THE EFFECTIVENESS OF DEODERATEX MEMBRANE TREATMENT OF ODOUR AT TOILET IN VERTICAL APPLICATION

SITI AINI NABILAH BINTI ABD RAHIM

SCHOOL OF CIVIL ENGINEERING
UNIVERSITI SAINS MALAYSIA
2018

THE EFFECTIVENESS OF DEODERATEX MEMBRANE TREATMENT OF ODOUR AT TOILET IN VERTICAL APPLICATION

By

SITI AINI NABILAH BINTI ABD RAHIM

This dissertation is submitted to

UNIVERSITI SAINS MALAYSIA

As partial fulfilment of requirement for the degree of

BACHELOR OF ENGINEERING (HONS.)
(CIVIL ENGINEERING)

School of Civil Engineering,
Universiti Sains Malaysia

June 2018

SCHOOL OF CIVIL ENGINEERING
ACADEMIC SESSION 2014/2015

FINAL YEAR PROJECT EAA492/6
DISSERTATION ENDORSEMENT FORM

Title:

Name of Student:

I hereby declare that all corrections and comments made by the supervisor(s)and examiner have been taken into consideration and rectified accordingly.

Signature: Approved by:

_______________________ _______________________

(Signature of Supervisor)

Date : Name of Supervisor :

Date :

Approved by:

____

(Signature of Examiner)

Name of Examiner :

Date :

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ACKNOWLEDGEMENTS

Praise to Allah for giving the opportunity for me to accomplish my Final Year Project's Report. I would like to express my deepest appreciation to my supervisor, Assc. Prof Dr Nastaein Qamaruz Zaman for giving me guidances, ideas and comments throughout the whole process.

Very special thanks to the Odour Laboratory technician, Mr Nabil who is helping me and supporting me with the process of refilling gas. I also like to thank Miss Syafinah and Miss Nuramalina for their cooperation and help. Their assistance was important in completing this final year project.

Finally, I want to express my deepest gratitude to my parents, Abd Rahim bin Shafie and Zunaida binti Said for giving me courage and keeps supporting me throughout my studies. Their constant love and blessing helped me to move forward. Last but not least, my thanks to School of Civil Engineering, USM and other lecturer for great commitment and cooperation during my Final Year Project.

ABSTRAK

Salah satu isu alam sekitar yang sering kali dibincang adalah masalah pencemaran bau. Kehadiran bau busuk di dalam kampus terutamanya di dalam tandas berpunca daripada aktiviti harian:pembuangan najis dan air kencing, najis haiwan dan sisa makanan telah dipeoleh melalui pemerhatian dan dari sesi kajian yang dijalankan kepada pengguna. Bagaimanapun, tiada kajian yang dijalankan untuk merawat ataupun mengawal masalah bau di tandas kecuali dengan kaedah pencucian tandas harian. Keadaan tandas yang bersih tidak dapat dikekalkan dalam jangka masa yang lama oleh kerana penggunaan tandas secara berterusan oleh pelajar. Maka, kajian ini dijalankan untuk merawat masalah bau di tandas dan untuk menyediakan persekitaran tandas yang selesa dalam jangka masa yang lama dengan mengunnakan fabrik pengawal bau "Deodoratex". Kajian ini dijalankan mengggunakan dua jenis fabrik Deodoratex yang berbeza iaitu Jenis 03 dan Jenis 32 dan setiap jenis Deodoratex akan digunakan untuk mengukur kepekatan bau, Ammonia dan Hidrogen Sulfida. Tahap kepekatan teresebut akan di ukur menggunakan SM100 Field Olfactometer dan TR8 Odotracker di dalam kawasan tandas asrama. Tambahan pula, kajian ini dijalankan untuk mengenal pasti tahap keberkesanan setiap jenis Deodoratex untuk mengawal kepekatan bau, Ammonia dan Hidrogen Sulfida apabila digantung secara menegak. Jenis 03 lebih berkesan untuk menghilangkan bau apabila digantung secara menegak.

ABSTRACT

One of the mainly discussed environmental issues the odour pollution. The presence of odour existing in the campus especially in the toilet due to the daily activity of the toilet; urine and faeces, animal waste and food waste was identified through observation and survey conducted to the user. However, none of the study is conducted to control the odour problem in the toilet except the daily cleaning of the toilet by the cleaner. The good condition after cleaning cannot last long due to continuous usage of the toilet. So, this study is conducted to control odour in the toilet and provide a comfortable usage of toilet to the user for a longer time by using odour removing membarane “Deodoratex”. This study is conducted by using two different types of Deodoratex ; Type 03 and Type 32 and each of the type will be used to identified 3 types of gas concentration in the toilet; Odour, Ammonia and Hydrogen Sulfide. This concentration will be obtained by using SM100 Field Olfactometer and TR8 Odotracker through field assessment. In addition, this study also conducted to identify the effectiveness of the different type of Deodoratex to remove the concentrations in vertical application. The Type 03 Deodoratex is more effective to remove odour when hung vertically.

