학 생 용

Yonsei University Early Admissions 2016

UIC Integrated Science and Engineering Field

Part I.

Municipal wastewater from urban areas contains organic pollutants, which have to be removed by wastewater treatment plants before it reaches a natural aquatic environment such as a river, lake or ocean. In many wastewater treatment plants, organic pollutants are biologically removed in so-called 'Activated Sludge' reactors. The main mechanism of the organic pollutant removal in Activated Sludge reactors is microbial degradation by diverse microorganisms.

It is important to accurately and precisely measure the activity of microbial degradation for evaluating the efficiency of removal of organic pollutants in individual Activated Sludge reactors. To explore any effects of different sampling sizes on the measurement of microbial degradation activity, sampling sizes were widely varied from 0.001 to 1,000 liters when liquid samples were taken at a fixed location in an Activated Sludge reactor in Seoul Metropolitan Municipal Wastewater Treatment Plant. Ten replicate samples were taken for each sampling size using a same sampling method, and their microbial degradation activities were measured using an identical method.

The results of measured microbial degradation activities are shown in **Figure 1**. The solid symbols in the figure indicate the values of microbial degradation activities divided by their corresponding sampling sizes. In addition, the average values and their standard deviations in microbial degradation activity measurements are shown in **Table 1**.

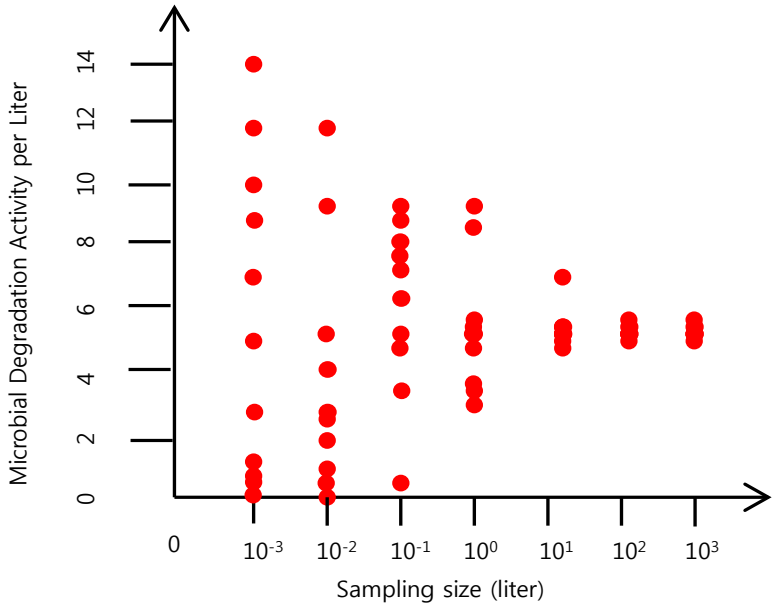


Figure 1. The measured microbial degradation activities (per liter) in response to different sampling sizes.

Table 1. The estimated average values and their standard deviations in microbial degradation activity measurements for the tested sampling sizes.

Sampling Size (Liter)	Microbial Degradation Activity per Liter		
	Average (A)	Standard Deviation (SD)	SD/A ratio
0.001	5.94	5.22	0.878
0.01	3.83	3.91	1.021
0.1	5.91	2.72	0.461
1	4.45	0.95	0.215
10	4.60	0.30	0.066
100	4.71	0.30	0.064
1000	4.71	0.30	0.064

문항 1

a) 이 실험 결과 시료 크기가 작아짐에 따라 측정결과의 평균치는 변화폭이 커지고 표준편차의 크기가 증가하는 것이 관찰되었다. 이 관찰 결과를 발생하게 하는 원인에 대해서 논하시오.

b) 시료의 크기가 0.001 liter 와 0.01 liter 인 경우 microbial degradation activity 가 관측되지 않았다. 어떻게 이런 결과가 나왔을지 추측하시오.

c) 해당 반응조 내에는 1,000 종의 다양한 미생물들이 혼합되어 서식하고 있다. 시료 크기에 따른 시료 내 미생물 종의 수적 변화가 microbial degradation activity (per liter)에 어떠한 영향을 미칠지에 대해서 논하시오.

