Innovative treatment device for polluted stormwater runoff

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INTRODUCTION

Stormwater from roads with high traffic density contains a number of pollutants like heavy metals and hydrocarbons that endanger our water bodies. In Hamburg runoff from a main distributor with a particularly high percentage of heavy trucks and an average of 18,000 vehicles per day is discharged into sensitive surface water. In 2006 a catchment area of 2,300 m^2, comprising the road itself, including a traffic light stop, together with a bus stop turning area was equipped with two innovative stormwater treatment units (Figure 1). Stormwater runoff from 6 road gullies enters the system at a central silt trap to remove coarse rubbish and leaves. From there the water flows into a control or balancing pit, from where it is distributed into two filter units in a shaft at DN 2,000. From the filters the water is transported into a final control and sampling shaft before it is discharged into the vegetation strip and so to the receiving water body.

TREATMENT SYSTEM

The central treatment unit itself consists of a hydrodynamic separator with an up flow filter (Figure 2). In the system the water is cleaned by sedimentation, filtration, ion-exchange and chemical precipitation. Incoming stormwater is led down to the basal section of the filter shaft. A hydrodynamic separator promotes the sedimentation of particles. A tangential inlet forces a radial flow pattern. A silt trap is situated below the separation chamber, so particles cannot be remobilized by intense rain events. Above the separator four filter elements are situated, occupying the full shaft width, so that the water must flow through the filter by hydraulic pressure. The filter elements are situated permanently below the water level. They can be easily exchanged when they are exhausted. The cleaned water finally passes an oil trap and is directed into the final control and monitoring shaft. The units have a fixed central pipe. This central access functions both as a security/bypass overflow and secondly as an access for de-silting the silt trap chamber.

Figure 1. The installation of the system.

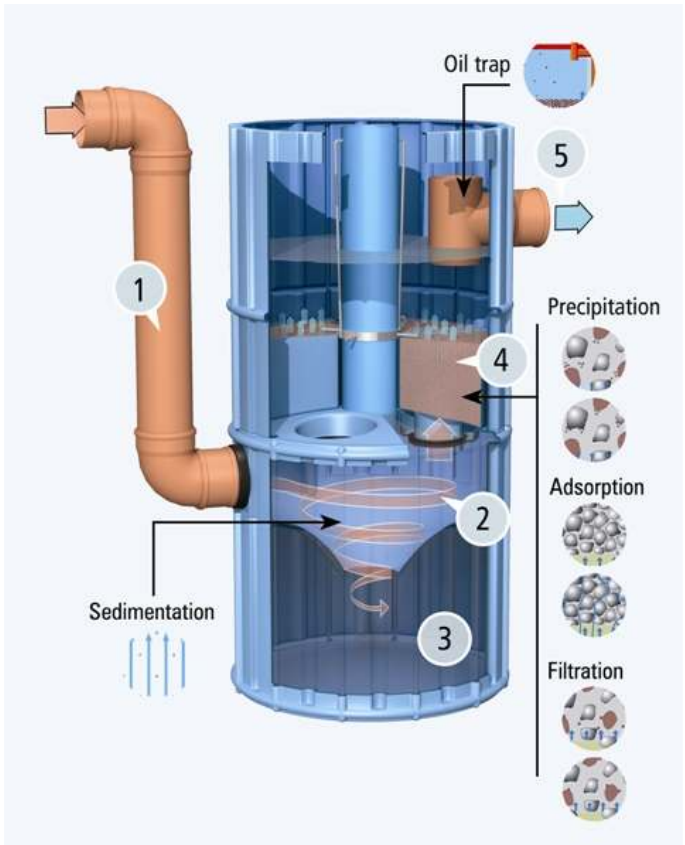

Figure 2. The treatment system with cleaning processes.

RESULTS

All results refer to the sampling period from December 7th 2006 to December 6th 2007, representing the first year of operation. The total amount of rainfall monitored was recorded at 1,083 mm for the sampling period. As the average annual rainfall for Hamburg is 780 mm per year, the amount of rainfall was unusually high. The runoff coefficient of the catchment was calculated from flow meter data and the rainfall at 0.9. Altogether 2,240 m^3 of stormwater runoff reached the treatment unit during the first year of the project.

