Simplified Model of Environmental Impact Assessment Concerned with Atmosphere and Ocean
− Simplification of Atmospheric Observation and Simple Setting Method of Oceanic Diffusion Coefficient −

Background

March 2004, the Ministry of Economy, Trade and Industry published the document entitled “The concepts regarding deletion of items and simplification of method in environmental impact assessment of power plants.” On the basis of the concepts, there is need to propose concrete methods to observe/predict the atmosphere/ocean environment reasonably and efficiently.

Objectives

In order to contribute to the rationalization of environmental impact assessment concerning the surrounding atmosphere and ocean of power plant, simplification of atmosphere observation and simple method for setting oceanic diffusion coefficient are proposed.

Principal Results

1. Meteorological observation

(1) Evaluation was conducted into the validity of estimating the wind speed at stack height based on that at the ground surface on the basis of existing information such as precedents of assessment or manuals instead of the information from upper atmospheric observation using meteorological sonde. As a result, as is shown in Table 1, it was clarified that the result of the diffusion simulation is affected little by using existing information so that upper atmospheric observation is not strictly necessary.

(2) To predict a short-term high concentration event under a special meteorological condition such as development of an internal boundary layer or an inversion layer, several parameters in diffusion models are set on the basis of meteorological observation or certain values without observation. Reasonable values of these parameters were proposed for the cases without observation. (Fig.1)

2. Simple setting method of oceanic diffusion coefficient

In the above described concept, it is assumed possible to use the CRIEPI’s simplified prediction model of warm water diffusion in environmental impact assessment of power plants. However, it was necessary to set the diffusion coefficient used in the model on the basis of field observation.

(1) Data from assessment reports on 83 thermal and nuclear power plants in Japan were arranged, and the regional characteristic and correlation of the diffusion coefficient in the neighboring sea of power plants with current characteristic were analyzed. As a result, it was clarified that the diffusion coefficients in the coastal area in front of a power plant show a strong correlation with (time-scale × typical velocity^2) regardless of region and current periodicity.

(2) On the basis of the abovementioned correlation, the simple setting method of oceanic diffusion coefficient was proposed as shown in Table 2. The method has made it possible to estimate diffusion coefficient from existing observation data with facility.

These results have been reflected in the guideline for environmental impact assessment concerned with power plant edited by Nuclear and Industrial Safety Agency, the Ministry of Economy, Trade and Industry, revised on January 2007.

Future Developments

A method to estimate upper wind at power plant with existing meteorological data will be further developed to advance the simplification of environmental assessment.

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References

M. Mizutori, et.al., 2006, “Simplification of Environmental Assessment Method(No.1) -Simple Setting Method of Coastal Diffusion Coefficient and Analysis of Seasonal Fluctuation in Ocean Environment-”, CRIEPI Report V06001 (in Japanese)

S. Kadokura and Y. Ichikawa, “Simplification of Environmental Assessment Method (No.2) -a Proposal for Simplification Method of Meteorological and Air Quality Observation-”, CRIEPI Report V06002 (in Japanese)

Table The maximum ground concentration (annual average) for estimation of upper wind (NOx[ppb])

Method to estimate upper wind	A-thermal plant	B-thermal plant	C-thermal plant
Observation with sonde (standard)	0.021	0.172	0.222
NOx Manual	0.024	0.175	0.238
Precedents of assessment	0.020～0.023	0.166～0.168	0.206～0.229

*"Precedents" means the past 56 precedents of assessments.

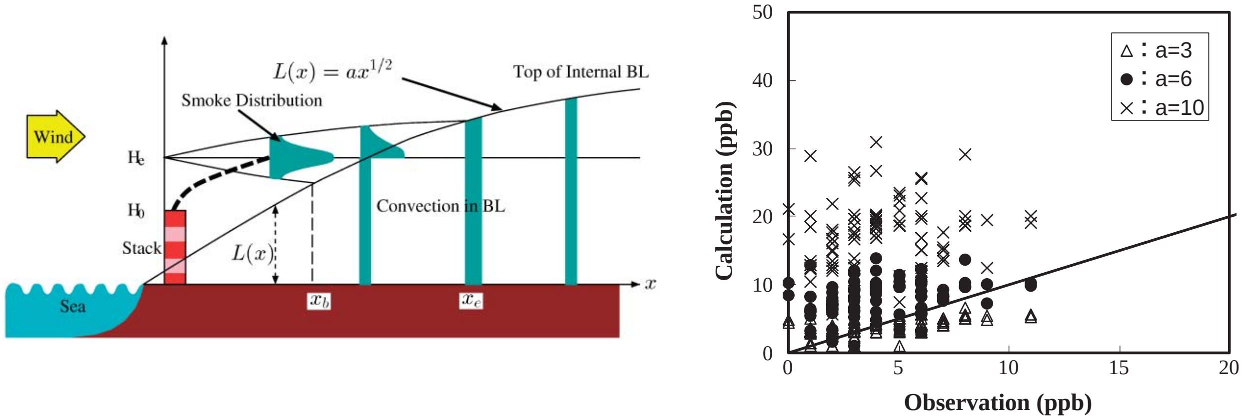

Fig.1 Ground concentration under the development of an internal boundary layer (IBL)

A study on setting the coefficient a in the development equation of IBL (See the left panel, :$L(x)=ax^{1/2}$, $L(x)$=:height of IBL, x: distance from sea shore). In a usual assessment, a is determined on the basis of upper atmospheric observation, or without observation, it used to be set at 8-9, which leads to an excessive estimation. In this work, it was shown that 6 is reasonable value for a. The solid line indicates observation = calculation.

Table 2 Diffusion coefficients as a guideline (Unit: cm²/s)

(In the coastal sea having explicitly periodic currents)

		T_p〔hr.〕
		12
U_p〔cm/s〕	5	1×10⁴
	10	1×10⁴
	15	1×10⁴
	20	5×10⁴
	30	5×10⁴
	40	5×10⁴
	50	5×10⁴

(In the coastal sea having little periodic currents)

		T_s〔hr.〕			
		12	24	36	48
U_s〔cm/s〕	10	5×10^3	1×10^4	1×10^4	1×10^4
	20	1×10^4	5×10^4	1×10^5	1×10^5
	30	5×10^4	1×10^5	1×10^5	5×10^5
	40	1×10^5	5×10^5	5×10^5	5×10^5
	50	1×10^5	5×10^5	5×10^5	1×10^6

The table shows diffusion coefficients as calculation condition. The coefficients are the values of half-order unit which are replaced from the values which are obtained from the following empirical formulas made from data of assessment reports on 83 thermal and nuclear power plants:

Empirical formulas of diffusion coefficient

$$K = 55 \cdot (U_p^{\,2} \cdot T_p)^{0.38}$$

(In the coastal sea having explicitly periodic currents. Ex. Tokyo Bay, Ise Bay, Seto Inland Sea etc.)

$$K = 1.9 \times 10^{-4} \cdot (U_s^{\,2} \cdot T_s)^{1.12}$$

(In the coastal sea having little periodic currents. Ex. The Pacific Ocean or Japan Sea coastal areas etc.)

where K:Diffusion coefficient as calculation condition, U_p:Typical tidal current amplitude of prevailing period, T_p:Prevailing period of tidal current, U_s:Typical current velocity, T_s:Time scale estimated by volume of warm water discharge.