.

3. Results

The horizontal and vertical atmospheric diffusion coefficients were calculated using the observed turbulence for 12 months at Hanul site (Fig. 1-2).

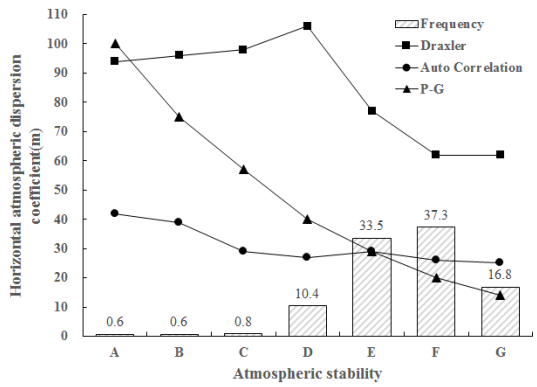

Fig. 1. Horizontal atmospheric diffusion coefficient with atmospheric stability.

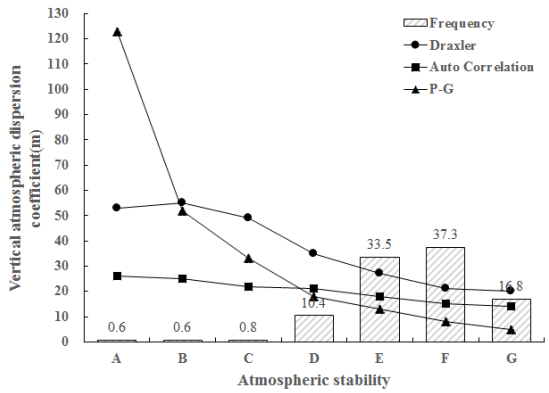

Fig. 2. Vertical atmospheric diffusion coefficient with atmospheric stability.

In the case of Draxler's method, the horizontal and vertical coefficients tend to decrease as the atmosphere stabilized. Draxler and P-G values were compared at atmospheric stability B to G. The coefficients of Draxler were 1.3~4.4 times and 1.1~4.0 times larger than P-G values, respectively.

On the other hand, when the horizontal and vertical atmospheric diffusion coefficients were calculated by autocorrelation function, atmospheric diffusion coefficient did not change with atmospheric stability. Especially, if the atmosphere was unstable (A~C), they were 2.0~2.4 times and 1.5~4.7 times lower than the P-G value. The results show that the relationship between turbulence and atmospheric diffusion coefficients is not consistent.

4. Conclusion

In order to evaluated the feasibility of the atmospheric diffusion coefficient currently used in domestic nuclear power plants, the method of estimating the atmospheric diffusion coefficient was reviewed.

As a result, Draxler's method is considered to be a comparison value for evaluating the suitability of atmospheric diffusion coefficient by the P-G curve.

REFERENCES

[1] KHNP, "Suitability validation of radioactivitiy atmospheric diffusion assessment model for hanul site", 2018-50003339-DAN-TR, 2018.