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Performance Test of HAQT(Hanyang Air Quality Test) System for Measuring Volatile Compounds

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ABSTRACT

Small chamber was developed to measure release intensity of chemical that emit from building material. But, this method can not analyze large size building material and can not experiment much building material on same conditions. Therefore, we need construction of improved measurement system to cope problems of this existing device. HAQT (Hanyang Air Quality Test) system can experiment small chamber in equal conditions at the same time, and was invented so that an experiment of large size building material may be available. Little more efficient and various experiment through this system's performance test was available.

1. INTRODUCTION

Nowdays, Indoor air pollution induced by chemical materials is becoming an issue in a house. Density of chemical pollutants in the indoor air is determined by the amount of both ventilation rate and amount of released chemical substances from building materials. Therefore, it is necessary to reduce the amount of released contaminant from building materials as well as to ventilate properly as indoor antipollution measures for chemical materials .

It is important to research about the quantity of VOCs emitted by different ratio and mixture of components for the control of the effect of the materials and IAQ (Indoor Air Quality). This research had been vigorously undertaken from early 1980s in Europe, and recently it has been vividly operated in North America, too. The common point of these two researches is emitting ratio. In other words, the density of the contaminants after putting the test sample into the chamber and passing the clean air through the chamber, can measure.

Although the standard for the method of determining and measuring the contaminants in working environment or air surroundings is existing, internationally authorized methods for the measurement of VOCs emitted from building materials and causes indoor pollution are still incomplete. So it is difficult to compare the various measured results. because each measurer used different analysis method.

2. INVESTIGATION OF EXISTING CHAMBER CASES

2.1 Material Measurement Method

It is a method to measure the ingredients of building material by pulverizing it. This method is used for analyzing chemical substances that compose building material.

2.2 Desiccator Method

It is a method to measure the density of released formaldehyde as used in JIS (Japanese Industrial Standard). In this method, inside temperature of desiccator (capacity 9~11L) is maintained uniformly, and the test piece is located in hermetical space. After prescribed time passed, the aqueous solution
This method can measure concentrations smelted in water to formaldehyde adsorption calamity using colorimetric determination by acetyl acetone law

2.3 Emission Examination Chamber Method

This is the chamber method regulated in ASTM (American Society for Testing and Materials) and ECA (European Collaborative Action), and divided into large chamber method and small chamber method. At this time, the chamber is made of glass or stainless steel. Large chamber is constructed to measure emission by installing furnishings inside chamber. On the other hand, small chamber has two

types: one is FLEC method that measures emission by attaching the chamber on the wall. The other method measures emission by installing materials inside chamber.

2.4 Problems of Existing Measuring Devices

In case of material measurement method, it is hard to grasp contaminants emitted by indoor air although it can analyze the chemical substances in material's composition itself. In case of desiccator, it is different from the emission characteristics of general indoor space since it measures the densities emitted from both two faces and sides of the material at the same time. In addition, large chamber is too big to analyze small building materials, and it is impossible to measure large building materials in a small chamber.

2.5 Necessity of VOCs Measuring Chamber

After examining the controversial points which existing measurement devices have, the necessity of improved measuring chamber has arisen because there is several problems to analyze contaminants emitted into indoor air from building materials.

2.6 The composition of HAQT (Hanyang Air Quality Test) system

HAQT system consists of 3 chambers (thermo-hydrostat chamber, thermostat chamber, measuring chamber) and air control unit. Thermo-hydrostat chamber and thermostat chamber can reproduce general indoor environment, and small chamber was usd as measuring chamber. (fig 1 and table 1)

Regulator and micro-flow meter were installed to control the amount of air that supplies into thermo-hydrostat chamber. During the measurement, they control the temperature and the humidity as prescribed, and clean air is sent to thermostat chamber through a cylindrical air-supplier. The temperature of thermostat chamber was set up the same as that of thermo-hydrostat chamber to minimize the variation of temperature and humidity. Inside the thermostat chamber, measuring chambers (21L, 24L) were installed. All experimental appliances can equip temperature and humidity sensor and manometer, and the data can be printed when it is necessary. In this test, the data measured by the temperature and humidity measuring device installed in thermo-hydrostat chamber, thermostat chamber and measuring chamber was used as the temperature and humidity of the measuring chamber.

