The Purification of the First Flush by Vortex Type and Filter Facility

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Abstract: Focus on the water pollution in lakes and rivers, we should have to measure for point pollutants, such as domestic sewage and industrial wastewater by devising various counteractions. To improving the water quality, use point pollutant measures is limited. By the research, the vortex type facilities are adopted to removal of sediments, oils and floatables from storm water runoff. the results of the precede research are about the Vortex type facility and setting the slope plate to make the facility strong, combine with the filter type which is the media sponge (60ppi, 80ppi) on the upflow and zeolite diameter 4:1 ratio. the sampling site was set at do-chung bridge in the north of deagu, where has a lot of traffic in every day. The rain water is collected and treated by treatmet plant under do-chung bridge. The treatment plant capacity is 30 m^3/hr with the rainfall intensity 10 mm/hr in bridge 888 m^2 area. At the treatment plant had done 12times to take a sampling from August 2008 to October 2009. the results of the facility treatment efficiency are follows by TSS 22.1%~91.7%, BOD_5 12.7%~71.5%, COD_{Mn} 9%~49.8%, TP 46%~74.5%, PO_4 77.8%~88.8%, NO_3 15%~84.6%, TN 42.1%~88.3%, Cu 17.1%~100%, Fe 1.7%~81.8%, Zn 11.7%~90.6%. by using the vortex type facility and filter facility in this research, the quality of water source can be improved.

Keywords: Non-point source, Vortex, Filter, Media

1. Introduction

In spite of the effort for a river water quality improvement, there is a limit to appeal contamination reduction of the rivers and ponds. That reason is presumed comes to be high relatively from nonpoint pollutants cause by point pollutants management. Actually, In the case of United States, it is investigated about 50% of total pollutants load from non-point pollutants. It is calculated about more 80% of nutrients from non-point pollutants in the closed water system (Novotny and Chesters, 1981).

According, to improving water quality, non-point pollutants management is accomplished with point pollutants regulation. Non-point pollutants management for public water area is not selection, became the indispensability.

Seeing classified by particle size of pollutants in the beginning rainfall, a case of the number of particle, particles in rainfall water is extremely much about 10 ㎛ particles. But a case of volume standard is investigated extremely much about 180 ㎛ particles. On outflow treatment, particle volume is more important than the number of particle. Therefore, 50% of total suspended solids will be able to remove more particle size of 180 ㎛.

By the previous researches in this case, the particle size analysis of suspended solids in rainfall water(Sartor et al, 1974), 84 % TS, 57 % VS, 58 % BOD, 62 % TKN, and 14 % PO4-P, about more 100 ㎛ particle size.

So, big particle size remove is more profitable method than treat small particle size.

This research aims to develop vortex facility treatment system which is operating by itself without power, unmanagement, with by upflow method filter equipment, and reducing non-point pollutants.

2. Methods

2.1. Experiment Condition and Driving

1) Experiment facility : The facility in pilot plant were made from the equipment advantage with high efficiency by previous studies. Vortex settlement facility was setup as a Pre-treatment process, while filter facility was applied in the main treatment process which filled sponge.

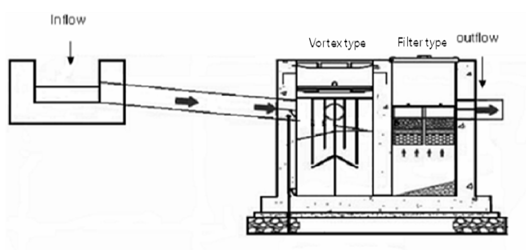

Figure 1. Schematic diagram.

Apparatus used in this experiment treatment capacity is designed total 30 m3/hr (W : 1,178 mm × D : 1,072 mm

× H : 1,494 mm). Stormwater is input to vortex settlement facility through gathering hole as tangent direction. It is often used to remove to big size particles. It's inflowed filter apparatus connected in series through tank.

Filter apparatus total volume is about 0.8 m^3(W : 500 mm × D : 1,072 mm × H : 1,494 mm), and filter metiarial fill ratio is 16.7 %. Filter media used in Sponge and Zeolite which mixing ratio to 4:1. Stormwater which is inputted filter apparatus is removed while through the filter media.

Sponge is a kind of polyurethane, it is divided by hard, soft, semi-hard. It is versatile and wide coverage so widely used in everyday life. This experiment is used in sponge which was processed urethane meterial and 60 ppi, 80 ppi void size. Weight of zeolite is about 2.1~2.2, is outputed of lump type. Zeolite diameter which used this experiment is 1~3 mm.