Question 1

a) As the sampling sizes were smaller, the average values were more fluctuating, and the standard deviations tended to increase. Please provide your explanation for the cause(s) of the observations.

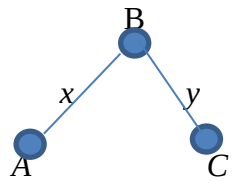
b) When the sampling sizes were 0.001 and 0.01 liter, no microbial degradation activity was detected. How could this happen?

c) In the Activated Sludge reactor, there were 1,000 species of diverse microorganisms. Please discuss about whether and how the number of species of microorganisms in a sample may affect microbial degradation activity (per liter) in response to varying sampling sizes.

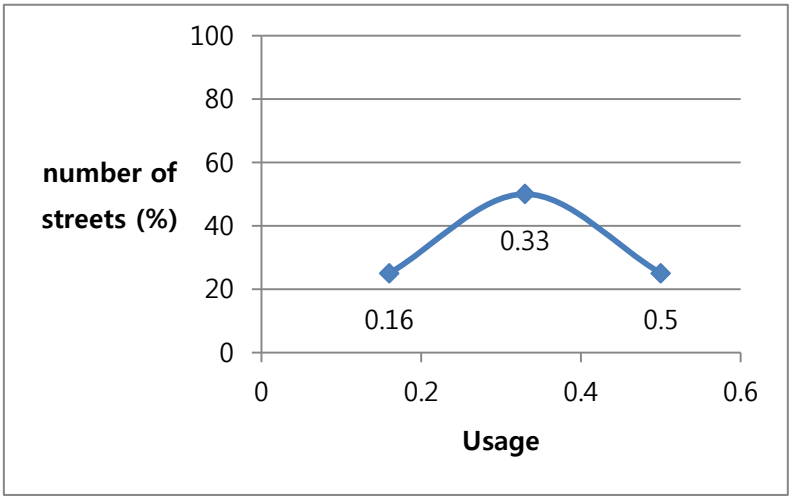
Part II.

The extent of use of a city street varies depending on how the specific street is connected to the other streets in the city. For example, if there is only one bridge in a river, the street on the bridge is heavily used in the routes across the river.

The **Usage** of a street can be defined based on how many times each street is used in the shortest length route. For example, in **Figure 1**, streets *x* and *y* (of an equal length) are used to travel between three places *A, B,* and *C*. Let us assume all streets are two-way and ignore the direction of routes. The shortest length route for *(A,B)* is *x*. Those of *(B,C)* and *(A,C)* are *y* and *xy,* respectively. The Usage of street *x* can be calculated as a probability of its occurrence in all possible shortest routes ***x***, *y,* and ***xy,*** which is *2/3=0.66*.



[Figure 1] The map of streets in City Q



[Figure 2] Street Usage distribution of City P.

문항 2

a) 도시 Q에 *A*와 *C*를 연결하는 도로 *z*를 새로 건설한다면, 이 건설로 인한 도로 *x*의 Usage값의 변화에 대해서 설명하시오.

b) Figure 2는 도시 P의 도로 Usage 값들의 분포를 나타낸다. 예를 들어 도시 P에

서는 25%의 도로가 0.5의 Usage값을 갖는다. 도시 P와 도로 *z*를 건설하기 **전**의 도시 Q 중 어떤 경우가 교통 관점에서 보다 더 이상적인지에 대한 의견을 개진하시오.

c) 도시 P와 도로 *z*를 건설한 **후**의 도시 Q의 경우들에 대해서 문제 b와 같이 비교하여 답하시오.

Question 2

a) How will the construction of a new street *z* (of the same length as *x*) connecting *A* and *C* affect the Usage of *x* in City Q?

b) **Figure 2** shows the street Usage distribution of City P. For example, 25% of the streets in this city have the Usage of 0.5. Compared with the case of City Q **before** the construction of the new street *z*, which case would you find more optimal in terms of traffic?

c) Comparing City P with the case of City Q **after** the construction of the new street *z*, which case would you find more optimal in terms of traffic?

Part III.

Do you think that your generation will have more freedom than your parents' generation? Explain your answer.

본인 세대가 본인 부모님 세대보다 더 많은 자유를 누릴 수 있을 것이라 생각하는가? 본인의 답에 대한 근거를 제시하시오.