CHAPTER 1

INTRODUCTION

1.1 Background

Odors are emitted from agricultural and industrial activities, such as animal farms, rendering plants, wastewater treatment plants, waste treatment or disposal facilities, paint shops, oil refineries, pulp and paper mills, and various chemical industries. Effects of this kind of air pollution may include: impairment of the quality of the environment; interference with business activities; discomfort, harm or impairment of the safety of any person; rendering any property, plant or animal unsuitable for human use (Barbusinski et al., 2017). Odour can be defined as a sensation resulting from the interaction of volatile chemical species inhaled through the nose, including sulfur compounds (e.g. sulfides, mercaptans), nitrogen compounds (e.g. ammonia, amines) and volatile organic compounds (e.g. esters, acids, aldehydes, ketones, alcohols) (Leonardos et al., 1969). Odours remain the biggest cause of complaints in regards to environmental issues for a wide variety of industries, including wastewater and waste management, intensive livestock, and biosolids, and continues to grow in both number and severity of complaints (Hayes et al., 2014). Exposure to environmental odour can result in annoyance, health effects and depreciation of property values. Therefore, many jurisdictions classify odour as an atmospheric pollutant and regulate emissions and/or impacts from odour generating activities at a national, state or municipal level (Schauberger et al., 2014).

Toilets are often associated with odour problem. The bad odour in the toilets is contributed from urine and feces and if the toilets are not well maintained and cleaned regularly, this odour can be very pungent. The serious odour problem in toilets is also due to bacterial absorption of organic waste and gas released. Besides, the generation of odour can lead to bacterial contamination of items such as toothbrushes that can contribute to health problems. Toilet odours are quite complex and consist of more than 200 different chemical compounds arising from feces and urine that change over time and vary depending on the health and diet (Weller, 2016).

1.2 Problem Statement

Odour nuisance to the toilet user is often detected through complaints and individual use of the toilet itself. Toilet ventilation is most important and simplest way to improve air quality. Study by Nazaroff & Weschler, (2004) suggested to use air freshener to remove odour caused by toilet. Unfortunately, the fragrance may also be another contaminant that can be converted to harmful secondary pollutants after reacting with another airborne substance.

Thus, this study is proposed to treat the toilet odour where the odour has become a nuisance to the users. Besides, the effects of this odour may be impairment of the quality of environment, harm or discomfort to the user and loss of normal enjoyment of normal use of property.

1.3 Objectives

The aim of this study is to identify the potential of Deodoratex in the control of the toilet odour. The following objectives are proposed in order to achieve the aim :

1. To determine the odour concentration, Ammonia (NH_3) concentration and Hydroden Sulfide (H_2S) concentration of toilet at student hostel without any odour treatment

2. To establish the effectiveness of Deodoratex Type 03 and Type 32 for odour, ammonia and hydrogen sulfide removal when applied in vertical condition.

3. To compare the suitability of vertical and horizontal application of the Deodoratex membrane in the toilet

1.4 Scope of Research

To carry out this study, the study area; toilet in student hostel (Desasiswa Jaya); Block 4, Groundfloor had been chosen based on observations and surveys that had been done toward the odour condition of the toilet. First, the level of concentration of odour, Ammonia and Hydrogen Sulfide will be identified first before starting any odour treatment. A special membrane called Deodoratex will be used to remove odour in the toilet. The Deodoratex will be applied in vertical direction at each of the toilet and shower doors.

The odor concentration (OU/m^3), hydrogen concentration and ammonia levels (ppm) will be assessed 3 times a day during normal working hours. The determination of the odour, hydrogen concentration and ammonia will be conducted in the toilet itself

1.5 Thesis Outline

This thesis consists of five chapters. A brief outline of the structure is given below.

Chapter 1 gives an introduction of the project. The introduction is about the background of the study which explain the toilet odour in the Desasiswa Jaya.

For Chapter 2, this chapter discuss about the literature review of other toilet problems. It also discuss about effect of odour in the toilet, characteristics of human feces and urine and other odour treatment that have been done in to remove odour in toilet.

Chapter 3 discusses about the details method that is used in the study. It includes the descriptions of study area, description of Deodoratex and data collection in the study.

For Chapter 4, this chapter discusses about the results obtain from field assessment, statistical analysis of SPSS and survey that have been carried out to the toilet users. The establishment of effectiveness of different type of Deodoratex in vertical application will also be discussed in this chapter. Besides, this chapter also discusses about effectiveness of different type application direction.

Finally, Chapter 5 contained the conclusion of this study. After all the data had been analysed, the Deodoratex type that is more effective in removing toilet will be discussed. The effectiveness of different type of application direction also can be identified in this chapter.

CHAPTER 2

LITERATURE REVIEW

2.1 Overview

The toilet odour treatment is the focus of this study study, therefore the previous publications involving odour problems and treatment are used for better understanding of odour. Research journal, references books, printed or online conference articles were the main source for study guides since they contain the current knowledge of the research.

