A Study on the Filtering Impact of Plants and Soil on the Reduction of Volatile Organic Compounds

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ABSTRACT

The research regarding the importance of indoor air quality is recently becoming issue from Korea and various methods are being used to improve interior air quality. Indoor air contamination became an important issue as the amount of infiltration is diminished by tightly sealed envelopes, and the building materials made of chemical components are frequently used. As the interest in plants improving indoor air quality is becoming higher like the study performed by NASA in 1980s, the study on the effect of plants or soil on the reduction of air pollutants is being performed plentifully.
This study aims at examining the impact of soil and plants, on the improvement of air purification. Experiments were performed in a mock-up system where the effect of concentration reduction in Volatile Organic Compounds can be monitored. The variations of concentration of Toluene, Etylbenzene, Xylene, Stylene and Formaldehyde were monitored. This study explored the reduction effect of indoor pollutants by the kinds of plant(*Aglaonema brevispathum, Pachira aquatica*) and Soil(*Hydro-ball, Neo-coal, Charcoal*).
In the result, the reduction effect of Toluene, Xylene and Ethylbenzene was to be sensed effectively, and the effect of plants and soil was proven. When Aglaonema was placed, the reduction effect of air pollutants was significant.

Also the effect of Charcoal and Hydro-ball was great.

1. INTRODUCTION

The quality of indoor air is closely related to the health of residents, so creating indoor air agreeable is very significant. The research regarding the importance of indoor air quality is recently becoming issue from Korea and various methods are being used to improve interior air quality. Indoor air contamination became an important issue as the amount of infiltration is diminished by tightly sealed envelopes, and the building materials made of chemical components are frequently used. As the interest in plants improving indoor air quality is becoming higher like the study performed by NASA in 1980s, the study on the effect of plants or soil on the reduction of air pollutants is being performed plentifully.
To make indoor air pleasant, a ventilation device is utilized as a whole. To add air purifying effect to a mechanical ventilating device, the study made an experiment after setting up plants and soil.

This study aims at examining the impact of soil and plants, on the improvement of air purification.

2. METHODS

Experiments were performed in a mock-up system where the effect of concentration reduction in Volatile Organic Compounds can be monitored. The variations of concentration of Toluene, Etylbenzene, Xylene, Stylene and Formaldehyde were monitored. The dimension of container was 0.9 m wide × 0.6 m long × 0.3m high. It is volume is 0.162 ㎥.

The soil or plants was contained in a small case whose dimension was 0.1m wide × 0.1 m long × 0.14m high. The mock-up system was installed for the generation of air pollutants and the testing of filtering effect of soil and plants. Circular shaped duct was installed to induce outdoor air to the mock-up system.

Toluene, Ethylbenzene, Xylene, Stylene was sampled with a Charcoal tube, and analyzed using GC-FID, and Formaldehyde was sampled with a DNPH-cartridge, and analyzed using HPLC. Mini pump with charcoal tube was used to sample VOCs for 20 minutes. After the sampling is completed, the sampled material was added to CS_2 solution in order to extract VOCs. After the VOCs are extracted they were transferred to GC-FID (Gas Chromatography-Flame Ionization Detector). DNPH-Cartridge was used to sample Formaldehyde for 20 minutes. After the sampled is completed, the sampled material was added to Acetonitrile solution. HPLC (High performance liquid chromatography) was used to analyze the concentration of Formaldehyde. Under this setting, the concentration of air pollutants were measured before the air entered the soil or plants and after the air passed through the soil. This study explored the reduction effect of indoor pollutants by the kinds of plants(*Aglaonema brevispathum, Pachira aquatica*) and Soil(*Hydro-ball, Neo-coal, Charcoal*). The diagram of mock-up system is shown in Fig 1 and Figure 2 shows the two types of soil and plants.

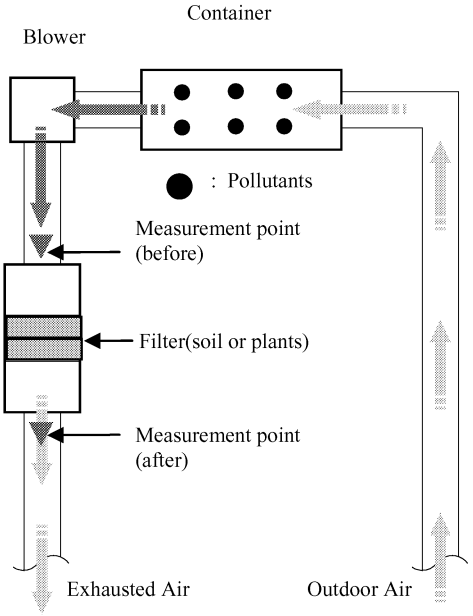
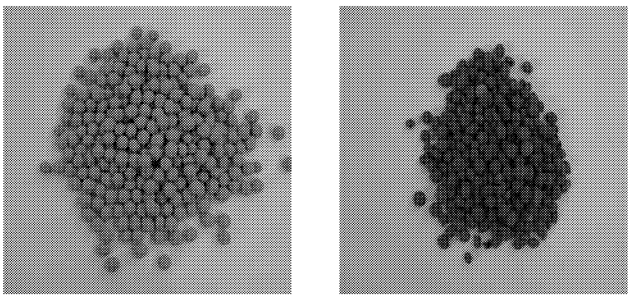
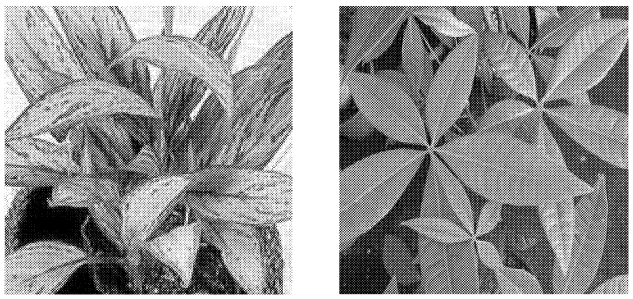


