SURFACE RUNOFF WATER QUALITY AT CONSTRUCTION SITE IN PUTRAJAYA

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ABSTRACT

Malaysia is rich in water resources, whose development has been the basis for the socio-economic development of the country over the past decades. Lately, water supply situation for the country has changed from one of relative abundance to one of scarcity. Population growth and urbanization, industrialization and the expansion of irrigated agriculture are imposing rapidly increasing demands and pressure on water resources, besides contributing to the rising water pollution. The way forward to a prosperous and sustainable future is to keep development to a level that is within the carrying capacity of the river basins while protecting and restoring the environment. Thus, surface runoff water recycling is the reuse of treated water for beneficial purposes in construction industry such as for washing machinery tyres and dust control. Water reuse allows communities to become less dependent on groundwater and surface water and can thus help reduce the impact on our ecosystem. The objective of this study is to identify the quality of runoff water at construction site where the pH number, Total Suspended Solids and Turbidity have been investigated. Samples for this study were collected from identified construction site in Putrajaya. The study found that pH number for runoff water is acceptable whereas Total Suspended Solids and Turbidity have to undergo filtration process. An appropriate practical technology for runoff water filtration in the construction industry is suggested regarding to sustainable water treatment systems in the context of urban areas of developing world.

Keywords: runoff water, construction site, filtration

1. Introduction

Sustainability is a New Economic Model (NEM) development pillar that Malaysia hopes will help ensure it becomes a "high income" economy by 2020. Construction and green buildings are integral sustainable New Economic Model (NEM) components that contribute to long-term growth that have been highlighted under Malaysia's Construction Industry Master Plan (Zuhairi, 2012).

The world's supply of fresh water is finite and is threatened by pollution. Rising demands for water to supply agriculture, industry and cities are leading to competition over the allocation of limited fresh water resources. In many countries, the available fresh water resources are already heavily committed and in some cases perhaps already overcommitted. To avoid a water crisis, many countries must conserve water, manage supply and demand, pollute less and reduce the environmental impacts of growing population. (Hinichsen et al., 1999).

The crisis of water shortage caused by factors of population, development of the industrial sector, the problem of pollution of water resources and so on. Water consumption for developed countries such as Malaysia has built much focus on the industrial sector. Water consumption in this sector involves a lot of water every day. Discharge from the used water or wastewater from the industrial sector is also causing problems to water quality due to discharge of effluents. According to Regulation of Environmental Quality Regulations (1979), there are 2 standards for sewage and industrial effluent which are: Standard A to discharge at upstream and Standard B for discharge downstream where some of parameters are shown in Table 1.

Table 1. Sewage and Industrial Effluents (Regulation of Environmental Quality Regulations (1979)

Parameter (mg/l except describe)	**Maximum allowable**	
	Standard A	**Standard B**
Temperature (^{O}C)	40	40
pH (units)	6.0-9.0	5.5-9.0
BOS_5 at $20^{O}C$	20	50
COD	50	100
Total Suspended Solids	50	100
Mercury	0.005	0.05

Effective solutions to solve the water shortage crisis are urgently needed. In addition to overcoming the crisis of water shortages, steps taken should also emphasize the environmental aspects. So, the best alternative should be provided to deal with this problem effectively. Water reuse by filtering wastewater is one of the best alternatives to reduce the problem of water shortage in the construction industry and thus help to reduce bad effects on the environment.

Water is so important in the industrial sector, for example in the food processing industry, manufacturing industry and electroplating, paper and chemical industry. Water demand in these sector sometimes exceeds supply hence causing water shortage crisis. Table 2 shows the total demand water for domestic, industrial and irrigation for Peninsular Malaysia.

