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Treatment of used ablution water from IIUM masjid for reuse

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ABSTRACT

Muslims have to conduct ablution before most of the religious rituals. This study was conducted at the International Islamic University Malaysia (IIUM) Masjid at Gombak Campus, which can accommodate about 9000 people during the special prayer times such as Jumma and Eid. The amount of water used for ablution only is calculated to be about 7 L/Cap.day. Unfortunately, the water used for ablution is discharged directly to the drain without any recycle and reuse. Quantity and quality of the used water after ablution was determined in this study. Laboratory tests on COD, TSS, TDS, turbidity and TN have indicated that, the used ablution water is not much polluted accept slightly high COD of 31 mg/L with respect to the Malaysian drinking water quality standards. As such, the used ablution water from the Masjid can be recycled and reused, after sand filtration, at least for general cleaning and landscaping purposes. On the other hand, treatment and reuse of commercial greywater would be too expensive in the contexts of Malaysian climate, where the rain-fed water is sufficiently available. It was realised that a low maintenance treatment system can be constructed to store, treat and reuse ablution water from the Masjid. For this purpose, size of the sand filter was determined for an overflow rate of 39.1 m/d. The treated water can be used for the landscaping and toilet flushing activities, which will reduce the water consumption in the university.

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INTRODUCTION

Ablution means the act of washing selected parts of the body by using clean water. Muslims and Muslimahs are required to clean certain parts of the body in preparation for the prayers (Salat). Islam strongly recommends that the Muslims perform their prayers at the Masjid. Besides the daily prayers, IIUM Masjid is also very active in conducting many types of religious and social community activities and programs. In most of the cases, the participants are required to make ablution before entering the Masjid.

Water in urban areas is used for various purposes. Domestic use, in general, is the main sector of urban waste use. The potable water supplied to the urban areas is treated before delivered to the users. Water usage has increased steadily to reflect more concentrated populations and intensified economic activities around urban areas. Although the volume of water dedicated to urban use is less than that used by irrigation sector, its social and economic importance is enormous. Future challenges in urban water management include development of new technical solutions as well as logistic and organizational methods in order to turn present problems into future opportunities [1]. Urban water also has high embedded energy content, between 1,100 and 20,100 kilowatt-hours per million gallons. Due to the pessimistic forecast concerning water shortage in the forthcoming decades and moreover, the increasingly stringent environmental regulations for efficient water utilization and wastewater disposal, it becomes necessary to adopt a new approach to design urban water supply networks [2].

Water supply services in Malaysia is managed and operated by both state authority and concession companies following the privatization exercise in year 1987. The water rates differ from state to state and are controlled by the state government. Kun [3] concluded that the corporatization and privatization exercises do not turn out to be a successful solution to a better service quality due to capital shortage and problems in cost recovery.

Water reuse is getting emphasis all over the world due to shortage of suitable raw water for urban usages. As a result, countries with less water resources, such as Australia, Singapore, Middle East countries [4] have started treating wastewater for various reuses. The waste water from the ablution places of the Masjids are not so polluted and can be considered a source far better than municipal or industrial wastewater. Although, until

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now, Malaysia has satisfactory amount of surface water, the pressure on the available resources is increasing. Manan *et al*., [5] conducted a study on Sultan Ismail Mosque at the Universiti Teknologi Malaysia using water cascade analysis (WCA) technique and predicted savings of 65.1% fresh water and 51.5% wastewater with reuse included in the system.

Literature on the use of ablution water is rare [6]. As such, the quality of the used ablution water was assessed and its potential to be used as recycled water in the campus is reported in this paper. The main objective of the short study was to determine the quantity and quality of ablution water used in the IIUM Masjid to assess its potential to be used as recycled water in the campus for non-potable usages.

Ablution Process:

The ablution process (Figure 1) is described below for the readers [who are not familiar with the steps] to understand that there is little source of water pollution in the whole process. The ablution steps are [7]:

1. To declare the intention that the act is for the purpose of worship and purity, start by saying "Bismillah" (by the name of Allah – the Only Creator).
2. To wash both hands up to the wrists, three times (starting with the right hand first).
3. To rinse out the mouth with water, three times, preferably after a brush whenever it is possible.
4. To cleanse the nostrils of the nose by sniffing water into them, three times.
5. To wash the whole face three times with both hands, if possible, from the top of the forehead to the bottom of the chin and from ear to ear.
6. To wash the right arm three times up to the far end of the elbow, and then do the same with the left arm.
7. To wipe the whole head or any part of it with a wet hand, once.
8. To wipe the inner sides of the ears with the forefingers and their outer sides with the thumbs. This should be done with wet fingers.
9. To wash the two feet up to the ankles, three times, beginning with the right foot.