2) Monitoring site and experiment methods. The pilot treatment plant was established under Dochong bridge at Buk-gu, Daegu metropolitan city. Dochong bridge traffic is about 2,240cars/hr. The bridge is inclined from center to walking road. Stormwater is gathering under the bridge through drain. The stormwater is treated by pilot plant before it's discharge into Sin-chon river.

This experiment is designed watershed area 888m^2, maximum rainfall strength 33 mm/hr, treatment volume 30 m^3/hr and land use is road 100 %.

Table 1. is sampling method and experiment item.

Table 1. Sampling frequeney and an item of variety analysis.

Item		Contents
Object		Input and output water by Stormwater
Dry antecedent days		more 2 days
Number of samples		12
Sampling time	Beginning of railfall	start, 5, 10, 15, 60min(each 2 time)
	middle ~ end	proper interval time (6 times)
Analysis items		BOD, CODcr, COD_{Mn}, TSS, T-P, T-N, Cu ,Mn, Cr, Fe, Cd ,Ni, Zn

3. Result and Discussion

3.1 Input Characteristic of Pollutants

Figure 2. The hydro-polluto graph of flow and pollutants. In April 20, 2009, it was rain with 4days ago it were a dry antecedent days. Rainfall was 9.8 mm, rainfall duration was 4hr, total rainfall of object area was 9.8m^3. From graph (1), At the begining, stormwater flow was increase, but in the middle time it was decrease, and it was increased a little at the end of time. Because the bridge was made by asphalt, the osmotic is very low. So, almost of the rainfall is come to pilot treatment.At the beginning of rainfall, TSS concentration of output collection is highest than the middle time and the last time. The figure 2, show that BOD, COD_{Mn}, TN, TP andheavy metals concentration is relative with rainfall flow. There were high concentration at the beginning rainfall flow and reduce at the middle and last time.

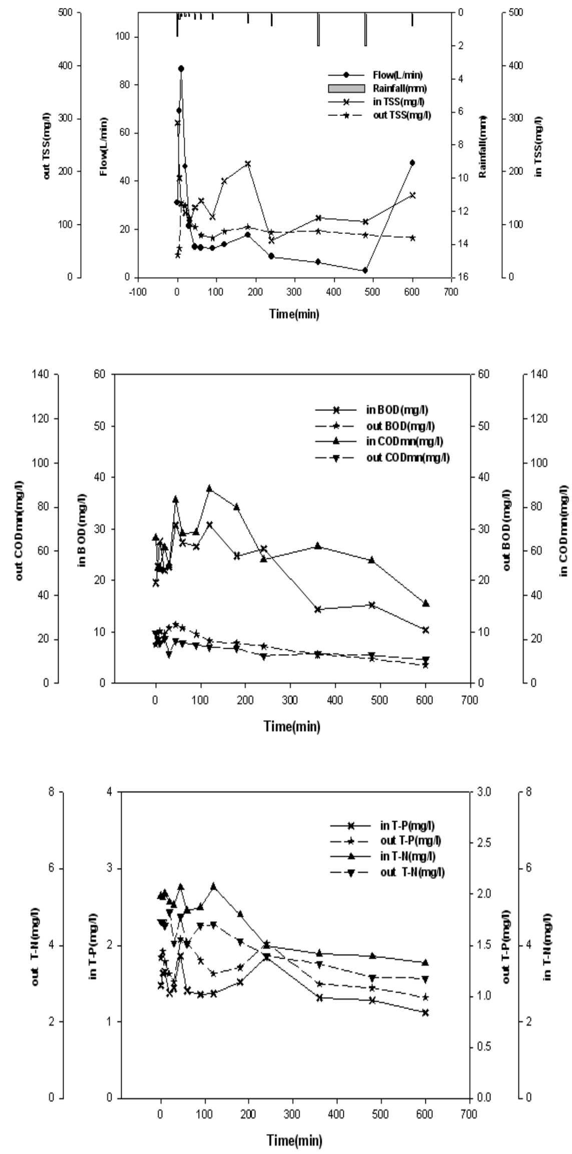

Figure 2. Examples of hydro-and polluto-graphs.

This result is similar characteristic which first flushing effect when it's raining on the city, and This research trying to confirm this phenomenon.

First flushing effect is influenced basin area, rainfall strength, rainfall duration, impermeability layer area and dry antecedent days, and it is appear that different trend according to analysis items(Deletic, 1998).

This research assessed to use cumulative load curve ratio which accumulate inflow ratio to accumulate pollutants load ratio.