2.2 Definition of odour

Odour, which refers to unpleasant smells, is considered as an important environmental pollution issue. Attention to odour as an environmental nuisance has been growing as a result of increasing industrialization and the awareness of people's need for a clean environment. As a consequence, efforts to abate odour problems are necessary in order to maintain the quality of the environment. In this framework, understanding the odour problem and the origin and dispersion of odours, abatement and detection methods are, therefore, very important aspects of odor pollution in the environment. Odour or malodor, which refers to unpleasant smells, is nowadays considered an important environmental pollution issue. Odour pollution abatement has involved a number of bodies. A comprehensive description of pollution abatement and the development of the accompanying instrumentation technology are therefore critical links to understand the whole dimension of odour pollution in the environment (Lammers et al., 2004)

2.3 Effect of odour to human health

Some effects of odours have been studied and well known. Effects of this kind of air pollution may include: impairment of the quality of the environment; interference with business activities; discomfort, harm or impairment of the safety of any person; rendering any property, plant or animal unsuitable for human use (Barbusinski et al., 2017). Odours may affect well-being by eliciting unpleasant sensations, by triggering possibly harmful reflexes and other physiologic reactions and by modifying olfactory function. Unfavourable responses includes nausea, vomiting, and headache; induction of shallow breathing and coughing; upsetting of sleep stomach, and appetite; irritation of eyes, nose and throat; destruction of the sense of well-being and of enjoyment of food, home and external environment; disturbance, annoyance and depression (National Research Council Committee on Odour,1979). The study by the National Research Council also found that the exposure to some odorous substances may also lead to a decrease in heart rate, constriction of blood vessels in the skin and muscles, release of epinephrine, and even alterations in the size and condition of cells in the olfactory bulbs of the brain. In addition, poor toilet sanitation increased prevalence of diseases and pollution of the environment (Zhang et al., 2018). Besides, odours affect health depending on their description and strength. Sometimes, an odour can be comfortable, while at other times it can be uncomfortable and influence people's health status (e.g., cause a migraine) (Horiguchi et al., 2015).

2.4 Characteristic of odour sources in toilet

2.4.1 Characteristic of human urine

The ammonia, dimethyl disulfide, allyl methyl sulfide and 4-heptanone were the main odorous compounds generated from human urine, with headspace concentrations hundreds of times higher than their respective odor thresholds (Liu et al., 2017).

Furthermore, the high temperature accelerated urine hydrolysis and liquid–gas mass transfer, resulting a remarkable increase of odor emissions from the urine solution. The odorous compounds present in urine could be influenced by gender, age,diet, physiological and hormonal status, and use of drugs (Edman and Brooks, 1983; Guernion et al., 2001). Hiroshi et al. (2001) determined the malodorous substances derived from human excreta (feces and urine) using thermal-desorption cold-trap and gas chromatography–mass spectrometry. Their results showed that fatty acids were the main malodor-causing substances, and other odorous compounds included sulfur-containing compounds (hydrogen sulfide and methyl mercaptan) and nitrogen-containing compounds (ammonia, pyridine, pyrrole, indole, skatole and trimethylamine).

From studies above, it is found that odour emission from urine solution inceases as the temperature increase. Besides, the chemical compounds in human urine highly influenced by gender, age and diet. From the study, it stated that Hydrogen Sulfide and Ammonia are odorous compounds included in urine solution.

2.4.2 Characteristic of human faecal

Faeces and faecal sludge are different. Faecal sludge is the faecal waste stored within onsite sanitation technologies. In addition to faeces it includes everything that goes into the toilet, for example, urine, flush water, greywater, anal cleansing materials and municipal solid waste (Strande et al., 2014). Faecal sludge differs significantly from fresh faeces alone; it is typically much more dilute due to the addition of liquids. Additionally, its characteristics are highly variable due to differences in storage duration, storage temperature and storage technology, and can range from fresh, to partially degraded, to completely stabilized (Strande et al., 2014). Faecal solids are composed of proteins, fats, fibre, bacterial biomass, inorganic materials and carbohydrates. Their chemical and physical characteristics vary widely depending on person's health and diet (Penn et al., 2018). The high nitrogen content of feces is partly due to undigested protein voided in the feces but is also due to the significant protein content of bacterial biomass in the feces. The bacterial biomass in the faeces and exposure to human faces can risk human health.

2.5 Technology of Odour Control

The control of odours may be regarded as a case objective of control gaseous emission into the atmosphere. For particular characteristics of odour, there are some additional requirements imposed and offer some attractive opportunities. For some offensive odorants, they can be detected at extremely low concentrations, the efficiencies required of control methods are often above 95%. Moreover, because the dilution of an odorant yields a less than proportional reduction in odour intensity, the efficiency of atmospheric dispersion as a control method is similarly reduced.

Many researchers have studied the state of indoor air contamination or its sources during the last few decades. Also, numerous practical studies have been conducted to eliminate unwanted odour and bacteria in bathrooms. Most methodologies focused on how to design ventilation systems in bathrooms effectively so that the unwanted materials would not contaminate rooms. (Seo and Seouk, 2009) simulated the airflow numerically and the flow path of contaminant particles in the bathroom with floor exhaust ventilation. (Tung et al., 2009) conducted an experimental study in a mock-up bathroom with a typical ceiling ventilation system. They utilized Sulfur hexafluoride (SF6) trace gas to verify the concentration at each sampling point. Their results showed that the removal efficiency of odours became more effective with higher ventilation rates and shorter distances between the toilet and the exhaust air vent, which reflects common sense.