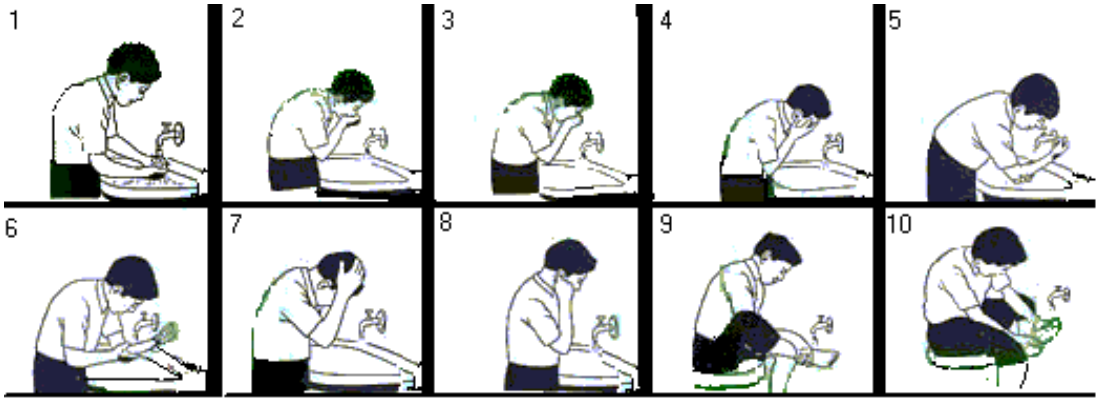


Fig. 1: Sequence of Ablution Process [8].

These modern days, most of the Masjid has tap water for ablution. The people seldom close the taps while the hands are busy washing the body parts (Plate 1). This is because closing taps [after holding water in the palm] every time before washing the body parts is not that convenient. As such, it can be said that about half of the tap water flows directly to the drain without any contamination. Such wastage can be avoided by using water from a container or pail. The Islamic historical records indicated that Prophet Mohammad [peace be upon him] used to make ablution using one "Mudd" of water [Hadith from Bukhari and Muslim] which is equivalent to about 0.544 L of water [9]. This indicates that how serious was he in the conservation of water during ablution. It is also discouraged to use access water unnecessarily during ablution, although there is abundant amount of water available at the source (Hadith from Ibn Majah). The Holy Qur'an also reminds the Muslims to be moderate in whatever they do and never be extravagant or wasteful, which is also valid for water use during ablution (Qur'an 17:26-27 and 25:67).

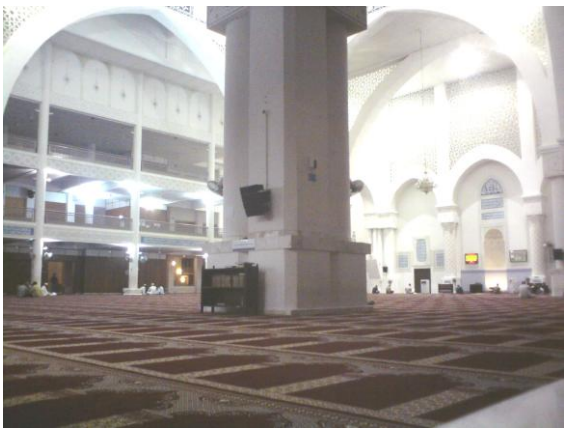
Plate. 1: Wastage of Water during Ablution by Typical Tap Water [10]

MATERIALS AND METHODS

Study location:

The study was conducted at the Sultan Haji Ahmad Shah Masjid (Plate 2), which is located at the center of the main campus of IIUM at Gombak, interconnecting the hostels, administrative and academic buildings. It can accommodate at least 9000 people at one time. Inside the Masjid, there are two places for ablution, one for the males and the other for the females. There are additional three ablution places outside the Masjid for the males. The ablution water is discharged through covered pipe drains, whereas the open drains around the Masjid collects the stormwater. However, there is no separate water meter for the Masjid to determine the exact amount of water used every month of the year. However, according to the Masjid Office, the estimated average total number of people prays in the normal working day [except Friday], is around 3000 per day. Although the price of water is not so high in Malaysia, it would be good for the environment and conservation of resources if the used ablution water is recycled and reused for various permissible activities in the campus.

(a) Outside View



(b) Inside View

Plate. 2: Central Masjid at IIUM

Sampling location:

Samples of used ablution water were collected from three main locations of the IIUM Masjid [Plate 3] to estimate the quantity of water used and its quality discharged to the drains. The used water from these places are discharged through the outlet shown in Plate 3[d]. Ablution water samples [5 samples from each location] were collected and analyzed for a period of 2 months. The following parameters were tested: Total Dissolved Solid (TDS), Turbidity, Total Suspended Solid (TSS), Chemical Oxygen Demand (COD) and Total Nitrogen (TN). The Standard Methods [11] were used to determine the quality of the used ablution water before and after treatment with sand filter.

