

PlumeStop® Technical Bulletin 2.2

Sorption of Contaminants from Solution – Column Study

Quick Reference:

- Dispersive placement of PlumeStop
- Retained sorptive capacity
- Emplaced material resistance to wash-out
- Contaminant capture at high flux

Background

PlumeStop® Liquid Activated Carbon™ is composed of very fine particles of activated carbon (1-2 μm) suspended in water through the use of unique organic polymer dispersion chemistry. Once in the subsurface the material behaves as a colloidal biomatrix, sorbing to the aquifer matrix, rapidly removing contaminants from groundwater and expediting permanent contaminant biodegradation.

Wide-Area Dispersive Distribution

Unlike any other sorbent technology, PlumeStop can be emplaced in the subsurface through dispersive flow from low-pressure injection (without fracturing the formation), providing a wide-area thin-film coating of the aquifer matrix through which it passes.

It does not create preferential flow pathways, plug the formation, or compromise monitoring-wells through extreme carbon loading in contrasting respect to the majority of the surrounding porosity (i.e. the porosity external to the fractures or ‘soil partings’ themselves) as may be the case with pressure-emplaced powdered activated carbon products. More information on low-pressure ease of distribution and dispersive emplacement of PlumeStop can be found in [PlumeStop Technical Bulletin 1.1: Distribution through a Permeable Medium](#) and [PlumeStop Technical Bulletin 1.2: PlumeStop Distribution in the Field](#).

Rapid Removal of Contaminants from Groundwater

PlumeStop rapidly sorbs organic contaminants from aqueous solution (hours). Pollutants partition directly into the PlumeStop particles sorbed to the soil formation,

removing the pollutants from groundwater. Contaminant advection in the aqueous phase is therefore eliminated ('the plume is stopped') and partitioning into the vapor-phase is reduced also (Henry's Law). Results can be dramatic, with groundwater cleanup objectives often met within days of PlumeStop application. The principles of contaminant sorption onto PlumeStop are described in Technical bulletin 2.1. Sorption of Contaminants from Solution. **The transfer of the sorptive capacity to a permeable soil matrix following permeation with PlumeStop and retention of the sorptive coating and resistance to wash-out** are the subject of the present technical bulletin.

Acceleration of Contaminant Biodegradation

Once in place and with contaminants partitioned onto its surface, PlumeStop is colonized by contaminant-degrading bacteria. These may be naturally present or applied as an inoculum. The bringing together of a degradative microflora and the target contaminant in local abundance (i.e. concentrated on the PlumeStop rather than dispersed in the groundwater and formation) reduces mass-transfer kinetic constraints and supports greater speed and efficiency of degradation. The net result is a substantial increase in the instantaneous rate and extent of contaminant destruction. Information on post-sorption biodegradation and acceleration of biodegradation rate by PlumeStop can be found in PlumeStop Technical Bulletin 3.1 Post-Sorption Contaminant Biodegradation.

PlumeStop – Post-Placement Contaminant Sorption

Introduction

Securing an effective distribution of PlumeStop easily through a saturated soil system is clearly a core component of its function as a practical technology (see Technical Bulletins 1.1. and 1.2).

Of equal importance are:

- The treatment to secure dispersion must not compromise sorption;
- The dispersed material must coat the formation and not wash out (contaminant mobility must be reduced not enhanced: 'Plume' and 'Stop'.)

These points are addressed in the present Technical Bulletin.

Test Description

The test set-up for evaluation of the sorptive capacity of PlumeStop compared two columns, through which an aqueous solution of 10,000 $\mu\text{g/L}$ of *o*-xylene in tap water was passed

(Figure 1) The columns were set-up identically and packed with loamy coarse sand¹.

An equal flux of aqueous *o*-xylene solution was passed in parallel through each column, and the systems run in this manner in order for the natural sorptive capacity of the soil to become equilibrated and baseline conditions to stabilize (approximately four weeks).

327 g of 0.2% PlumeStop colloidal suspension was then added to the head of the test column and allowed to distribute through it. The control column remained unchanged.

O-xylene concentrations in the effluent of each column were recorded at intervals of 1 – 3 days through the duration of the six-week study.