2.5.1 Biological treatment of odour

Odour treatment technologies can be classified into three categories, namely ones employing chemical (thermal oxidation, catalytic oxidation, ozonation), physical (condensation, adsorption, absorption) and biological (using biofilters, biotrickling filters, bioscrubbers and other bioreactor types) treatment methods. An important advantage of biological treatment methods over physical and chemical technologies is that the biological processes can be conducted at moderate temperatures (10–40 °C) and atmospheric pressure (Barbusinski et al., 2017). Barbusinski et al., (2017) stated that biofiltration is the oldest biological method for the removal of undesired gaseous compounds from air. For almost a century now, biofilters have been applied to remove odorous compounds emitted from wastewater treatment plants or intensive animal farms.

Biofiltrations method is a cost effective method and this method is suitable to treat low-concentration odorous gases (Barbusinski et al., 2017). However, biofiltrations method has dificullties in moisture content and pH control, low efficiency of the treatment of high-concentration pollutants, deterioration of the bed material leading to the need for its periodic replacement and possible clogging of the bed due to particulate matter (Datta and Alen, 2005; Mudliar et al., 2010).

2.5.2 Activated carbon for odour removal

Activated carbon has been widely used as adsorbents, catalyst support and energy storage materials (Ao et al., 2018). In addition, Ao et al,(2018) stated that activated carbon (AC) has been proven to be an effective adsorbent for removing a wide variety of organic and inorganic pollutants, polar and non-polar compounds in the aqueous phase or from gaseous environment and has also been used in energy storage fields.

Another study conducted by Bertone et al, (2018) to understand the potential adsorption of powdered activated carbon to remove taste and odour compound. Powdered activated carbon (PAC) typically added to the raw water during the treatment process because PAC has sponge-like property that ideal to absorb organics (Bertone et al., 2018).

2.5.3 Usage of perfume to remove odour

Zhang et al, (2013) stated that one of the easiest and fastest ways to solve the odor problem is to use perfumed products which are biodegradable, nontoxic, safe, and inexpensive, on the odor source. The principle of this method is to cover or mask the odor with pleasant smell, and thus prevent complaints on the odor from the surrounding area. At present, various sprays, powders, and jells are available in the market, and have been used in practice to mitigate odor offence to the public. However, it is not a preferred solution because of the fact that the use of the perfumed products just covers or masks but not eliminates the odor, which implies that the possibility of toxic odor from lagoons to attack the neighborhood still exists(Zhang et al., 2013). Thus, the usage of perfume is not suitable to treat odour in toilet since the perfumes are not able to remove the odour permanently.

2.6 Summary of Literature Review

The literatures have shown that the concerns to remove toilet odour are increasing widely where many study have been conducted to eliminate unpleasant odour in bathroom/toilet. The exposure to some odorous substances can lead to health problems, therefore some association already establish the odour treatment method to control or reduce odour in the toilet. For odour treatment in toilet, most publications suggested to provide proper ventilation in the toilet and one of the publication is from

Seo and Seouk, 2009. The literature review also pointed out the characteristics of human waste in order to know the level of odorous substance in the urine and faeces.

CHAPTER 3

METHODOLOGY

3.1 Introduction

This chapter discuss about the methods and process carried out during the study. In order to achieve the objectives, field assessment was required to be done at selected toilet that has odour problem.

3.2 Description of Study Area

The study area is the USM Engineering Campus located in Nibong Tebal, Pulau Pinang. The campus's location is very unique because it is located in between the border of three states; Pulau Pinang, Perak and Kedah. The campus covers about 320 acres of land which was formerly palm-oil plantation even the palm oil tree still can be seen at certain area inside the campus especially near the main gate. Besides, there are nearby factories such as palm oil mill and paper mill that produce malodour. Thus, the possibility for the USM community to experience malodour from these factories is very high.

There are two hostel inside the campus; Desasiswa Jaya and Desasiswa Lembaran. In total, the hostel has six hostel blocks. Desasiswa Jaya has three hostel blocks; 2 male hostels and 1 female hostel. The location of male hostel is located near Taman Ilmu's gate which far from the factories compared to female hostel and Desasiswa Lembaran. Hence, the female student at Desasiswa Jaya may frequently experience the malodour from the factories.

The proposed location of the study is the toilet at Desasiswa Jaya as shown in Figure 3-1. The toilet is chosen based from observations and odour complaints from the students. Besides, it is also easy to access for the purpose of the study. The layout measurements of the toilet are shown in Figure 3-2 and Figure 3-3.