(a) Indoor Ablution Place

(b) Outdoor 1 Ablution Place

(c) Outdoor 2 Ablution Place

(d) Discharge Outlet

Plate. 3: Ablution Places and Discharge Point

Lab-scale sand filter was used to remove the physical and other pollutants from the used ablution water. Locally available sand was cleaned to be used as filter media. Sand characteristics were determined using sieve analysis of 5 grab samples of collected sand.

RESULTS AND DISCUSSION

Wastewater characteristics:

The daily water consumption due to ablution in the IIUM Masjid is about 7 L/Cap.day. As such, the monthly water consumption would range within 650 and 750 m^3/month. Although, in terms of monetary value the cost or savings due to recycling of 750 m^3/month is not very high but in relation to the conservation of natural resources and energy, the recycling and reuse of the ablution water would be a commended option, if the quality of the used water is not so polluted.

Ablution water quality was measured in terms of a few common major parameters (Table 1). It was observed that the mean values of the parameters were lower than the Ministry of Health (MOH) Standard for drinking water quality in Malaysia. However, it does not necessarily indicate that the used ablution water is suitable for potable usages. Because, the other important parameters, such as *E. coli* was not measured in the study.

Table 1: Water Quality Data of Ablution Water

Parameter	Unit	Before Treatment	SD	After Treatment	SD	MOH Standard
TDS	mg/L	24.7	2.07	25.1	1.53	< 1000
TSS	mg/L	31.0	6.29	19.9	3.90	15-30
Turbidity	NTU	16.4	1.17	3.5	0.84	<5.00
COD	mg/L	31.3	7.22	16.9	5.07	N.A
TN	mg/L	0.92	0.26	0.47	0.15	N.A

Sand filtration:

Although, the data indicated that quality of selected chemical and physical parameters are acceptable for non-potable usages, occasional increase in the aesthetic pollutants [such as turbidity and solids] can be high. Therefore, to ensure good quality of recycle water the used ablution water should be treated through sand filters [12] with sand media having effective size ranging between 0.3 and to 1.0 mm, and uniformity coefficient should be range between 1.3 and 1.7 [13]. As such, clean river sand was tested in a lab-scale filter for its filtration performance. The sand was sieved to determine its effective size [ES] and uniformity coefficient [UC], as shown in Figure 2, and found to be suitable for gravity sand filtration.

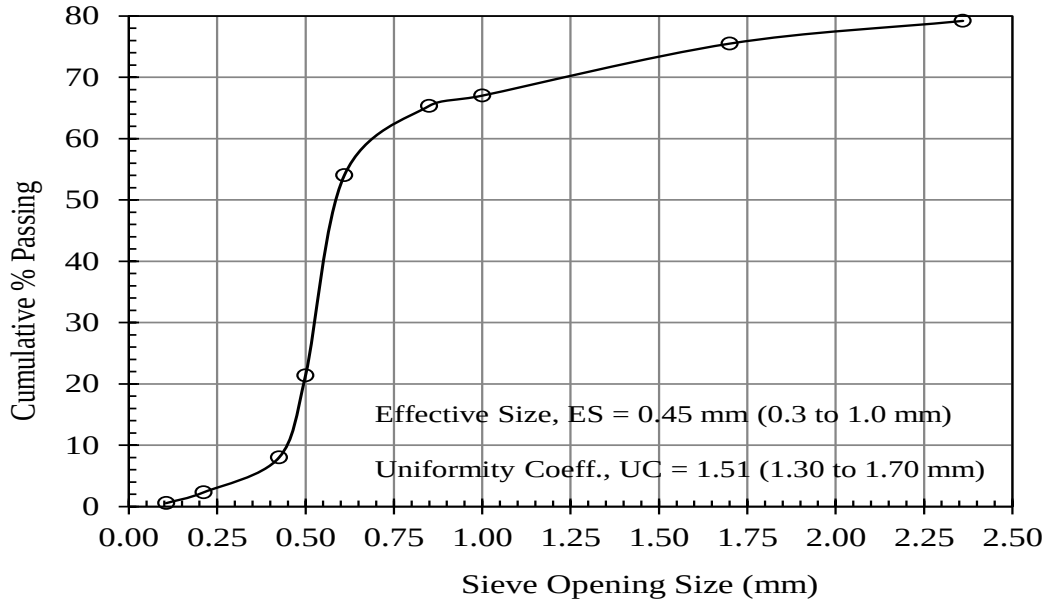


Fig. 2: Characteristics of the Sand Filter Media used for the Lab-scale Filter

The conventional filtration process is probably the most important single unit operation of all water treatment processes. It is an operation process to separate suspended matter from water by flowing it through porous filter medium or media. The filter media may be sand, anthracite coal, diatomaceous earth, garnet or finely woven fabric.