Water quality of the road runoff at Hamburg was compared to data from a literature study. The results can be seen in Table 1. pH in the stormwater is unusually low at 6.4 units. The reason for this is not clear. Usually the pH in road runoff in Germany is between 7 and 8 units. The concentration of total suspended solids (TSS) is notably high. This may be the result of an unpaved road which feeds into the catchment. Dirt particles on tires of vehicles from this road are deposited within the catchment itself. As a result the TSS values are double those expected. Zinc concentrations are a little bit higher than the average in literature; lead is lower as an effect of unleaded fuel. Notably, the copper concentrations are also very high, perhaps an effect of the traffic light (causing slowing down of the vehicles and therefore abrasion of the brakes) and the high amount of heavy trucks and buses on the road.

Phosphorous concentrations are a little bit higher than in the literature, whilst ammonia is as anticipated from the literature study. Mineral oil type hydrocarbons are lower than the studies published.

Table 1. Concentrations in road runoff.

	pH -	TSS mg/L	Zn mg/L	Cu mg/L	Pb mg/L	Cd mg/L	PO_4-P mg/L	NH_4 mg/L	MOTH mg/L
Literature	7.4	163	0.41	0.097	0.170	0.0019	0.29	0.90	4.2
Runoff B 75	6.5	425	0.68	0.279	0.113	< 0.0025	0.52	0.83	2.2

Observations of the outflow of the system showed that most parameters were reduced significantly. pH is buffered from 6.5 to 7.4. The suspended solids are reduced by 94 %, a result apparent even from simple visual observation of the water samples.

Total zinc is reduced by 86 % from 0.680 mg/L to 0.090 mg/L. For comparison the permissible limit for seepage in Germany is 0.5 mg/L. Copper and lead were removed with efficiencies between 82 % and 84 %.

For the receiving water body it is the nutrients, especially nitrate and phosphates that are also of special interest. Nitrate can not be removed in this unit facility, because the contact times of the water with the filters are

too short for biological processes. To prevent eutrophication only the phosphates can be reduced. Here the reduction rate for phosphorus is about 81 %. Ammonia is removed by 91 %.
The amount of mineral type hydrocarbons in runoff decreased during the last years. The inflow concentrations were 2.2 mg/L. At the outflow 0.2 mg/L were measured. Figure 3 shows graphically the input and output concentrations for selected key parameters.

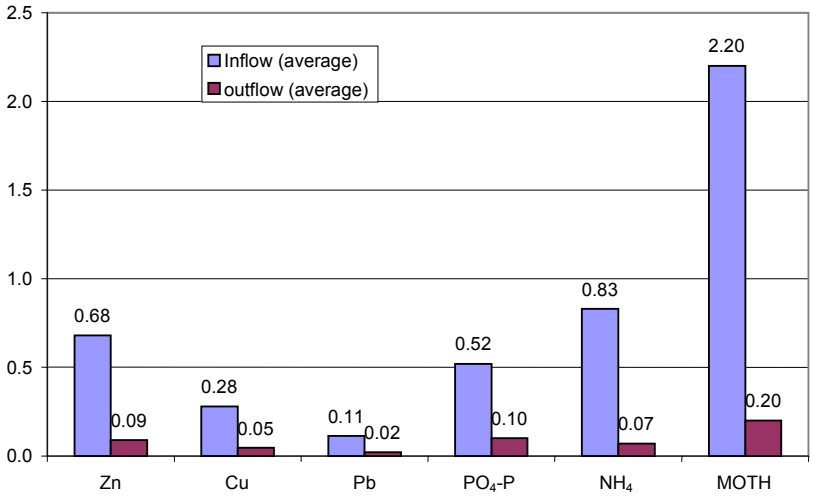

Figure 3. Performance of the system (concentration in mg/L)