In this research, heat-resist glass chamber (diameter: 30㎝, height: 30㎝, capacity: 21L) and stainless (SUS-304) chamber (diameter: 30cm, height: 35cm, capacity: 24L) were used for the convenience of conveyance, disassembly, washing, installation, heat-treatment etc.. By these, contamination and adsorption of contaminants were inhibited and minimized. In addition, the chamber was formed by cylindrical shape to reduce the welding portion and to minimize the connections. The upper part of the measuring chamber has cover having 4 holes for sampling. The packing parts were finished by the structure that makes it possible to seal.

Air change rate is controled by the amount of air, which is sampled by suction pump of HAQT system, inside the chamber. Integral flow meter was equipped on the outside of the system to measure the flow rate by measuring the exhausted air from the system. [picture 1, 2] show HAQT's thermo-hydrostat chamber, thermostat chamber, and [picture 3] shows interior measuring chamber (24L).

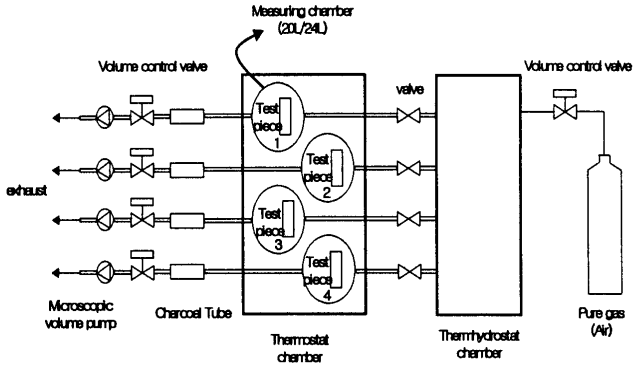
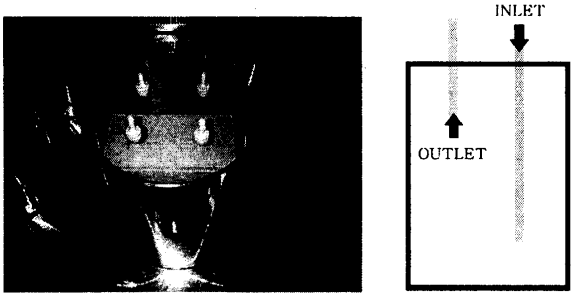


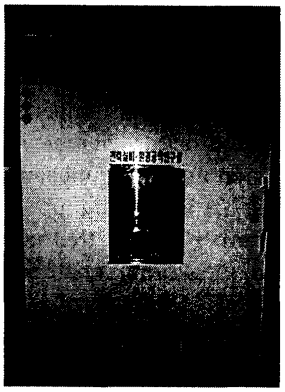
Figure 1. HAQT system diagram

Table 1. HAQT system's composition

		Thermostat chamber	Thermo-hydrostat chamber		Measuring chamber	
					20L	24L
Size(inner) W×D×H[mm]		1000×1000 ×1000	500×630×600		Diameter 300 Hight 300	Diameter 300 Hight 350
Control Range	Temp. [℃]	-5℃~90℃	-40℃~150℃		left same	left same
	R.H. [%]	-	at 10℃ at 30℃~85℃ at 90℃ at 120℃	15~85% 10~98% 10~85% 10~50%	left same	left same



Picture 1. Measuring chamber



Picture 2. Thermostat chamber

Picture 3. Thermo-hydrostat chamber

Table 2. Measuring items and instruments

	Measuring location		Measuring Instruments
Temp. [℃]	Thermo-hydrostat chamber	center part	- Data logger-Data scan 7320,7020 - Software -DLITE v.2.40 - Sensor - CC Thermo-Couple (Φ 0.25mm T-type)
	Thermostat chamber	center part	
	Measuring chamber	center part	
R.H. [%]	Thermo-hydrostat chamber	center part	- ALMEMO 0~100% R.H>100...138.5Ω (room version). 0~100% R.H>100...138.5Ω. (duct version)
	Thermostat chamber	center part	
	Measuring chamber	center part	