Bridge of target area in this research, SS is situated at bisection line mostly. And this observation data is far away from bisection line. This result means pollutants output is occur inititially and output load is decreasing more pass the time, and it can appraisal that appear clearly first flushing effect.

BOD, COD_{Mn}, TN and TP was not divided clearly maximum distinction point. In other words, it is judged not noticeable first flushing.

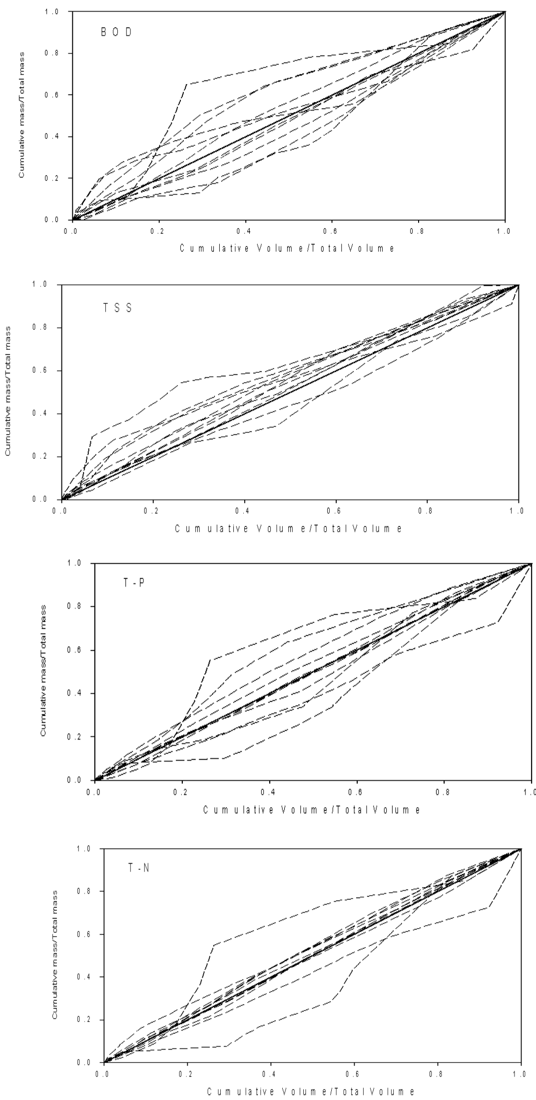

Figure 3. Plot of cumulative load fractions as a function of cumulative runoff volume.

3.2 Pollutants Treatment Efficiency of Stormwater

1) Efficiency of apparatus : Treatment efficiency of Stormwater is calculated by formula (1) using collected data which quantity, pollutants and stormwater continuous time, etc.

$$Re\ moual\ Efficiency(\%) = \frac{\int_0^t C_{in}(t)\cdot Q(t) - \int_0^t C_{out}(t)\cdot Q(t)}{\int_0^t C_{out}(t)\cdot Q(t)} \times 100 \quad (1)$$

Cin(t) and Cout(t) is pollutants concentration of apparatus entrance and exit each (t)time on this formula. Q(t) is outflow quantity by stormwater at target area.

Apparatus of this target area efficiency is appeared table 2.

Table 2. Summary of the pollutants removal efficiency for the each rainfall event.

Parameters (mg/L)	Removal(%)					
	Event1	*Event2*	*Event3*	*Event4*	*Event5*	*Event6*
TSS	71.3	22.1	30.0	45.1	46.1	58.0
BOD5	28.2	12.7	25.3	14.1	40.6	29.3
COD_{Mn}	49.8	13.2	10.6	22.7	17.4	24.2
T-P	1.8	-46.0	6.5	29.6	35.9	74.5
T-N	-42.1	15.5	8.1	39.8	88.3	53.4
Cu	17.1	81.2	43.0	45.6	80.8	38.5
Zn	3.4	95.0	-11.7	16.3	73.6	22.9
Fe	13.6	60.8	-1.7	74.3	57.1	21.5

Parameters (mg/L)	Removal(%)					
	Event7	*Event8*	*Event9*	*Event10*	*Event11*	*Event12*
TSS	29.0	39.0	71.7	54.5	31.6	91.7
BOD5	28.4	65.1	53.8	16.8	75.1	46.6
COD_{Mn}	9.0	74.3	38.0	37.5	27.8	18.7
T-P	16.2	13.3	31.2	28.4	22.7	34.4
T-N	6.4	11.7	27.5	31.5	35.6	52.0
Cu	23.5	100.0	N.D	N.D	N.D	100.0
Zn	1.9	84.1	15.7	100.0	78.1	90.6
Fe	19.8	47.2	36.5	6.0	42.3	81.8

Removal efficiency from particle size Particle size analysis of inflow and outflow equate to figure 3, figure 4.

