Development of Laboratory testing Method for the Certification of Filter Media

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Abstract

A standardized testing procedure is required to evaluate the long-term hydraulic performance and pollutant retention capacity of a filter media. This work provides a laboratory-scale column testing method that mimics real environmental conditions. Based on this research a testing method and performance requirements for all types of filter media have been issued by the Austrian Standards Institute (ASI). The testing procedure consists of the steps and several influencing factors are described. Results showed that the test method is reproducible and has been used for establishing an accredited testing institute and national filter media certification criterion.

Introduction

Simultaneous removal of all the main pollutants typically found in roadway and roof runoff is a bigger challenge. Well-characterized filter media and testing procedures are needed for designing effective stormwater treatment systems. As field testing is often highly variable due to different site conditions, a laboratory test method must be developed to verify their efficiency. An ideal test method needs to:-

- produce results which measure and reproduceable,
- produce results which are comparable with field testing,
- produced results which were able to be meaningfully compared with results from operational filtration systems
- be practical to conduct from a time and cost perspective

To assess the efficiencies, different guidelines of authorities were summarized to correlate local regulations with the test criteria of this study (Table 1).

Table 1. Current regulatory guidelines

Reference		Procedure	Parameters
Victorian SW committee, 2006	AUS	Lab & field	TN, TP, TSS, dissolved subst.
ASI 2506- 2, 2012	AUT	Field	Cu, Zn, TPH, TSS
VSA, 2017	CHE	Lab & Field	Cu, Zn, TSS, Diuron, Mecoprop
DIBt, 2015	DEU	Lab & field	Cu, Zn, NaCl, TPH, TSS
LANUV, 2014	DEU	Lab	Cu, Zn, NaCl, TPH, TSS
BLR 2036, 2008	NLD	Lab & field	Cu, Zn, P, TPH & TSS
PDEP, 2012	NZL	Lab & field	Cu, Zn, P, TSS
Department of Ecology, 2011	USA	Lab & field	Cu, Zn, TPH, TSS

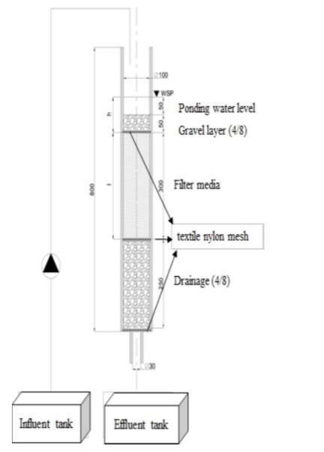

Fig1. Overview of column setup

Direct comparison of soil and Aquafilt in a dual system treating equal runoff volume and sized (filter surface area to drainage area) 4% and 0.4%, ,respectively

Fig2. Validation of the test method in field measurements

Methods and Materials

The efficiency of total suspended solids (TSS), total petroleum hydrocarbon (TPH) and trace metal removal was tested in a lab-scale column. The testing procedure consists of eight steps. A well-defined silica substance (Milisil W4) that mainly contains particles smaller than 63 µm was used to evaluate the removal of TSS. An additional test without TSS load in the inflow was conducted to evaluate decrease in infiltration rate and possible washout of trapped. Long-term heavy metal retention capacity was tested in a scale column dosed with four-year load of dissolved copper, lead and zinc. Finally, the columns were flushed with 5g/L NaCl to evaluate remobilization of retained metals. The testing procedure steps and requirements are summarized in Table 2. The test procedure was developed based on two soil and four commercial filters, while sand was used as base line. Distinct and realistic concentrations were used in the testing procedure depending on source area (e.g., roof and roadway runoff). Based on lab-results validation of the test method was performed in a full-scale filtration system (Fig. 2).

Table 2. Testing procedures and requirements.

Test			Parameter	Requirement
I	1	Infiltration rate	Ksat	> 10-5 m/s
II	2.1	Particle retention [a]	Millisil W4	TSS > 80%
III	3.1	Trace metal removal [b]	Cu, Zn & Pb	Cu > 80%, Zn > 50% & Pb < 9 µg/L
IV	4	TPH (4 years load)	TPH	> 95 % or < 0.1 ppm
V	2.2	Particle retention [c]	Millisil W4	TSS > 80
VI	5	TSS mobilization & reduction in Ksat	TSS & Ksat	< 20 % mobilization, 30 – 50 % reduction in Ksat
VII	3.2	Heavy metal removal [d]	Cu, Zn & Pb	Cu > 80%, Zn > 50% & Pb < 9 µg/L
	3.3	Remobilization by NaCl	Cu, Zn & Pb	Cu < 50, Zn < 500 & Pb < 9 µg/L
VIII	6	Buffering (pH 3 ± 0.1)	pH	pH > 6.0; 42 L or 30 min test duration

[a] 33% of 4 years load; [b] 100 mm column and mean stormwater concentration; [c] 32 mm column highest stormwater concentration; [d] 67% of 4 years load

Results

Results demonstrated that the test method provide reproducible results and an accurate estimation of the size and lifespan of filtration systems. The effect of de-icing salt (NaCl) on the mobilization of retained heavy metals is presented in Table 3. Based on this study the requirements and test procedures was published by ASI as a Standard Testing Method for the approval of all types of filter media in Austria (ASI B 2506–3, 2016). Field results were comparable to that measured in column test. In situ comparison of soil and Aquafilt filtration system showed effluent concentration met Austrian groundwater quality ordinance, except for TPH during high oil spills (Figure 3). Field verification revealed that the testing protocol is a useful decision-making factor for designing and sizing of stormwater treatment facilities.

