TECHNICAL BULLETIN // **UP-FLO™ FILTER**

EVALUATION OF SIL-CO-SIL 106 REMOVAL PERFORMANCE USING CPZ MIX™ MEDIA

94 Hutchins Drive • Portland, ME 04102
Tel: 207.756.6200 • Fax: 207.756.6212
www.hydrointernational.biz

EVALUATION OF SIL-CO-SIL 106 REMOVAL PERFORMANCE USING CPZ MIX™ MEDIA

INTRODUCTION

The Up-Flo™ Filter is a high rate, modular filtration system designed to meet the most stringent stormwater treatment regulations. It incorporates multiple elements of a treatment train design into a single, small-footprint device. The Up-Flo™ Filter is engineered to remove over 80% of fine TSS and associated pollutants. Filter Media can be customized to target site-specific pollutants. This test evaluated the TSS removal performance of Hydro International's CPZ Mix™ media at an operational filtration rate of 25 gpm per Filter Module. The feed pollutant used was Sil-Co-Sil 106, a commercially available ground silica gradation having 100% of particles smaller than 212 microns in diameter and 75% of particles smaller than 45 microns in diameter. The particle size distribution for Sil-Co-Sil 106 can be found in **Figure 1**.

TESTING ARRANGEMENT AND PROCEDURES

A full-scale, Catch Basin configuration Up-Flo™ Filter equipped with one Filter Module was used for this test. The Filter Module contained two (2) media bags of Hydro International's CPZ Mix™.

A 3-inch Flygt pump delivered influent from the 23,000 gallon clean water reservoir to the Up-Flo™ Filter through an 8-inch PVC pipe network. The pipe network was equipped with a Hershey VP-820 butterfly valve to return flows in excess of the desired influent flow rate to the feed reservoir. A slurry supply tank containing Sil-Co-Sil 106 and clean water was continuously mixed and fed to the delivery line with a Watson Marlow 704 S/R peristaltic pump at 80 rpm. The slurry was fed to the delivery line three (3) feet upstream of the Up-Flo™ Filter. The

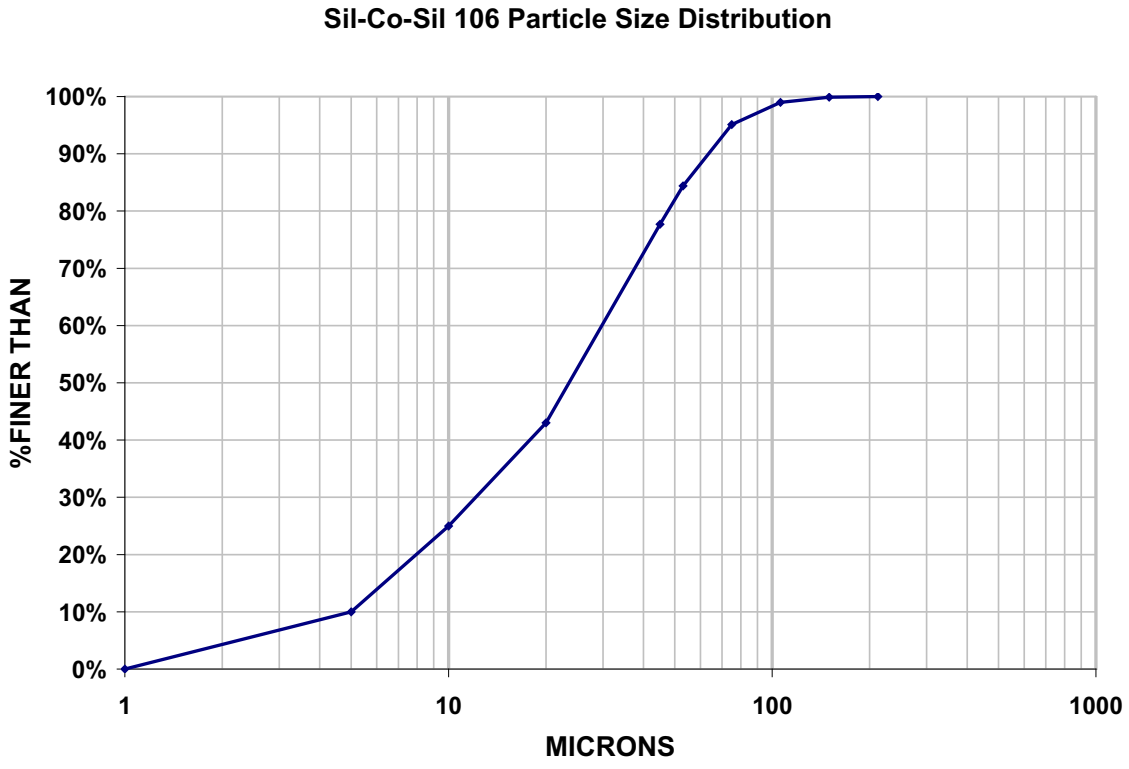

Figure 1: Sil-Co-Sil 106 particle size distribution verified according to ASTM D422 (AASHTO T88)

