



Feasibility of the Pharem Filtration System

Assessed by Isle Utilities based on data provided
by Pharem Biotech

P H A R E M
B I O T E C H



stowa

**Dutch Innovation on Micropollutants
Removal from Municipal Wastewater
November 7th 2019 Aquatech Amsterdam**

PFS Principles

Pharem Filtration System (PFS):
Purified Enzymes immobilized on
(sand-like) filter medium.

Process Development:

1. Selection / development of enzymes:
 - Broad effect on OMP's
 - Under wastewater conditions
2. Selection of the right mix of enzymes
3. Immobilization on filter medium
4. Filter medium in filtration columns =
robust & scalable



Enzyme (Mix) Selection

An overview of how the combination of enzymes can have an added and broad effect on substances

| Enzym ID | PBpCM6e1 | PBpCM6e3 | PBpCM6e4 | PBpCM6e5 | PBpCM6e7 | PBpCM6e8 | PBpCM6e9 | PBpCM6e10 | PBpCM6e12 | PBpCM6e15 | PBpCM6e16 | PBpCM6e17 |
|------------------------|----------|----------|----------|----------|----------|----------|----------|-----------|-----------|-----------|-----------|-----------|
| | | | | | | As | | | | | | |
| <i>Ciprofloxacin</i> | | | • | • | | | | • | | | | |
| <i>Citalopram</i> | | | | • | | | | | | | • | • |
| <i>Clarithromycin</i> | • | | • | | | | | | | | | • |
| <i>Diklofenak</i> | • | | | • | | | | | • | | | |
| <i>Erytromycin</i> | • | | | | | | | | | | | • |
| <i>Estradiol</i> | • | | • | | | | | | | | | • |
| <i>Etinylestradiol</i> | • | | • | | | | | | | | | • |
| <i>Flukonazol</i> | | | | • | | | | | | • | • | |
| <i>Ibuprofen</i> | | | • | | | | | | • | | | |
| <i>Karbamazepin</i> | | • | | | | • | | • | | | | |
| <i>Levonorgestrel</i> | • | | • | | • | | | | | | | • |
| <i>Losartan</i> | • | | | • | | | | | | • | • | |
| <i>Metotrexat</i> | | | | | | | • | | • | • | • | |
| <i>Metoprolol</i> | • | • | | | • | | • | | | | | |
| <i>Naproxen</i> | | • | • | | | | | | • | | | |
| <i>Oxazepam</i> | | | | • | | | | | | | • | • |
| <i>Sertralin</i> | | | | • | | • | | | | | | |
| <i>Sulfametoxazol</i> | | | | | | • | • | • | | | | |
| <i>Tramadol</i> | | | • | | • | | • | | | | | |
| <i>Trimetoprim</i> | | • | | | | • | • | • | | | | |
| <i>Zolpidem</i> | | | | | | • | | • | | • | | |

- Typically 10-15 enzymes per mixture, activity on functional groups
 - 1 enzyme effects multiple OMP's, 1 OMP effected by multiple enzymes
- = Broad effect & high removal

Approach

- Assessment of pilot & lab test data:
 - Estimate removal of 11 indicator substances
 - Estimate required empty bed contact time (EBCT; 5 min)
- Discussion on expected ecotoxicological effects
- Design 100 000 p.e. tertiary treatment step:
 - CapEx & OpEx
 - CO₂ footprint

Results

| Criterion | Score with respect to: ozonation + sand filtration |
|----------------------------|--|
| Removal of micropollutants | 0 |
| CO ₂ footprint | ++ |
| Costs | + |
| Ecotoxicity | 0 |

- *Removal:* 7 of 11 substances proven
- *CO₂ footprint:* Low, since non-carbon based; mainly transport and enzyme production
- *Cost:* Mainly media replacement
- *Ecotox:* Predictable due to mode of action

- Optimizing enzyme mix can bring further efficiency

Next steps

Field pilot on WWTP effluent in NL:

- Demonstrate removal of 11 indicator substances
- Demonstrate broad removal of OMP's
- Optimise enzyme mix
- Measure ecotoxicological effects
- Fine-tune & confirm CO₂ footprint & cost estimates





Thank you for your attention!



Bastian Piltz

Isle Utilities

Email: bastian.piltz@isleutilities.com



More info? Visit Pharem at booth: 01.615 (Hall 1)

stowa

**Dutch Innovation on Micropollutants
Removal from Municipal Wastewater
November 7th 2019 Aquatech Amsterdam**