Table 2. Total demand water for domestic, industrial and irrigation for Peninsular Malaysia (National Water Resources Study, 2000)

Total Demand Water For Domestic, Industrial And Irrigation								
Demand		**1998**	**2000**	**2010**	**2020**	**2030**	**2040**	**2050**
Domestic	Mld	5022	5558	8184	10582	12622	14388	16176
Indutrial	Mld	3453	3985	7101	9756	11863	13743	15452
Domestic & industrial	Mld	8475	9543	15285	20338	24485	28131	31628
Irrigation	Mld	20139	20139	17875	17857	16802	16802	16802
Total	Mld	28614	29682	33142	38195	41287	44933	48430

Mld: megalitres per day

In addition, the discharge of industrial water also has a big impact on the environment. Most plant operators overlooked this aspect of arbitrarily releasing wastewater without proper industrial wastewater discharge. Due to these factors, study on the construction's runoff water as a treated water for reuse at construction sites is crucial. The objective of this study is to identify the quality of runoff water from the identified construction site and from the results obtained, the suggestion of filtration system can be designed and developed. The parameters identified to be studied are pH, total suspended solids (TSS) and turbidity where;

The pH of water determines the solubility (amount that can be dissolved in the water) and biological availability (amount that can be utilized by aquatic life) of chemical constituents such as nutrients.

Suspended solids influence the purity of water where high sediment loads interfere with coagulation, filtration, and disinfection. More chlorine is required to effectively disinfect turbid water and cause problems for industrial users. Suspended sediments also interfere with recreational use and aesthetic enjoyment of water. A positive effect of the presence of suspended solids in water is that toxic chemicals such as pesticides and metals tend to adsorb to them or become complexes with them which makes the toxics less available to be absorbed by living organisms.

Turbidity is a unit of measurement quantifying the degree to which light traveling through a water column is scattered by the suspended organic (including algae) and inorganic particles. The scattering of light increases with a greater suspended load. Turbidity is commonly measured in Nephelometric Turbidity Units (NTU). Human activities such as construction can lead to high sediment levels entering water bodies due to storm water runoff. This can lead to high levels of turbidity. Siltation, or sediment deposition, eventually may close up channels or fill up the water body converting it into a wetland.

2. Methodology

Samples of runoff water were collected from construction site at Parcel F, Precinct 1, Putrajaya site as shown in Figure 1. The parameters that have been measured were pH, Turbidity (NTU) and Total Suspended Solid (mg/L).

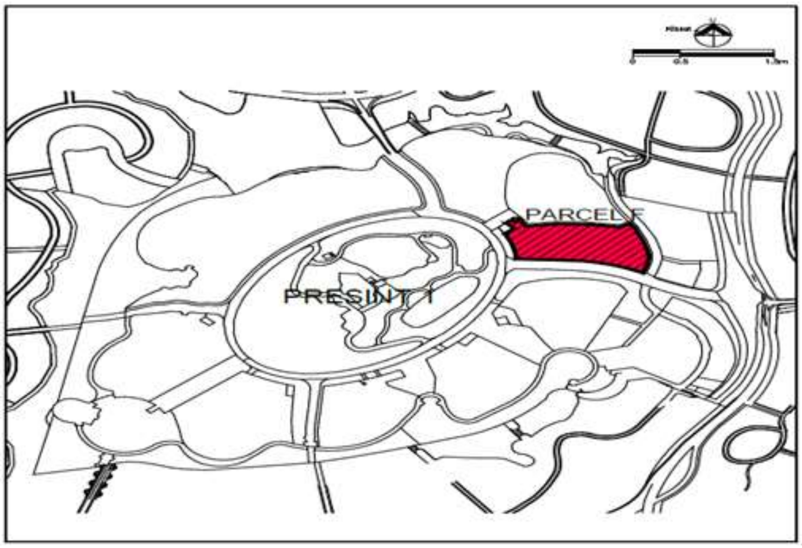

Figure 1. The location of construction site for sampling

2.1. pH Number

10 samples of runoff water were taken from the construction site at Parcel F, Precinct 1 Putrajaya to identify the pH number for alkalinity. The alkalinity of water is a measure of its capacity to neutralise acids. The alkalinity of natural waters is primarily due to the salts of weak acids, although weak or strong bases may also contribute.

Procedure of measuring pH:

i. Rinse pH electrode and 150 mL beaker with distilled water.
ii. Transfer 100 mL of water sample into the beaker.
iii. Dip pH electrode into the sample.
iv. Stir the sample with a magnetic stirrer.
v. Record pH when constant reading is obtained.

2.2. Total Suspended Solids

Two well-mixed samples were filtered through a pre-weigh glass filter. The filter is then dried in a drying oven and reweighed. The weight gain represents the total suspended solids. It is expressed in mg/L. The apparatus is shown in Figure 2.