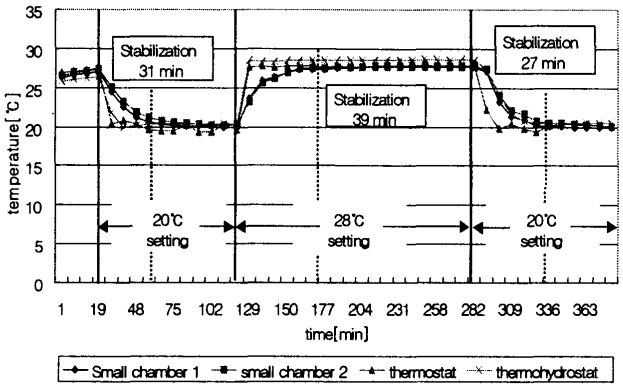


Figure 2. HYAQ system's temperature control

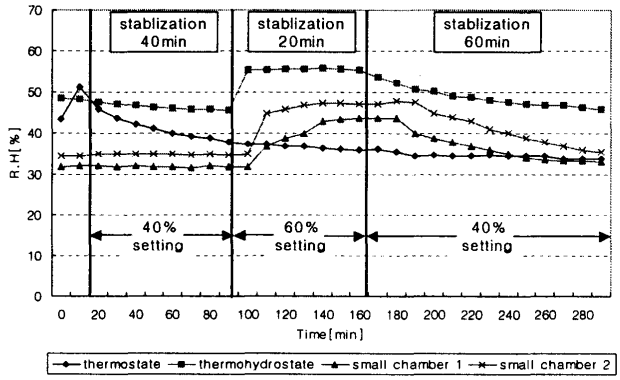


Figure 3. HYAQ system's humidity control

3. EFFICIENCY TEST OF MEASURING CHAMBER

3.1 Characteristis of HAQT System

The advantage of HAQT system is the it is efficient by using 4 measuring chambers (small chamber) in the same experiment condition. Moreover, the materials of various sizes can be experimented since the material that cannot be put into the measuring chamber (small chamber) can be measured in the thermostat chamber.

3.2 Temperature · Humidity Adjustment Experiment

The result of temperature and humidity adjustment experiment for each chamber is as follows. In case of temperature, when the temperature was set up as 20℃, each measuring chamber reached the target temperature in 31 minutes while thermo-hydrostat chamber and thermostat chamber reached in 20 minutes and 14 minutes respectively. When the temperature was set up as 28℃, thermo-hydrostat chamber and thermostat chamber reached after the lapse of 9 minutes, but each measuring chamber reached the target temperature after 39 minutes passage. (show fig 2)

In case of humidity, when the humidity was set up as 40%, both thermo-hydrostat chamber and thermostat chamber took 20 minutes. When the humidity was set up as 60% set, thermo-hydrostat chamber took 10 minutes, and it is revealed that thermostat chamber isn't greatly affected by humidity. Again, humidity was set up as 40%, thermo-hydrostat chamber and each measuring chamber's target humidity were kept changelessly after 1 hour passage.(show fig 3)

3.3 Air Flow Characteristics Inside Chamber

This research verified the air current speed and flow rate in system by CFD simulation, to verify HAQT (Hanyang Air Quality Test) system's performance.

1) Modeling

To investigate the air current stream in the measuring chamber, we modelled as follows. Valves for measurement were constructed that 1 for entrance and 1 for way out were installed because normally 1 entrance and 1 exit are used. For analysis, each 80 grids were established for x, y, z directions.