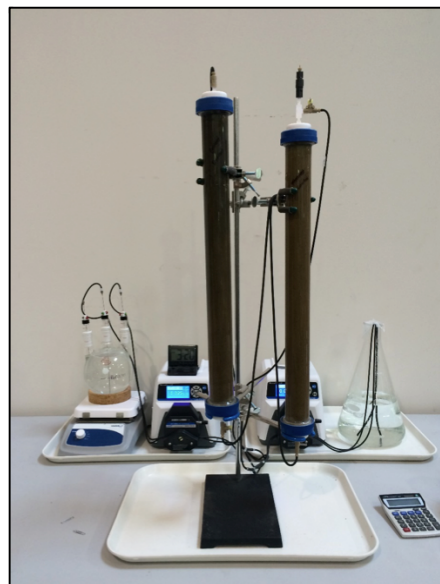


Figure 1. O-Xylene column study set-up

Test Results

The comparative *o*-xylene concentrations in the effluent of the column study treatment and control systems are presented graphically in Figure 2.

O-xylene concentrations in the effluent from the PlumeStop-treated column were reduced from a baseline of approximately 11,000 $\mu\text{g/L}$ to below the quantitation limit of 1,000 $\mu\text{g/L}$ within ten days of application, with the response delay corresponding closely with the residence time of contaminated water within the column (i.e. drainage time of non-treated water ahead of the PlumeStop distribution). Concentrations in the treated system remained below quantitation limits through the course of the study (six weeks), over which time approximately fifteen pore volumes of ca. 11,000 $\mu\text{g/L}$ *o*-xylene solution were fed through each system (equivalent hydraulic seepage of ca. 260 ft/year (80m/year)).

¹ (48% coarse grain; 31% med; 8% fine; 2% v. fine; 11% fines.)

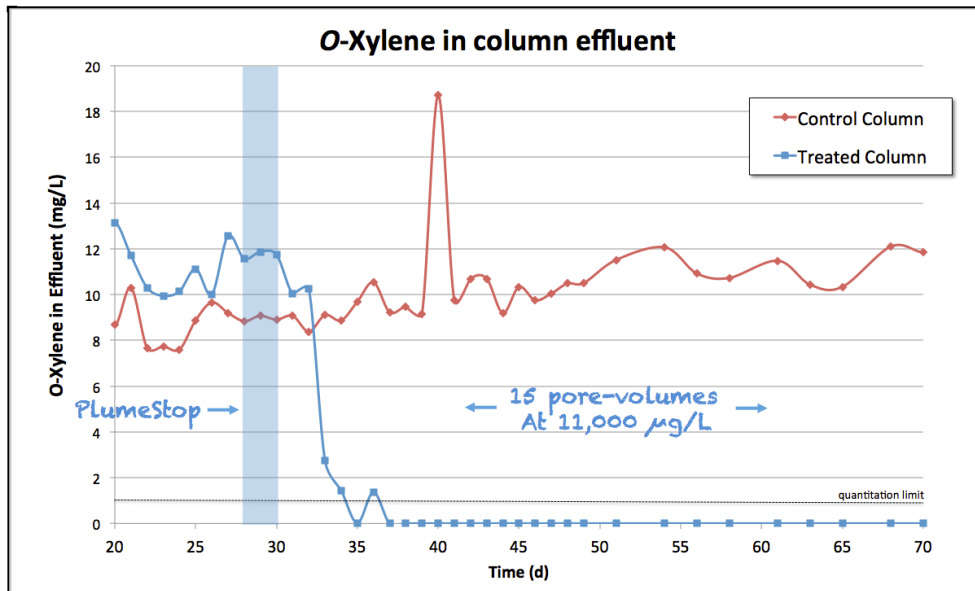


Figure 2. Comparative o-xylene concentrations in column effluent (PlumeStop application to test column at 28-30 days)

Test Conclusions

The column study provides confirmation that the distribution treatment of PlumeStop does not inhibit contaminant sorption – the PlumeStop in the test system was able to sorb over 10,000 µg/L o-xylene for well over ten pore volumes.

The study additionally confirms that the PlumeStop was retained within the formation sufficiently to effect this result – the dispersive treatment neither inhibited sorption nor resulted in excessive mobility leading to wash-out, at a hydraulic flux equivalent to a field seepage velocity of *ca.* 260 ft/year (80 m/year). (See also Technical Bulletin 1.1.)

The retained sorptive capacity of dispersion-emplaced PlumeStop, its resistance to post-placement wash-out, and continued contaminant capture at high flux are therefore illustrated by the present study.