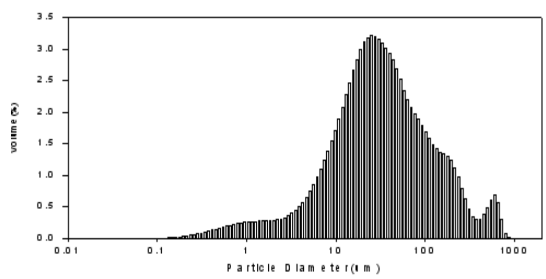

Figure 4. Size distribution of particle from inflow.

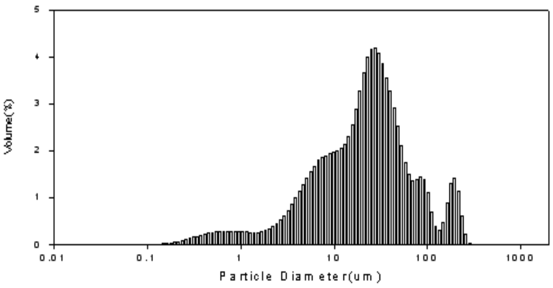

Figure 5. Size distribution of particle from outflow.

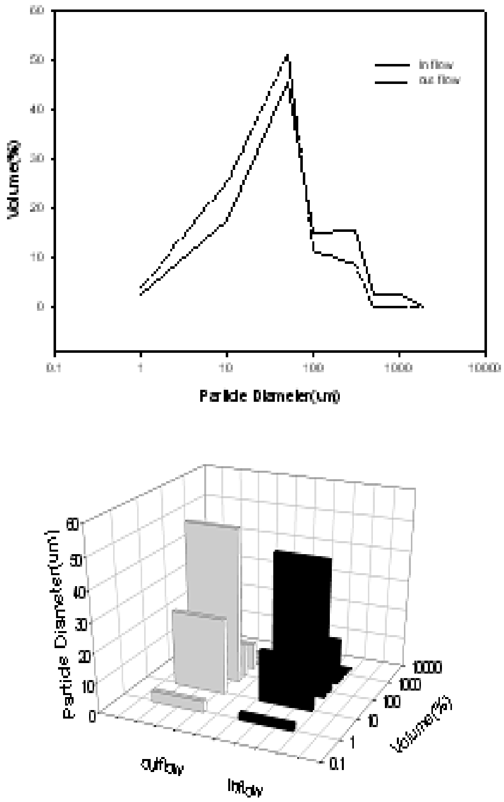

Figure 6. Size distribution of particle from inflow and outflow.

By compare inflow particle size and outflow particle size, inflow 2.4 %, outflow 3.8% under 1 ㎛ particle size. And under 1~ 10 ㎛ is inflow 17.4 %, outflow 25.3 %, and under 10~50 ㎛ is inflow 45.7 %, outflow 51.4 %, and size 50 ~100 ㎛ is inflow 14.7 %, outflow 11%, and size 100~300 ㎛ is inflow 15.3%, outflow 8.5 %, over 300 ㎛ is only appeared inflow 4.5 %.

Under 50 ㎛ is over 80 % efficiency at outflow particle size, therefore this apparatus treatment efficiency is low at under 50 ㎛ particle size. Over 300 ㎛ size is appeared 100 % efficiency.

4. Conclusions

This is research of about vortex + upflow filter apparatus that reduce non-point pollutants at bridge of covered area.

Research result, bring to a conclusions.

- It is appear that first flushing effect at particle pollutants, but other organic pollutants does not. But Particle pollutants is direct influence river pollutants load, therefore it is important that management of first rainfall treatment.
- From "August 2008" to "October 2009" did 12 times sampling. The results of the experiment areas follows by TSS 22.1%~91.7%, BOD_5 12.7 % ~ 71.5 %, COD_{Mn} 9 % ~ 49.8 %, TP 46 % ~ 74.5 %, TN 42.1 % ~ 88.3 %, Cu 17.1 % ~ 100 %, Fe 1.7 % ~ 81.8 %, Zn 11.7 % ~ 90.6 %.
- Result of particle size analysis is followed by Under 300 ㎛ particle is removed by vortex separator, and it is removed mainly by filter facility. The results suggest that it's limited vortex separator's remove, it will improve particle treatment efficiency by adjust sponge void size of filter facility.

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No.2

专题2：面源污染特性分析

Session 2: Characteristics and Analysis of Diffuse Pollution