delivery line freely discharged the synthetic waste stream with a Sil-Co-Sil 106 concentration of 200-300 mg/L into the open top of the Up-Flo™ test tank at a rate of 25 gpm. A steady-state water level in the Up-Flo™ Filter test tank was continuously maintained to confirm the desired filtration rate of 25 gpm per Filter Module. Influent grab samples were taken from the free discharge of the delivery network. Effluent grab samples were taken from the free discharge of the Up-Flo™ Filter outlet pipe, two (2) feet downstream of the Up-Flo™ Filter.

SAMPLE ANALYSIS

Influent and effluent samples were analyzed using an equivalent standard to the TSS Test Method 2 Filtration in ASTM, 1999, D 3977-97 - the Standard Methods 19th Ed 1995 for the Examination of Water and Wastewater prepared and published by the American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF) chapter 2-2540 D Total Suspended Solids Dried at 103-105 °Celsius.

A total of 15 paired influent and effluent samples were analyzed for Total Suspended Solids concentration. All influent samples had a TSS concentration in the 200 – 300 mg/L range, while all effluent samples were in the 28 – 40 mg/L range (see **Figure 2**).

DATA ANALYSIS

The percent of Sil-Co-Sil 106 removed was derived from the concentrations of each paired sample. To ascertain the representativeness of the data, the sample sets were subjected to a Dixon Q's test and an ANOVA analysis.

Table 1 shows the percent of Sil-Co-Sil 106 removed by the CPZ Mix™ during the test trials. The percent of Sil-Co-Sil 106 removed for each sample pair was determined using **Equation 1**:

$$\% \text{ Removal} = 100 \times ([TSS]_{INF} - [TSS]_{EFF}) / [TSS]_{INF}$$

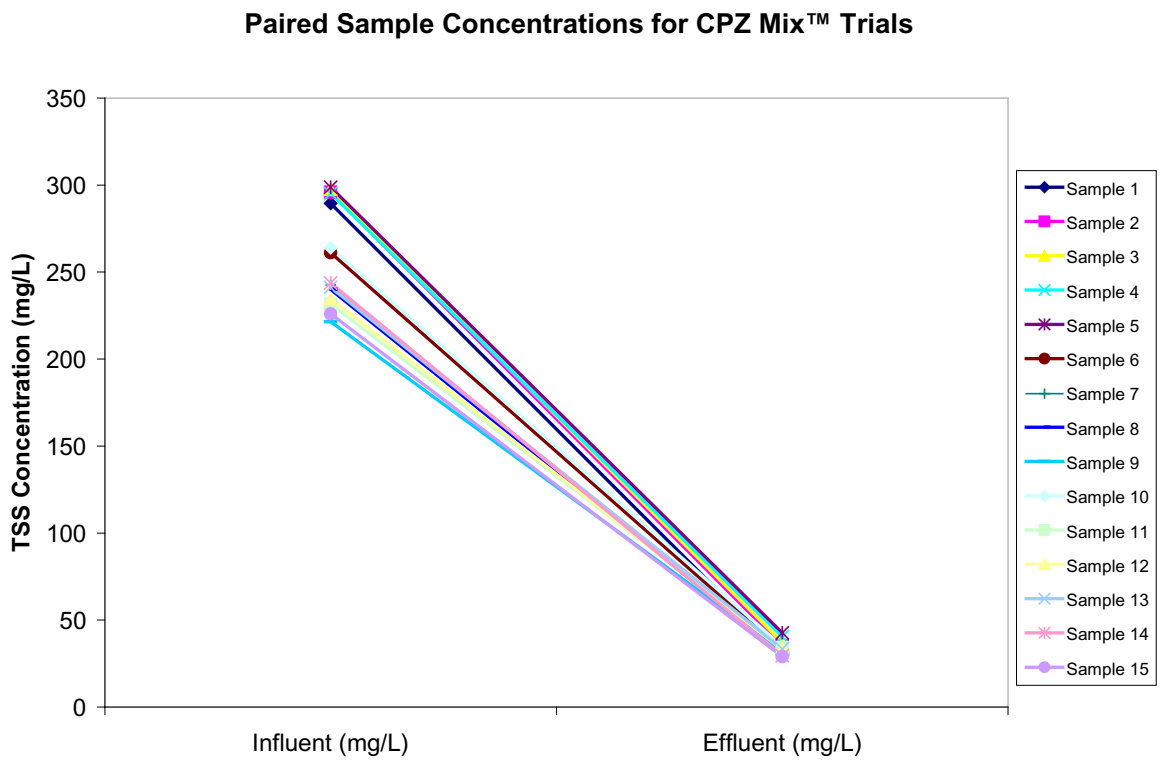

Figure 2: Influent and Effluent TSS concentrations

Paired Samples for CPZ Mix™ Trials

	Sample	Influent (mg/L)	Effluent (mg/L)	% Removed
Sample Set 1	1	289.51	29.89	89.7%
	2	295.89	35.23	88.1%
	3	297.56	36.99	87.6%
	4	295.24	40.48	86.3%
	5	298.73	42.62	85.7%
Sample Set 2	6	261.11	32.37	87.6%
	7	242.67	32.56	86.6%
	8	240.00	30.95	87.1%
	9	221.52	31.76	85.7%
	10	264.00	34.83	86.8%
Sample Set 3	11	231.58	34.12	85.3%
	12	234.67	32.94	86.0%
	13	241.25	33.33	86.2%
	14	243.71	29.55	87.9%
	15	225.97	28.89	87.2%
	AVG	**258.89**	**33.77**	**87.0%**

Table 1: Paired sample TSS concentrations and percent removed

The Average % Removal for each laboratory trial was calculated using **Equation 2**:

$$\%REM = 100 \times ([TSS]_{AVG\ INF} - [TSS]_{AVG\ EFF}) / [TSS]_{AVG\ INF}$$

By Equation 2, the average Sil-Co-Sil 106 Removal for all 15 trials is 87% at a flow rate of 25 gpm per Filter Module.

To evaluate the sample sets for statistical validity, a Dixon's Q analysis was conducted. **Table 2** shows that all samples have a $Q < Q_{15}$, thus there are no "outliers" within the samples and the data set may be deemed valid

DIXON Q TEST of CPZ Mix™ Trials on Sil-Co-Sil 106

SAMPLE SET			
Influent (mg/L)	**Q** influent	**Effluent (mg/L)**	**Q** effluent
221.52		28.89	
225.97	0.0577	29.55	0.0478
231.58	0.0726	29.89	0.0247
234.67	0.0400	30.95	0.0777
240.00	0.0691	31.76	0.0591
241.25	0.0162	32.37	0.0441
242.67	0.0183	32.56	0.0137
243.71	0.0135	32.94	0.0279
261.11	0.2254	33.33	0.0286
264.00	0.0374	34.12	0.0571
289.51	0.3304	34.83	0.0520
295.24	0.0742	35.23	0.0288
295.89	0.0084	36.99	0.1287
297.56	0.0216	40.48	0.2535
298.73	0.0152	42.62	0.1563

99% confidence Q15=0.475

Table 2: Dixon's Q test for paired influent and effluent sample concentrations

SUMMARY

Groups	*Count*	*Sum*	*Average*	*Variance*
Column 1	17	41.024	2.413	0.003
Column 2	17	22.135	1.302	0.031

ANOVA

Source of Variation	*SS*	*df*	*MS*	*F*	*P-value*	*F crit*
Between Groups	10.49407	1	10.494	621.580	1.56E-22	4.149
Within Groups	0.540252	32	0.017			
Total	11.034	33				

Table 3: ANOVA regression analysis for the log values of influent and effluent sample concentrations

with 99% confidence. An ANOVA single factor test was conducted on the influent and effluent sample sets to show that the data sets were significantly different. The log values of the influent and effluent concentrations were used, as most water quality data follow a log normal distribution. **Table 3** shows the results of the ANOVA analysis. The P-value is shown to be 4.21 E-43, which indicates that the influent and effluent sample sets are significantly different with over 99.9% confidence.

CONCLUSIONS

Based on laboratory testing, the Up-Flo™ Filter with CPZ Mix™ media will remove 87% of Sil-Co-Sil 106 at a filtration rate of 25 gpm per Filter Module.

A detailed lab report is available upon request.