Figure 1: The diagram of the mock-up system



(a) Neo-coal (b) Hydro-ball



(c) Aglaonema brevispathum (d) Pachira aquatica

Figure 2: Two types of soil and plants

3. RESULTS

Of the both plants, VOCs decrease effect of *Aglaonema brevispathum* was excellent. The Reduction of Volatile Organic Compounds concentration by Plants is shown in Fig.3.

In setting up *Aglaonema brevispathum*, Formaldehyde concentration was indicated as 302.5 ㎍/㎥ before passing plant and as 154.2 ㎍/㎥ after passing, and the decrease volume by plant indicated as 148.3 ㎍/㎥.

In case of setting up *Pachira aquatica*, the decrease volume was by 108.3 ㎍/㎥ from 412.8 ㎍/㎥ to 304.5 ㎍/㎥. The decrease effect of Formaldehyde was larger in *Aglaonema brevispathum* set-up than *Pachira aquatica* set-up.

In setting up *Aglaonema brevispathum*, Toluene concentration was indicated as 1354.5 ㎍/㎥ before passing plant and as 1054.5 ㎍/㎥ after passing, and the decrease volume by plant indicated as 300.0 ㎍/㎥.

In case of Ethybenzene, Xylene, Stylene, the concentration decrease volume was more largely indicated in *Aglaonema brevispathum* set-up than *Pachira aquatica* set-up. In VOCs decrease effect by plant, the effect was more excellent in *Aglaonema brevispathum* set-up.

The Reduction of Volatile Organic Compounds concentration by Soil is shown in Fig.4.

In the effect by soil, VOCs decrease effect by *Hydro-ball* and *Neo-coal* was compared, and in addition, the effect by charcoal was experimented. In the decrease effect of Formaldehyde by two kinds of soil(*Hydro-ball*, *Neo-coal*), the decrease volume was indicated to be 199.2 ㎍/㎥ in case of *Hydro-ball* set-up, and *Neo-coal* was decreased to 152.1 ㎍/㎥.

In case of Toluene, Ethylbenzene, Xylene, Stylene, as shown figure 4, the decrease effect of *Hydro-ball* was more excellent. The effect by charcoal was more excellent in VOCs decrease effect than two kinds of soil, which is thought that the excellent absorbent ability of charcoal increases the decrease effect of VOCs.

In VOCs decrease effect by soil, the effect was more excellent in *Hydro-ball* set-up.

The variation of Formaldehyde concentration is shown in Fig. 5, The variation of Toluene concentration is shown in Fig. 6, The variation of Ethylbenzene concentration is shown in Fig. 7, Xylene concentration is shown in Fig. 8, Stylene concentration is shown in Fig. 9.

