

**CONTAMINATED LAND ASSESSMENT AND
REMEDiation RESEARCH CENTRE
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Contract Research Report

Laboratory and Field Testing of PermaKleen

Prepared for

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BACKGROUND

MYCELX is a patented polymeric surfactant technology that is used in all Mycelx Technologies products. The Mycelx instantly bonds to hydrocarbons etc. to make them hydrophobic and viscoelastic thus removing them from the water process stream. Mycelx is reported by the manufacturers to remove a wide range of contaminants:

- Aromatic Hydrocarbons (BTEX)
- Aliphatic Hydrocarbons & Solvents
- Crude Oil & Fuel/Sheen
- Cycloalkanes
- Chlorinated Organics
- Pesticides & POPs*
- Organic Polymers
- Vegetable Oils & Animal Fats
- Colloidal Heavy Metals
- Silicone Oil

*Persistent Organic Pollutants: PCBs, Dioxin, Furan, DDT, Aldrin, Chlordane, Dieldrin, Endrin, Heptachlor, Hexachlorobenzene, Mirex & Toxaphene.

PermaKleen (Figure 1) has been designed primarily for hydrocarbon removal from flowing water in a range of filtration applications including storm drain cisterns, bag filtration systems and packed columns.

Technical Data on PermaKleen:

- Weight: 1.5 lb./cu.ft. (Approx. 24g/L)
- Capacity: 15-45 lbs. (Approx. 6.4 - 20.4kg) of Oil Pollutant
- Color: Yellow
- pH: Neutral
- Standard pH Operating Range: 2-12
- Substrate: cloth / material / string etc, chipped to approx. 25mm size.

As pollutants come in contact with the Mycelx, they are solubilised into the infused coating, making them hydrophobic and thickening them so they will not re-disperse into the solution. A low ash content and potentially high oil content makes incineration an attractive option for used material.



Figure 1: *PermaKleen*

LABORATORY TRIALS

Permakleen was tested in column experiments where 40g of diesel, petrol or used engine oil was added to 1L samples of collected rainwater (pH 5.9) and passed through 50g of Permakleen. The effluent was collected and total oil content determined gravimetrically as Solvent Extractable Material (SEM). Results are shown in Table (1) below.

Table 1: *Hydrocarbon removal in shock load column experiments (n=3, ± Standard Error)*

Contaminant	Effluent SEM (mg L ⁻¹)	Removal (%)
Rainwater Control	43 ± 13	NA
Petrol	43 ± 3	99.9
Diesel	48 ± 8	99.9
Used Engine Oil	78 ± 19	99.8

All tests showed >99% removal of shock loaded hydrocarbon. Residual SEM (around 15 mg L⁻¹) was also determined in effluent from rainwater control columns. This was not identified as being contaminant hydrocarbon and would likely be comprised of other SEM in the Permakleen matrix.

In US Patent No. 5,473,793 the inventor of Mycelx, Haluk Alper, describes the chemical composition of the Mycelx 'coagulant' as being linseed oil chemically reacted with isobutyl methacrylate polymer diluted in a solvent. Subsequently, new products (US Patent No. 5,837,146) were produced from a variety of natural animal and vegetable oils as well as fatty acids, alkenes and alkynes. This reduced to 18 mg L⁻¹ following a second leaching.

It was also observed that the Permakleen reduced the pH of both rainwater and distilled water passing through it (Table 2).

Table 2: *Reduction in pH observed in column experiments (*n=3, ±Standard Error)*

Contaminant	pH
Rainwater	5.60
Rainwater Control	4.75
Petrol*	4.73 ± 0.02
Diesel*	4.77 ± 0.03
Used Engine Oil*	4.74 ± 0.01

Permakleen also introduced a yellowish colour to water passed through it. This was not felt to be significant and likely to be temporary. The colour is introduced by a harmless vegetable dye added to the product to identify treated from non-treated material.

FIELD TRIALS

Field trials were conducted using the wastewater from the settlement tank of a full-scale constructed wetland treatment system for gully wastes (Figure 2) operated by Realm Construction Ltd as part of the Bowhill Recycling and Restoration Project.



Figure (2): Full-scale gully waste treatment wetland at Bowhill in Fife.

The settlement tank receives the liquid fraction from the gully tankers after filtration through straw bales. A siphon, fed a small tank (300 x 300 x 300mm) filled with Permakleen. Samples were taken pre and post filtration over a three-month period.

In the field study, shock loading of hydrocarbon was not examined. The water from the settlement tank was found to contain only low levels of hydrocarbons (typically $<5 \text{ mg L}^{-1}$). Therefore Total Petroleum Hydrocarbon (TPH) was determined by Gas Chromatography using a Flame Ionisation Detector (GC-FID). Results from the pre and post Permakleen filtered samples are shown in Figure (3) below.