Figure 3-1: The toilet of Desasiswa Jaya as the proposed study location

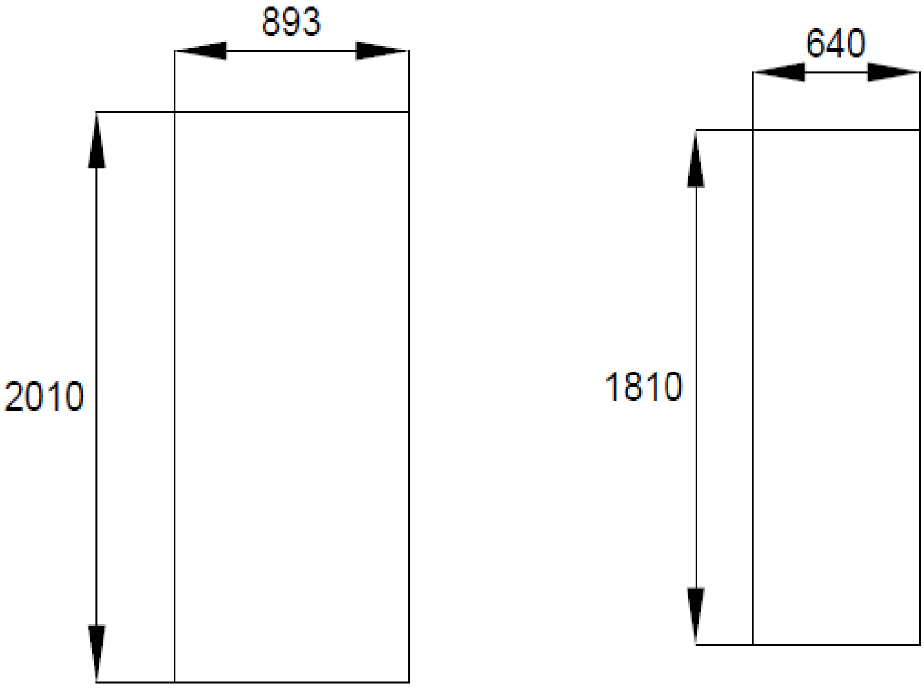

Figure 3-2 : Details measurement of shower and toilet door

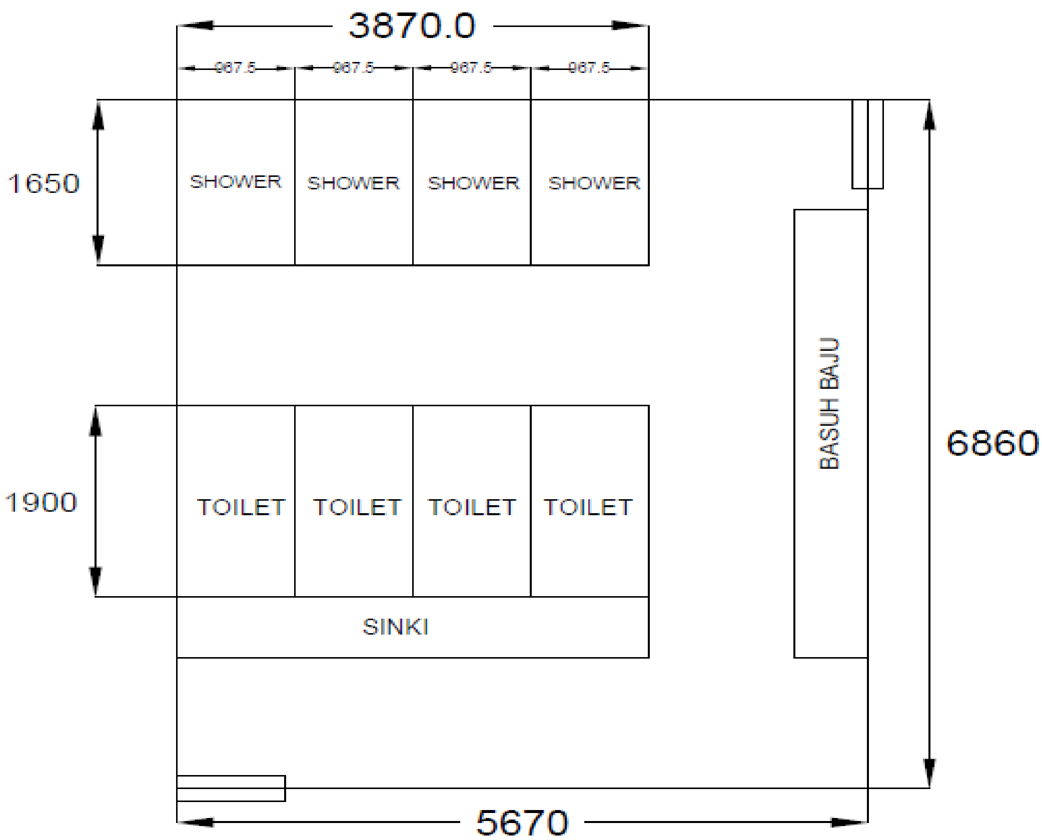

Figure 3-3 : Layout and measurement of the toilet

3.3 Description of odor removing membrane

Deodoratex (Hiraoka Ltd., Japan) is a unique odour eliminating mesh fabric. Deodoratex has a specialised coating which allows the mesh to adsorb a range of odours. It has been use in critical applications to reduce ammonia gas in poultry and pig sheds. Deodoratex is chemically adsorbs odours therefore improving ambient conditions which has been proven to reduce livestock stress and mortality birthing rates in livestock sheds. The characteristics of Deodoratex are shown in Figure 3-5 and Figure 3-6. Deodoratex is reuseable, a washing process renews the performance properties of Deodoratex. Therefore, this study is conducted to identify the effectiveness of Deodoratex to remove odour concentration, hydrogen sulphide (H_2S) and ammonia (NH_3) in toilet.