Table 3. Modeling

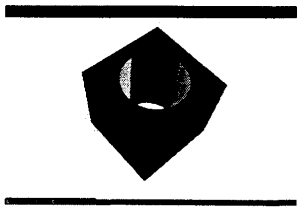
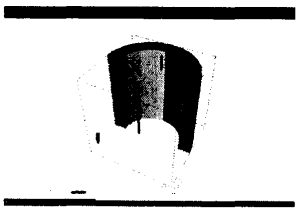
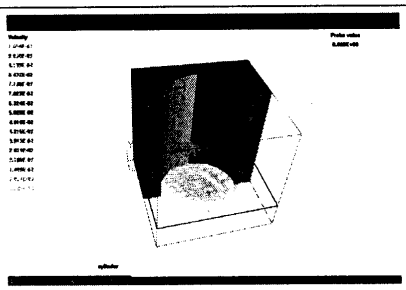
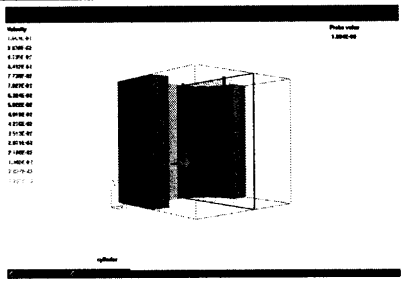
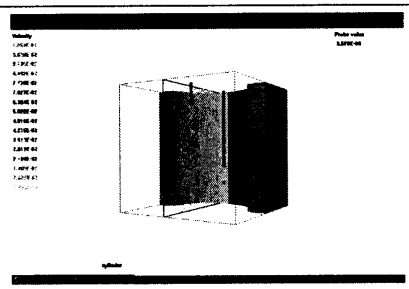
	
modeling for simulation 1	modeling for simulation 2 (1/2 mass, inlet, outlet)

Table 4. Modeling condition

	conditions
Temp.	Equally Temp.
Air flow	inlet : free-inflow outlet : forced-outflow 0.177[L/min]
Volume	30cm×30cm×30cm=27000(㎤)
velocity	0.014038 m/sec

Table 4. Air flow distribution

direction	air flow distribution
x	
y	
z	

Actually, it is possible to change the velocity of the flow freely by altering the size of the measuring chamber in HAQT system and adjusting the size of test specimens.

As the result of examining for each x, y, z direction, it is found that air current distribution of the measuring chamber reaches the measuring chamber floor. In addition, we also found that air current reached the floor is exhausted to way out again.(show table 4)

3.4 Stabilization Period of HAQT System (Thermohydrostat chamber, Thermostat chamber, Measuring chamber)

In case of temperature, when the temperature was set up as 20℃at normal temperature, thermohydrostat chamber and thermostat chamber reached the target temperature after 14 minutes, and measuring chamber 1, 2 reached after 32 minutes. when the temperature was set up as 28℃, thermo-hydrostat chamber and thermostat chamber took 14 minutes, and measuring chamber 1, 2 took 39 minutes. After setting up 20℃ again, thermo-hydrostat chamber and thermostat chamber took 18 minutes, and measuring chamber 1, 2 took 27 minutes to become 18℃. (show fig 2)

In the case of humidity, when the humidity was set up as 40%, measuring chamber 1, 2 did not reach a little to 40% of target humidity after 40 minutes, but kept uniform humidity. It is revealed that thermostat chamber isn't largely affected by humidity. when the humidity was set up as 60%, the humidity of measuring chamber increased later than thermo-hydrostat chamber, namely after 20 minutes it began to rise, but maintained the humidity that couldn't reached the target humidity by 10%.

4. CONCLUSION

The results are as follows.

① When temperature altered in HAQT(Hanyang Air Quality Test) system, it was found that we can get the aimed temperature in thermo -hydrostat, thermostat, and measuring chambers. In case of changing humidity the reproduced humidity was similar to the aimed humidity in thermo-hydrostat chamber, but it was found that the humidity in measuring chamber did not reach the target.

② As a result, it was found that air flow spreads uniformly in measuring chamber by CFD simulation.

③ Later, we need the improvement of the connection part between thermo-hydrostat chamber and measuring chamber to satisfy the prescribed humidity in measuring chamber.

④ The advantage of HAQT system is the it is efficient and co-timeable by using 4 measuring chambers (small chamber) in the same experiment condition. Moreover, the materials of various sizes can be experimented since the material that cannot be put into the measuring chamber (small chamber) can be measured in the thermostat chamber.

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