A lab-scale sand filtration system was fabricated and tested to clean the used ablution water. The section of the gravity sand filter is shown in Figure 3, where the major information is given. Size of the sand filter was determined based on the allowable overflow rate, which was 39.1 m/d. This value falls within the range of slow sand filter (2.9 to 7.6 m^3/d) and rapid sand filter (120 to 235 m^3/d) as mentioned by [13]. However, it was realized that the sand filter, to clean the used ablution water with a target to use for landscaping and toilet flushing, can be operated as a slow sand filter to minimize its maintenance frequency.

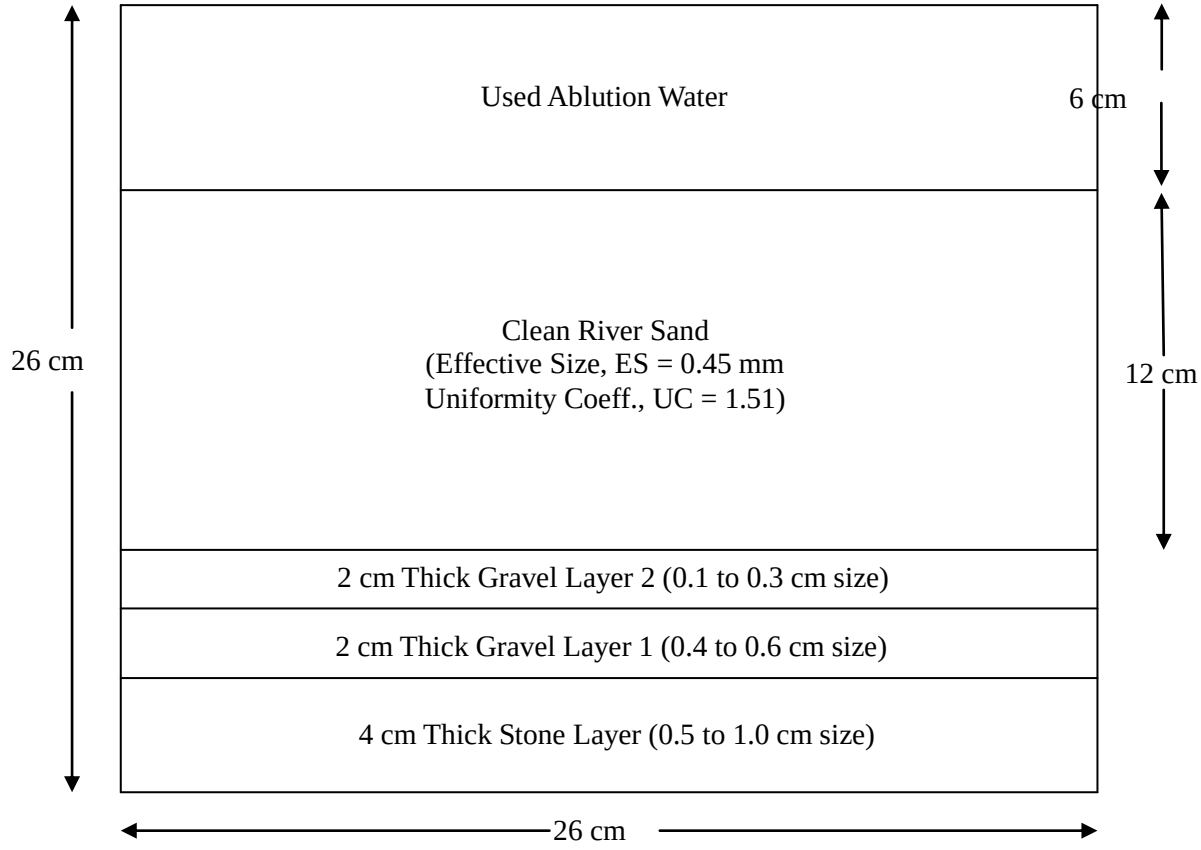


Fig. 3: Schematic Section of the Lab-scale Sand Filter (Not to Scale)

Conclusions:

This study revealed that the concentration of COD, TSS, TDS, turbidity and TN in the used ablution water was quite low, accept slightly high COD of 31 mg/L with respect to the Malaysian drinking water quality standards. Therefore, the ablution water discharged from IIUM Masjid could be recycled in order to conserve water resources. The water used for ablution is recommended to be filtered by sand filter and recycled for flushing toilets and landscaping of the surrounding areas. A lab-scale sand filtration system was designed, fabricated and tested to clean the used ablution water. Size of the sand filter was determined based on the allowable overflow rate, which was 39.1 m/d.

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