The Deodoratex membrane is made from inorganic system deodorizer (Silicon Dioxide, Zinc Oxide and Aluminiumsilicate). The Deodoratex helps to improves air quality by adsorbing various odour chemically. The adsorption mechanism of Deodoratex is shown in Figure 3-4. It adsorbs both acid and base materials because it has both adsorption sites. The Deodoratex targets to remove 4 major gases that generate bad smell such as Ammonia, Hydrogen Sulfide, Methanethiol, Trimethylamine. The Deodoratex is effective for many months. The duration will depend on the concentration of odorant. The Deodoratex can be simply washed with water and mild detergent to release trapped odour molecules. The washing process renews the performance properties of the Deodoratex to allow re-use.

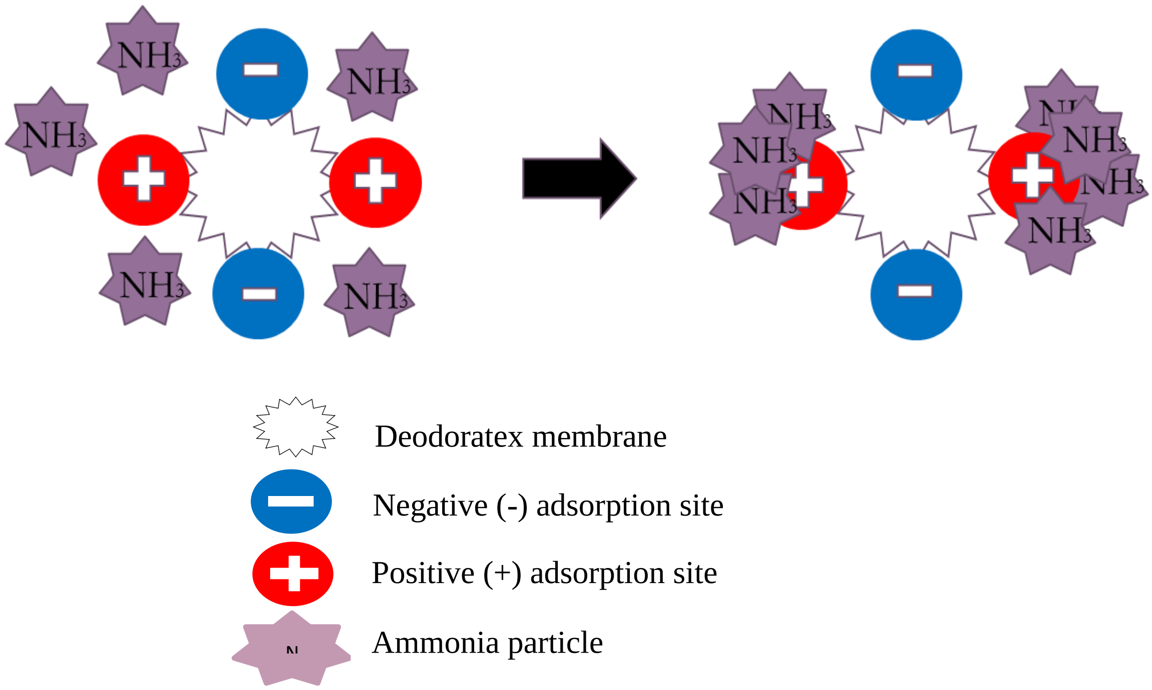

Figure 3-4 : Adsorption mechanisms of Deodoratex

The characteristic of Deodoratex is shown in Figure 3-5 and Figure 3-6. The parameter difference between both Deodoratex is pore sizes. From figures, the pore size of Type 03 is larger than Type 32. In practical industrial applications, however, geometries should be emphatically considered during the comparison and selection of filters, due to different requirements of filtration performance levels. More importantly, geometry has a substantial influence on the filtration performance of filters, and, in particular, the pore size is one of the most important influencing parameters. A filter with smaller pore size has a larger fiber surface area (or a smaller fiber diameter). Based on single-fiber theory, such filters act to improve the capture efficiency of particles or droplets. In addition, the filtration performance of fibrous filters, as a kind of porous media, is closely related to pore size. As a result, there is a growing need to study the effect of the pore size on adsorption performance.