Procedure of Total Suspended Solids

i. Dry the filter disk in oven at 103^0C to 105^0C for several times, cool in a desiccators and weigh. Name it as A.
ii. Assemble filtering apparatus, filter and begin suction.
iii. Pour 100 ml of water sample onto centre of filter disk in a Buchner flask.
iv. After filtration is complete, remove filter from filtration apparatus to aluminum weighing dish as a support.
v. Dry at least one hour at 103^0C to 105^0C in an oven, cool in desiccators to balance temperature and weigh. Name it as B.
vi. Calculate the total suspended solids using the following equation:

$$Suspended\ Solids, mg/L = \frac{(\mathrm{A}-\mathrm{B})\mathrm{x}\,1000}{\text{sample volume (ml)}}$$

where; A = weight of filter + dried residue, mg
B = weight of filter, mg

Figure 2. Apparatus of Total Suspended Solids

2.3. Turbidity

The 10 samples of runoff water collected from the construction site at Parcel F, Precinct 1 Putrajaya were also tested to identify its turbidity. Turbidity is measured using a turbidity meter as shown in Figure 3. For chlorinated water, turbidity should be less than 5 NTU and preferably less than 1 NTU for chlorination to be effective. Table 3 shows the levels of NTU categorised accordingly.

Table 3. NTU level

Category	**NTU's**
Excellent	≤ 10
Fair	15 - 30
Poor	> 30

Procedure of Turbidity Test

i. Allow a short warm-up period of about 5 minutes for the turbidity meter.
ii. Calibrate the turbidity meter using the standard turbidity suspensions.
iii. Pour the sample into the sample tube. Be careful not to introduce air bubbles into the sample tube.
iv. Wipe dry the sample tube thoroughly, using tissue paper.
v. Read off the turbidity meter readings

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Figure 3. Turbidity meter

3. Result and Discussion

3.1. pH Readings

pH tests conducted on 10 samples show that all samples have alkalinity property where the readings for all samples are greater than the scale value of 7.0 as shown in Table 4 and is acceptable. The allowable pH value is between 6.0 and 9.0 according to the Regulation of Environmental Quality Regulations (1979). Therefore no water treatment is needed in terms of the pH number.

Table 4 : Results for pH

Sample	1	2	3	4	5	6	7	8	9	10
pH	8	7.5	7.5	8.5	7.5	7.5	8.5	7.5	8.5	7.5

3.2. Total Suspended Solids (TSS)

The average total suspended solids from two samples collected is 85 mg/L which is not accepted according to Regulation of Environmental Quality Regulations (1979), where the maximum allowed is 50 mg/L. This result shows that the quality of runoff water from construction site is poor and a filtration process is needed before the water can be reused.

Total suspended solids are due to the particles that are larger than 2 microns found in the water column. Most suspended solids made up of inorganic materials, though bacteria and algae can also contribute to the total solids concertration. At construction sites, these solids include anything drifting or floating in the water, from sediment, silt and sand to plankton and algae. Organic particles from decomposing materials can also contribute to the

TSS concentration. As algae and plants decay, the decomposition process allows small organic particles to break away and enter the water column as suspended solids.

3.3. Turbidity

All samples show high level of turbidity which is greater than 30 NTU as shown in Table 5. This proved that all the samples have high content of suspended organic (such as algae) and inorganic particles (sand, silt and clay) due to construction activities.

Table 5: Results for Turbidity

Sample	1	2	3	4	5	6	7	8	9	10
Turbidity (NTU)	165	169	220	175	220	180	158	161	156	150

On site where construction works are on going, particles from the surrounding area are washed into the outlet making the runoff muddy brown in colour. That indicates that the water has high turbidity values.

4. Conclusion

This study discovered that runoff water from construction site at Parcel F, Presint 1, Putrajaya has to undergo filtration process as one of water treatment before it can be reused. From the three parameters that have been measured in this study, only pH number is acceptable whereby the runoff water is free from acidic substances. For the two other parameters which are Total Suspended Solids and Turbidity, results show that the wastewater samples contain high levels of sediments and should be filtered before it can be reused. It is suggested that a simple filtration unit can be designed and developed to be located at the construction site so that runoff water will go through proper filtration process before the water can be reused for construction purposes.

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