A STUDY ON THE DEVELOPMENT OF A GAS EMISSION DEVICE

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ABSTRACT

In approach to alleviating the problems causing 'sick building syndrome', many types of indoor air pollution removal products have been developed. In the various performance evaluation methods for these removal products, the pollutant constant-emission test is the most ideal. In order to generate pollutant-gas constantly, a surface evaporation type constant-emission device was developed. However, this device generates gas regularly by heating a diffusion tube containing the reagents under investigation and mixtures could not be used if the boiling point differed for the component ingredients. This device also had the demerit of being unable to build high concentrations of gas pollution.

A constant-emission device was developed which has a heating furnace to instantly vaporize pollutants. These are then carried away by purified air. In the present study, the aim was to determine the basic performance and characteristics of this newly developed constant-emission device, using a large stainless-steel chamber under controlled environmental conditions.

Steady states of formaldehyde concentration were successfully achieved in the chamber. Concentration prediction was conducted using the emission rates obtained from two calculation methods. The mean correspondence rate between the predicted and measured concentrations was 93.5[%].

KEYWORDS

Pollutant-emission device, Instantaneous evaporation type, Surface vaporization type, Emission rates, Formaldehyde, Mitigation technique

INTRODUCTION

Nowadays, to solve indoor air pollution caused by harmful chemical substances, many countermeasure products intended to prevent indoor air pollution have been used in the Japanese home.

There are several performance evaluation methods for these removal products, the pollutant constant-emission test is the most ideal method. In order to generate pollutant-gas constantly, a surface evaporation type constant-emission device was developed. However, this device generates gas regularly by heating a diffusion tube containing reagents under investigation and mixtures could not be used if the boiling point differed for component ingredients. This device also had the demerit of being unable to build high concentrations of gas pollution.

In the present study, the aim was to determine the basic performance and characteristics of newly developed constant-emission device.

METHOD

Outline of the newly developed constant-emission device

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The chemical pollutant constant-emission device that the authors developed has heating furnace which instantly vaporizes solutions of the pollutants under study.

The pollutants are then conveyed into the chamber by purified air (see Fig. 1).

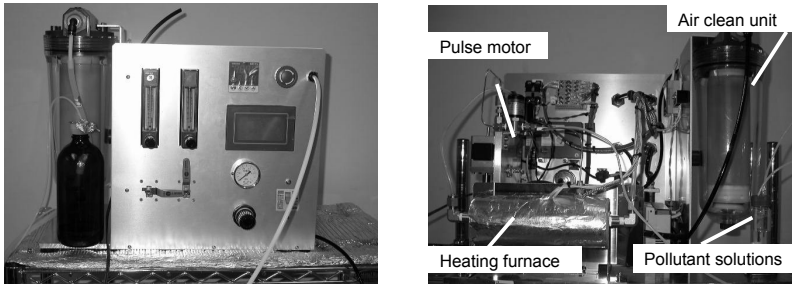

Figure 1. Photographs of the chemical pollutant constant – emission device

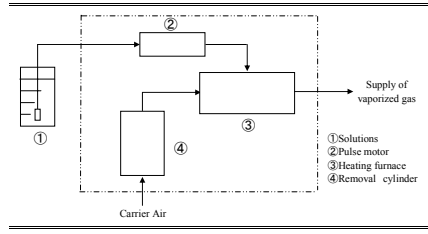

Figure 2. Diagram of the chemical pollutant constant–emission device.

Outline of the experimental system

The experimental system is shown in Figure 3 In the present study, a large environmental chamber was used.