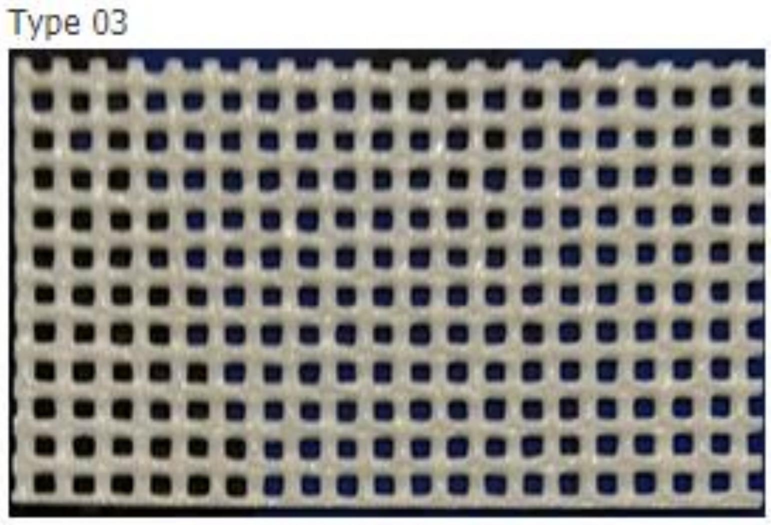

Figure 3-5: Type 03 Deodoratex

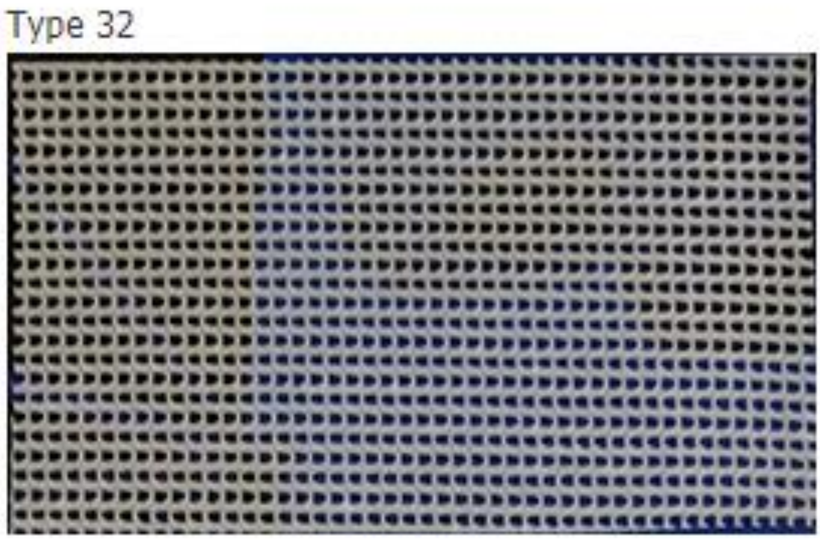

Figure 3-6: Type 32 Deodoratex

3.4 Data Collection

This is the important part of the study that involves the collection of odour concentration, NH_3 concentration and H_2S concentration. The Deodoratex is applied in vertical as shown in Figure 3-7. For vertical application, the deodoratex is applied at each of the shower and toilet doors. There are two types of Deodoratex used in the study; Type 03 and Type 32 , the details of each type is as shown in Figure 3-5 and Figure 3-6. Each type of Deodoratex will be tested for vertical (1 week) application .

The data collection for odour concentration, NH_3 concentration and H_2S concentration is done at the same time for three times a day. For odour concentration, the data was obtained by using SM100 Olfactometer. During the assessment, the observer is standing at the aisle in between shower and toilet section. For NH_3 concentration and H_2S concentration, the data were obtained using Scentroid Odotracker TR8. The instruments were set up first and it will measures the concentrations of two chemicals in ambient air at the same time.

Figure 3-7 : Deodoratex application in vertical conditions at toilet and shower doors using Deodoratex Type 03

The potential of Deodoratex to control odour in terms of hydrogen sulfide and ammonia will be tested in three different conditions :

1) Without application of Deodoratex

2) Type 03 Deodoratex

3) Type 32 Deodoratex

For all the conditions, the testing are conducted for 5 days and the odour concentration (OU/m^3) will be assessed 3 times a day, tentatively as shown in Table 3-1. The assessment time is selected at 9.00 am because it is the peak time of toilet usage. Most students used toilet in the early morning since class usually starts in the morning. For 2.00 pm, it is chosen because it is lunch time where the student are most likely come back the hostel to fresh up and to have their lunch. So at 2.00 pm the toilet is used quite frequent. At 6.00 pm, it is the time where the student has finished their class and coming back from their exercise. This is the peak time of toilet usage same as in the morning time.

Table 3-1 : Testing schedule

Day	Time
Monday/Tuesday/Wednesday /Thursday/Friday	9.00 a.m
	2.00 p.m
	6.00 p.m

During the assessment, a survey to the toilet users will be conducted and the observation of the toilet condition such as cleaning time will be recorded, etc.

3.5 Determination of Odor, Ammonia and Hydrogen Sulfide Concentration

The odour concentration (OU/m^3), hydrogen sulfide and ammonia levels (ppm) were measured at time as in Table 3-1, the concurrent observation of the toilet condition and usage such as cleaning time were recorded.