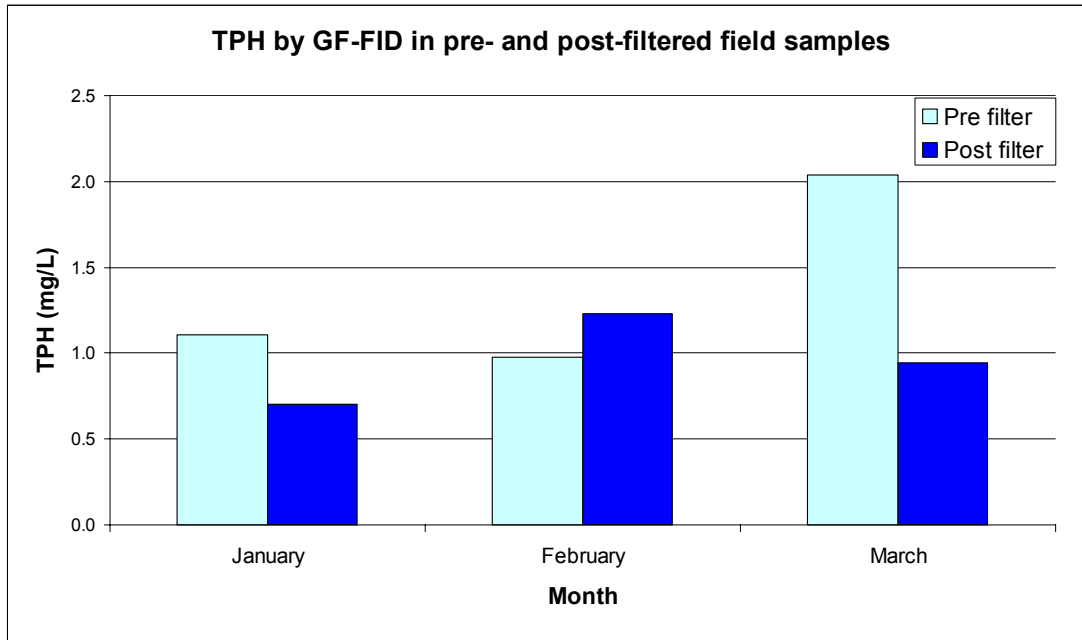


Figure (3): Mean ($n=2$) TPH by GC-FID in pre and post-filtered field samples

The TPH result for February, where the output was higher than the input was likely the result of freezing of the systems outflow and accumulation of TPH in the Permakleen matrix. In both other months, the Permakleen was able to reduce the TPH to below 1 mg L^{-1} although input values were very low with a maximum of around only 2 mg L^{-1} .

Total Suspended Solids (TSS), was also determined for pre and post-filtered field samples (Figure 4).

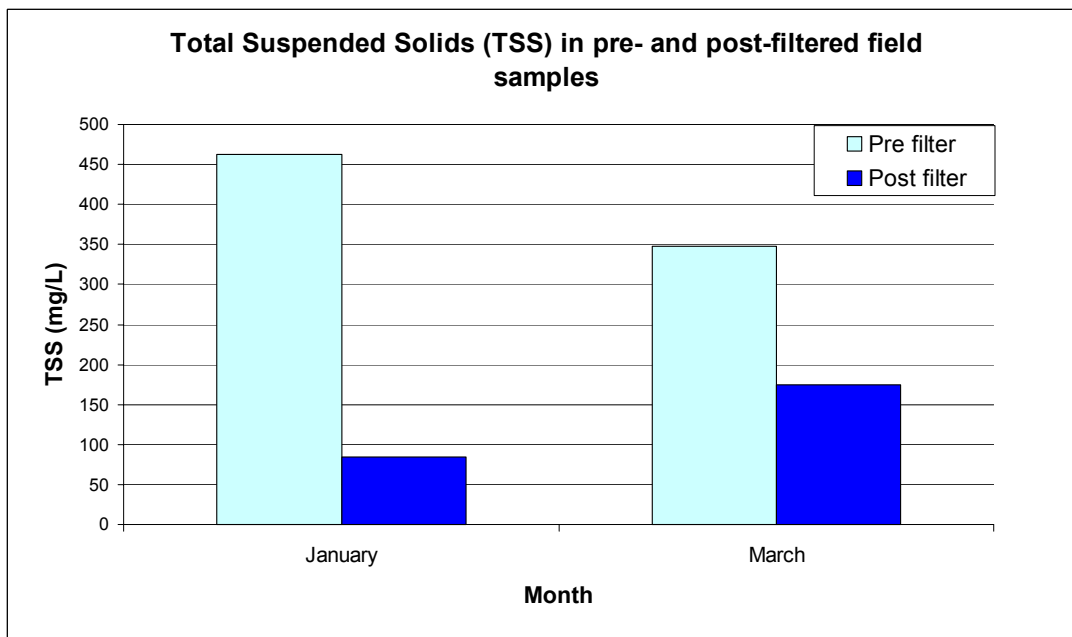


Figure (4): Mean ($n=2$) TSS in pre- and post-filtered field samples

Due to the problem with freezing during February, TSS was not determined. In the January samples, TSS was reduced from a mean of 466 mg L⁻¹ to 85 mg L⁻¹ representing a reduction of 82%. The March samples showed a reduction of 50% from 347 mg L⁻¹ to 175 mg L⁻¹, which may also have been influenced by the period of freezing.

CONCLUSIONS

- (i) Laboratory trials showed that PermaKleen was very effective at removing 'shock loaded' light and heavy hydrocarbon contaminants with efficiencies of >99.9%.
- (ii) PermaKleen reduced Total Petroleum Hydrocarbon (TPH) levels to <1 mg L⁻¹ in the field trial.
- (iii) Total Suspended Solids (TSS) were substantially reduced by between 50% and 82%.
- (iv) Freezing of the system may have adversely influenced the field trial.
- (v) Overall, PermaKleen is likely to be a suitable material for use as part of Sustainable Urban Drainage. Suitably monitored field trials would be required before widespread adoption could be recommended.