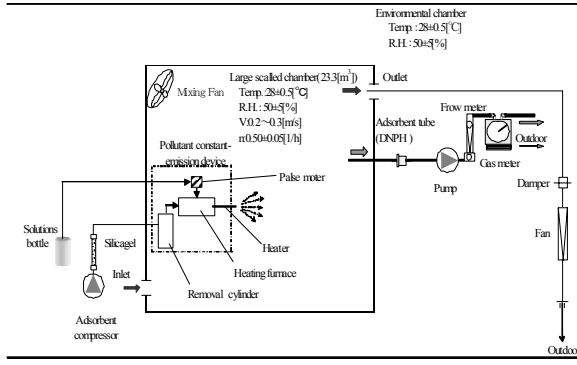

Figure 3. Diagram of the experimental system

The environmental conditions were controlled to produce a temperature of 28 ± 0. 5[℃], relative humidity of 50 ± 5 [%], air velocity of 0.2-0.3 [m/s] and air exchange rate of 0.5±0.05 [1/h]. Table 1 shows the stable conditions generated by the pollutant constant-emission device. In present study, attempts were made to create a steady state of formaldehyde flow.

Table 1. Test settings of the pollutant constant-emission device

Object chemical substances	Formaldehyde
Stable temperature of the heating furnace	130[℃]
Stable temperature of the mantle heater	130[℃]
Solution supply rate(γ)	0.1[mL/h]
Emission rate of vaporized gas	0.10[L/min]

Calculation of emission rates during operation of the constant-emission device

Emission rates (*M*) during operation of the constant-emission device were calculated by two methods. One method used the steady-state concentration in the environmental chamber, using equation (1) ; and the other calculated the mass of solution consumed during operation, using equation (2).

$$M_1 = Q(C_{ss} - C_0) \quad (1)$$

M : Emission rate of object contaminant [μ g/h] , *Q* : Ventilation rate of chamber [m^3/h] , C_{ss} : Steady state concentration of object contaminant [μ g/m^3] , C_o : outdoor concentration of object contaminant [μ g/m^3]

$$M_2 = W \cdot D / t \quad (2)$$

W : consumption weight of solution [μ g] , *D* : Dilution [%] , *t* : Operation time [h]

RESULTS

Tests were carried out to confirm the steady-state of formaldehyde concentration in the environmental chamber.

Two important requirements must be met to measure the efficiency of pollutant removed : pollutant constant-emission, and close control of the room environment. Figure 4 shows that we succeeded in achieving steady states of formaldehyde concentration in the environmental chamber.

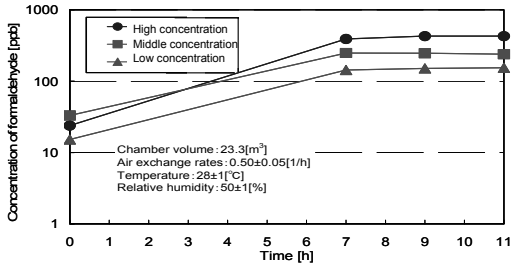

Figure 4. Formaldehyde concentration in an environmental chamber with gas emission device operationing

Figure 5 shows the results of concentration prediction using the emission rates obtained from two calculation methods. The averaged correspondence rate between the predicted and measured concentrations was 93.5[%].

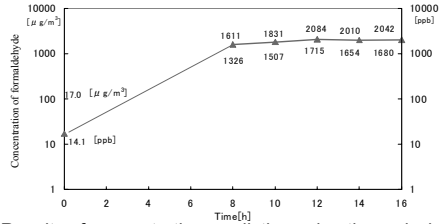

Figure 5. Results of concentration prediction using the emission rates obtained from the two calculation methods

Table 2 shows the correspondence of the formaldehyde emission rates using calculations based on steady state concentration in the environmental chamber versus calculating the mass of solution consumed during operation.

Table 2. Comparison of formaldehyde emission rates derived from two calculation different methods

	M_1[μg/h]	M_2[μg/h]	Error ((1-M_1/M_2)･100)[%]
High	5544	-	-
Middle	3033	-	-
Low	1905	1997	4.60

Emission rates calculated by steady-state concentration were 4.6 [%] smaller than calculated by the mass of solution consumed.

SUMMARY & CONCLUSIONS

1. The basic performance and characteristics of a newly developed constant-emission device were elucidated
2. Steady states of formaldehyde concentration were successfully produced in a large chamber using the newly developed the chemical substance constant – emission device.
3. Emission rates calculated by steady-state were 4.6 [%] smaller than those calculated by mass of material consumed.
4. It is necessary to confirm these results in producing steady state emission of other chemical substances.

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