The methodology to observe the odour concentration is based on the use of a dilution instrument, called olfactometer, which presents the odour sample diluted with odour-free air at precise ratios to a panel of human assessors. The odour concentration usually expressed in odour units (OU/m^3). It numerically equal to the dilution factor necessary to reach the odour threshold that is the minimum concentration perceived by 50% of population. The detection limit of SM100 Infield Olfactometer (Scentroid, Canada) is 3.5 to 16,667 OU/m^3.

The Scentroid Odotracker TR8 is used to measure Hydrogen Sulfide (H_2S) and Ammonia in ppm level. The Odotracker is a multi-sensor device that measures the concentrations of two chemicals in ambient air at the same time. The detection limits of OdoTracker TR8 (Scentroid, Canada) is shown in Table 3-2:

Table 3-2 : The detection limits of instruments

Gas compound	**Sensor type**	**Maximum detection limit**	**Lowest detection limit**	**Resolution**
Ammonia	Electrochemical	100 ppm	0.5 ppm	0.3 ppm
Hydrogen Sulfide	Electrochemical	2000 ppm	1 ppm	1 ppm

Figure 3-8 and Figure 3-9 show the SM100 Infield Olfactometer (Scentroid, Canada) and OdoTracker TR8 (Scentroid, Canada) the will be used during the assessment.

Figure 3-8 : SM100 Infield Olfactometer (Scentroid, Canada)

Figure 3-9 : OdoTracker TR8 (Scentroid, Canada)

3.6 Survey to The Toilet Users

A survey is conducted to evaluate the current odour conditions of the toilet by distributing a questionnaire to the toilet user (Appendix A). The survey was carried out in the evening where the students has finish their class. The target respondents were the regular toilet user that used the study toilet.

The approach method was by distributed the google form to the respondents. A short brief to describe the study was given to the respondent before they start to answer the questions. The respondents need to answer two parts of questions; before installation of Deodoratex and after installation of Deodoratex. They need to give their opinion about the odor in the toilet before and after the application of Deodoratex.

3.7 Data analysis

3.7.1 Paired samples t-Test analysis

A Paired Samples t-Test analysis is the method used to compared mean from two samples (two different methods of application and two different type of membrane used in the study) and test whether it is likely that the samples are from populations having different mean values. The data from Paired Samples t-Test analysis are reported numerically in the text or table to help people better understanding the meaning of the analysed data. The purpose of the test is to determine whether there is statistical evidence that the mean difference between paired observations on a particular outcome is significantly different from zero. The Paired Samples t Test is a parametric test.

The test is also known as ;

1. Dependent t Test
2. Paired t Test
3. Repeated Measures t Test

The variables used in this test known as dependent variable or test variable, measured at two different times or for two related conditions or units. The Paired t Test is commonly used to test statistical difference between two conditions, two time points, two measurements or a matched pair. The Paired Samples *t* Test can only compare the means for two (and only two) related (paired) units on a continuous outcome that is normally distributed. The Paired Samples *t* Test is not appropriate for analyses involving the following: 1) unpaired data; 2) comparisons between more than two units/groups; 3) a continuous outcome that is not normally distributed; and 4) an ordinal/ranked outcome. The data of Sig (2 tailed) value is the p -value corresponding to the given test statistic t. If p value < 0.005, it means that there is a significant different between the two samples (Ken States University Library, 2018). The data must meet the following requirements:

1. Dependent variable that is continuous (i.e., interval or ratio level)
    1. **Note:** The paired measurements must be recorded in two separate variables.
2. Related samples/groups (i.e., dependent observations)
    1. The subjects in each sample, or group, are the same. This means that the subjects in the first group are also in the second group.
3. Random sample of data from the population
4. Normal distribution (approximately) of the difference between the paired values
5. No outliers in the difference between the two related groups

CHAPTER 4

RESULTS AND DISCUSSION

4.1 Introduction

This chapter discusses about the results obtained from the research. The data obtained from field assessment are presented in graphical presentation by plotting graph of the gases concentration. The data obtained from the field assessment then been compared by using SPSS and they are presented in tabulation presentation. From survey to the toilet users, the data is presented in pie chart.

4.2 The identification of odour, Ammonia and Hydrogen Sulfide at the toilet without odour treatment.

From Figure 4-1, the odour concentration without any odour treatment for vertical appplication ranged from 6.4 ou/m^3 to 20 ou/m^3 and while for horizontal in Figure 4-2 the concentration ranged from 6.4 ou/m^3 to 11 ou/m^3. The efficiency of odour concentration removal is about 45%. The result may vary with days as the cleaning of toilet may took places. For ammonia concentration in Figure 4-3, the concentration before start any treatment forr vertical ranged from 0.006 to 0.0111 ppm. For the ammonia concentration without treatment in horizontal as in Figure 4-4, the ammonia level at ranged of 0.0057 ppm and 0.0095 ppm .The ammonia concentration is very low in the toilet since the minimum detection limit for ammonia is 0.5 ppm. For hydrogen sulfide concentration in Figure 4-5, the concentration ranged from 0.0057 ppm to 0.0095 ppm. From Figure 4-6, the concentration of ranged from 0.725 ppm to 1.550 ppm. The concentrations were fluctuated every day due to cleaning of toilet, frequency of toilet usage and toilet condition.