Clean air delivery rate (CADR) analysis based on energy consumption for different air flow rates of air cleaners

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Recently, it has been further important to save energy for electrical devices owing to global warming and lack of hydrocarbon resources. Thus, the energy efficiency has started to be classified as its rated classes such as US EPA's Energy Star for the different household electrical devices such as air conditioners and refrigerator. The main performance of air clenaers has been expressed as their clean air delivery rate (CADR), which indicates the fraction of particles (of a particular size distribution) that have been removed times the air flow rate through the device. The CADR of air cleaners has a linear relationship with air flow rate (Q) and particle collection effiency (η) and thus CADR ~ ηQ. Therefore, a large-scale air cleaner with a high air flow rate can obtain a high CADR value. However, the high CADR would not be appropriate from an energy efficiency point of view because a high flow rate probably leads to a high power consumption. In the present study, the CADR of air cleaners has been investigated based on power or energy consumption to understand which air cleaner is better or which air flow rate of operation is better at a fixed air cleaner.

Figure 1 shows the CADR (m^3/min) divided by power consumption (W) at the maximum flow rates (m^3/min) for ten different filter-type air cleaners. The data of CADR/Watt was scattered between 0.08 and 0.18 (m^3/min)/W and thus it showed little relationship between the CADR/Watt and the maximum air flow rates of the air cleaners. This result probably suggests that the energy efficiency of air cleaners may be rarely related to their air flow rates and it is just dependent on the different models of air cleaners. Figure 2 shows the CADR/Watt with different flow rates for the identical air cleaners which have maximum air flow rates of 2.9, 5.9 and 16.3 m^3/min, respectively. For the identical air cleaner, the highest CADR/Watt was found at the smallest air flow rate regardless of three models of air cleaners. It decreased with exponential forms as air flow rate increased. Furthermore, the air cleaner with a higher maximum air flow rate had a higher CADR/Watt for the fixed air flow rate. Therefore, it could be concluded that the CADR/Watt of air cleaners is highly dependent on their air flow rates as well as the models (types of filters and fans) of the air cleaners. This result suggests that the air cleaner having a higher maximum air flow rate is profitable to a higher energy saving as operated with the smallest air flow rate.

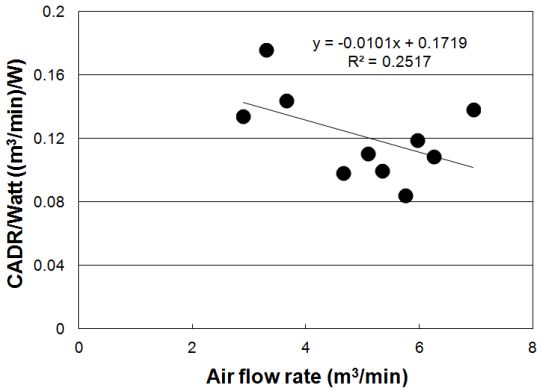

Figure 1. CADR/Watt at the maximum air flow rates for ten different air cleaners.

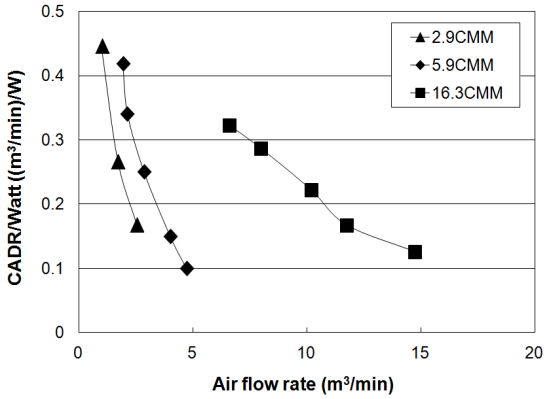

Figure 2. CADR/Watt at different air flow rates for three air cleaners.

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