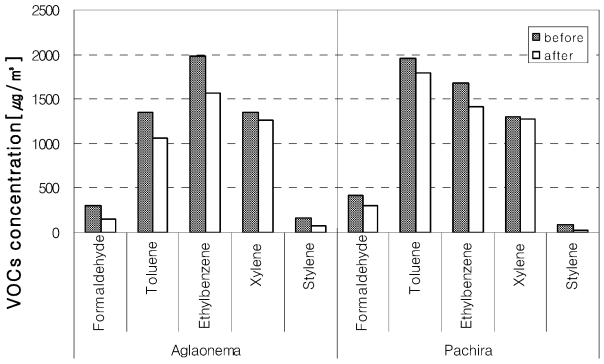


Figure 3: Variation of VOCs concentration by Plants

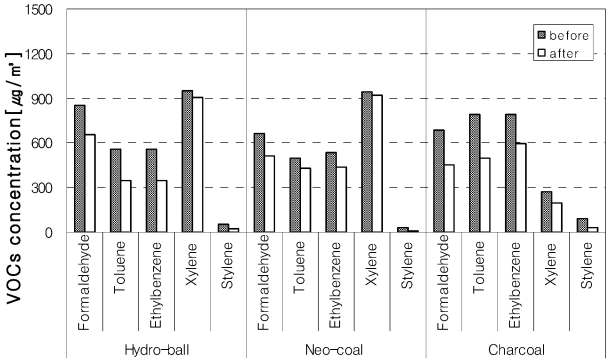


Figure 4: Variation of VOCs concentration by Soil

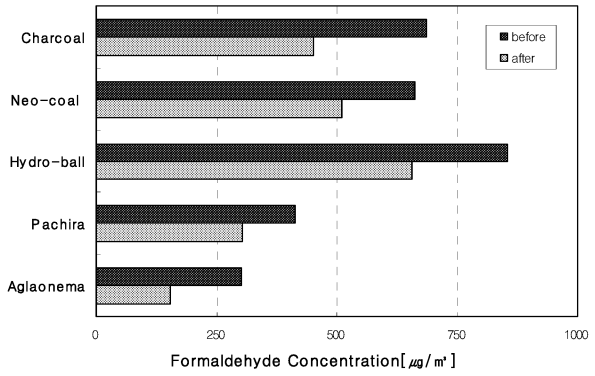


Figure 5: Variation of Formaldehyde concentration

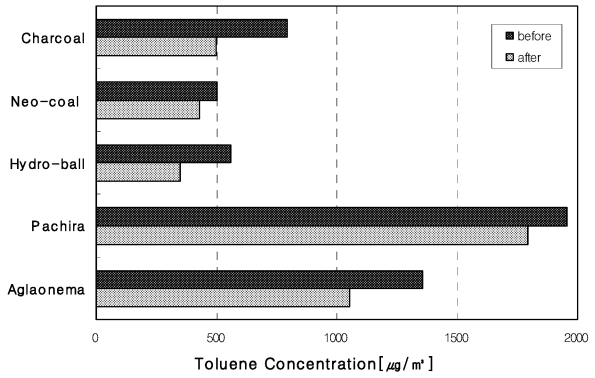


Figure 6: Variation of Toluene concentration

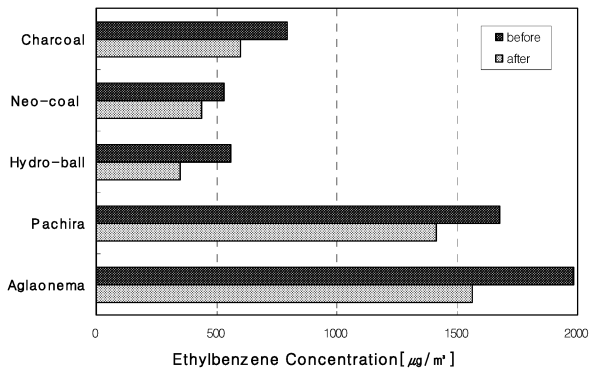


Figure 7: Variation of Ethylbenzene concentration

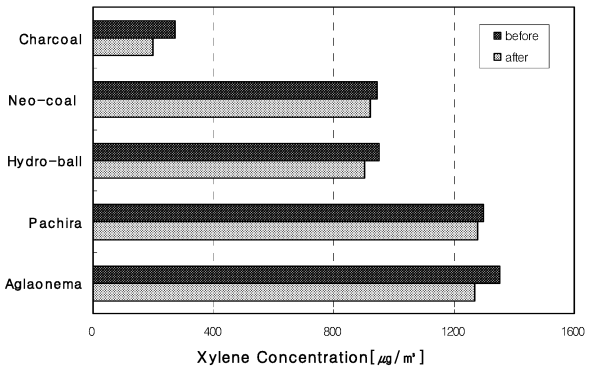


Figure 8: Variation of Xylene concentration

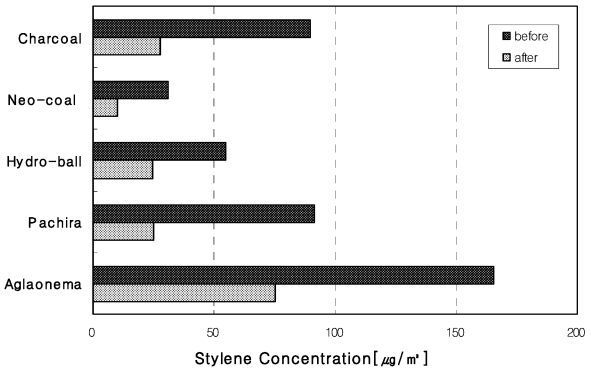


Figure 9: Variation of Stylene concentration

4. CONCLUSIONS

In the result, the reduction effect of Toluene, Xylene and Ethylbenzene was to be sensed effectively, and the effect of plants and soil was proven.

In VOCs decrease effect by plant, the effect was more excellent in *Aglaonema brevispathum* set-up.

When Aglaonema was placed, the reduction effect of air pollutants was significant. Also the effect of Charcoal and Hydro-ball was great.

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