Discussion

Laboratory based assessment has several advantages over field-based assessment. Cost, greater control over test variables and production of reproducible result being the main advantages. Implementation of a verified test method enables establishing criteria for sizing stormwater treatment devices based on runoff volumes and pollutant retention capacity to meet their water quality standards. This is a useful decision-making factor for government authorities for installing decentralized stormwater treatment facilities. Results of this study demonstrated that mineral-based commercial filter media can be high hydraulic loading to treat a larger runoff volumes in small filtration systems relative to their impervious catchment area (0.4% to 1.0%). Such treatment systems are potentially suitable for utilization in compact stormwater treatment, particularly in urban landscapes where space is very limited.

Table 3. Heavy metal remobilization using 42 L solution of 5 g/mL NaCl

Filter media	Adsorbed mass (mg)			Remobilized (%)		
Sand	48.6	98.5	157	10.8	8.4	27
Soil	52.1	303	526	0.29	0.13	0.18
Aquafilt	51.9	358	542	0.26	0.11	0.21
TF-I	49.5	342	507	0.34	0.18	0.48
TF-III	54.6	309	393	0.51	0.38	2.7

key issues

- Strict protocol and appropriate measurement equipment
- Installation of the test columns must be defined accurately (e.g., filling)
- Chemical composition & Concentrations of the synthetic runoff must be specified and reflect field conditions
- Field up-scaling depends on system's individual sizing and runoff source

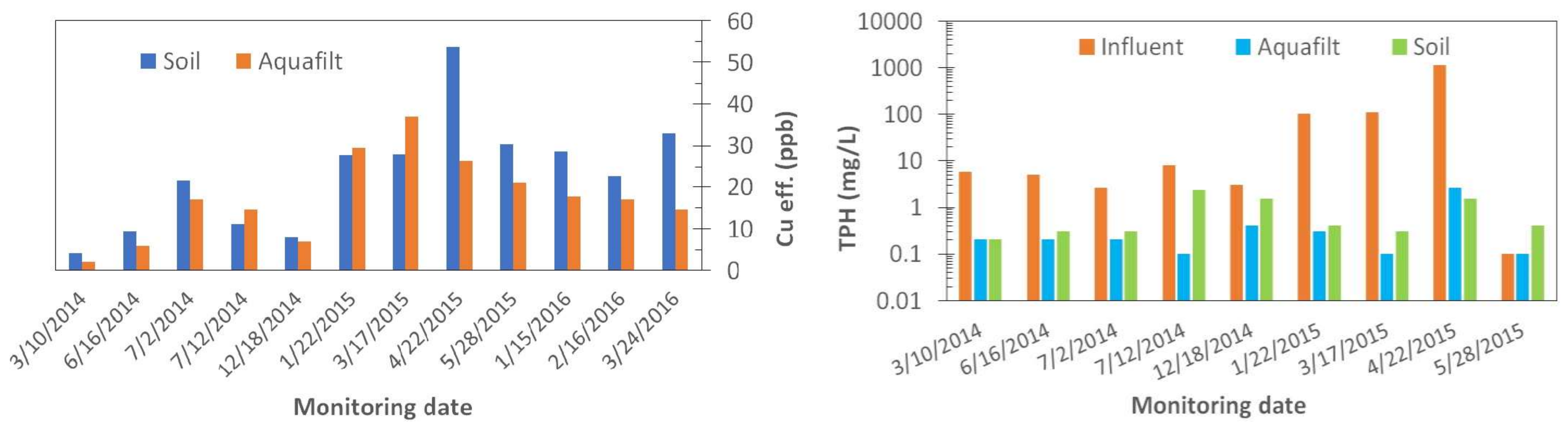

Fig 3. Direct comparison of soil and Aquafilt in dual system treating equal runoff volume

Conclusions

- Laboratory test method produced results which are comparable to filed monitoring, but at much lower cost, time and with greater reliability.
- A national standardized testing method was issued by ASI.
- Implementation of a verified test method enables certification of several filter media produced by different companies in Austria.
- Results of field monitoring from a dual filtration system confirmed the applicability of the test method.
- The test method provides regulatory authorities, designers, and operators with a more objective bases for selecting design variants, e.g., pollution source and sizing.

Contact

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