Lab Activity No. 5: Microenvironments

Crizzia Mielle de Castro

1 General and Specific Objectives

1.1 General Objective

- To calculate the air change rate per hour of the individual's living space

1.2 Specific Objectives

- To determine if the ACH of the individual's living space fall within the ideal values
- To investigate the effects of varying fan speeds to the ACH in an enclose space

2 Description of Site/Sampling Area

For this activity, I picked my bedroom as the focus living space. My room has a floor area of 2.7 $m \times 3.4$ m, and a height of 2.7 m. I have a window on one side (which I rarely open), a fan (usually set to the lowest speed), and an air conditioning unit. I spend 10-12 hours daily inside my bedroom, and I use my electric fan about 3-4 hours only, while the rest of the time, I use my air conditioning unit.

3 Review of Related Literature

In this lab activity, we investigate how well ventilated our living spaces are. We use the air change rate per hour (ACH) as a measure of our living spaces' ventilation. The air change rate per hour is the ratio of how much air is added or removed from a space in an hour and the size of the space. The ideal ACH for a living space is between 3 h^{-1} and 6 h^{-1}, and the higher the ACH, the better ventilated the space is [1]. Based on the equation for calculating ACH (Eqn. 1), one can either increase the space's air flow or decrease the space's size to increase the ACH. In the case of established living spaces, we can implement methods that increase our living space's air flow instead of renovating.

According to previous studies [2, 3], opening windows more often and using electric fans greatly improve the ACH of living spaces. Even in living spaces with an air conditioning unit, fans are still necessary to improve the ACH [4]. Some studies [2, 5, 6] also show that high temperature differences between indoors and outdoors can also increase the ACH, but at a less effective rate than using fans or opening windows. Thus, using air conditioning units to cool living space during hot weathers can help improve ACH, but using a fan is still preferable. Numerous studies [2–6] stress the importance of improving the air change rate in a person's living or work space to maintain a healthy air quality.

4 Methods Framework

I measured and took note of the dimensions of my room using a tape measure. The average wind speeds for the three settings of a typical electric fan were already given to

us: 0.5 m/s, 1.0 m/s, and 1.4 m/s. To calculate the ACH in my bedroom, I used the following equation

$$ACH\left(h^{-1}\right) = \frac{Q \times 60}{\text{Area} \times \text{height}} \tag{1}$$

where Q is the average fan speed, and the denominator corresponds to the dimensions of my bedroom.

5 Results and Discussion

Using Eqn. 1 with the different electric fan speeds, we see that, as expected, the ACH increases with increasing fan speed (shown in Table 1). My fan has to be at least at the highest speed setting, or I have to use more than one fan for the ACH in my room to meet the ideal $3 - 6\ h^{-1}$. However, I use my air conditioning unit most of the time, so the calculated ACH values below aren't even consistent. During the times I use my air conditioning unit, the ACH of my bedroom would decrease. Also, I keep my windows and door closed most of the time, so the air circulated by my electric fan more or less remains inside the room. Thus, I can say that my bedroom is poorly ventilated (based only on its average ACH). I can improve my room's air quality by opening my windows more often, the most efficient and cost-effective way. It is important for me to maintain the air quality of my bedroom, since this is where I sleep, and sometimes work. This activity is a good learning experience for me to form better habits to ventilate my bedroom.

Table 1: Calculated air change rate per hour for different electric fan speeds

fan speed (m/s)	**ACH** (h^{-1})
0.5	1.21
1.0	2.42
1.4	3.39

References

[1] webtotrade GmbH, Calculate air volume by using air change rate and example of use (2020), last accessed 16 June 2021, https://www.creoven.co.uk/calculation-of-air-volume.

[2] L. A. Wallace, S. J. Emmerich, and C. Howard-Reed, Continuous measurements of air change rates in an occupied house for 1 year: The effect of temperature, wind, fans, and windows, *Journal of Exposure Science Environmental Epidemiology* **12**, 296 (2002), ISSN 1559-064X.

[3] C. Howard-Reed, L. A. Wallace, and W. R. Ott, The Effect of Opening Windows on Air Change Rates in Two Homes, *Journal of the Air Waste Management Association* **52**, 147 (2002), ISSN 1096-2247.

[4] S. C. Sekhar, Enhancement of ventilation performance of a residential split-system air-conditioning unit, *Energy and Buildings* **36**, 273 (2004), ISSN 0378-7788.

[5] F. W. Sinden, Wind, temperature and natural ventilation - theoretical considerations, *Energy and Buildings* **1**, 275 (1978), ISSN 0378-7788.

[6] N. Malik, Field studies of dependence of air infiltration on outside temperature and wind, *Energy and Buildings* **1**, 281 (1978), ISSN 0378-7788.