*Supplementary Information Material*

**Performance evaluation of porous graphene as filter media for the removal of pharmaceutical/emerging contaminants from water and wastewater**

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**Table S1.** Chemicals used for synthetic grey water preparation.

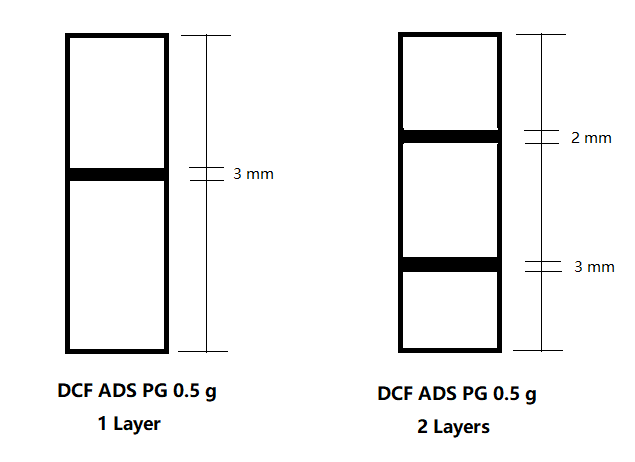
|  |  |  |  |
| --- | --- | --- | --- |
| **Product** | **Quantity Used / Concentration** | **Product** | **Quantity Used / Concentration** |
| Calcium Chloride | 36 mg/L | Magnesium Sulphate | 126 mg/L |
| Kaolin | 57.5 mg/L | Monopotassium Phosphate | 54 mg/L |
| Cellulose | 57.5 mg/L | Iron (III) Chloride | 30 mg/L |
| Humic Acid | 15 mg/L | Boric Acid | 3.0 mg/L |
| Sodium Chloride | 70 mg/L | Manganese (II) Chloride | 3.0 mg/L |
| Sodium Hydrogen Carbonate | 55 mg/L | Zinc Sulphate | 10 mg/L |
| Distilled water | <1L | Copper Sulphate | 4.5 mg/L |
| Potassium Nitrate | 50 mg/L | Ammonium Molybdate tetrahydrate | 1.0 mg/L |
| Calcium Nitrate | 80 mg/L | Cadmium Oxide | 7.0 mg/L |
| Secondary Treatment Effluent with microbial content | 60 ml/L | Nickel Oxide | 0.1 mg/L |
| Sodium Phosphate Monobasic | 130 mg/L | Chromium (III) nitrate | 38 mg/L |
| Lead (II) Oxide | 0.9 mg/L | Sodium Sulphate | 15 mg/L |

**Tables S2**. Water quality and characteristics of the synthesised greywater.

|  |  |  |
| --- | --- | --- |
| **Analysis** | **Value** | **Unit** |
| BOD | 23 | mg/L |
| COD | 70.3 | mg/L |
| Ammonia as Nitrogen | 1.08 | mg/L |
| Nitrate as Nitrogen | 5.3 | mg/L |
| Ortho-phosphate-phosphorus | 28.4 | mg/L |
| pH | 7.5 |  |
| Redox potential | -6.8 | mV |
| Turbidity | 103.6 | NTU |
| Electronic conductivity | 543.8 | μS/cm |
| Dissolved oxygen | 10 | mg/L |

**Table S3.** Water quality of the effluent from secondary settlement tank prior to tertiary biological aerated flooded filter (BAFF) treatment unit, existing at Countess Wear Wastewater Treatment Works, South West Water Co., Exeter, Devon, UK.

|  |  |  |
| --- | --- | --- |
| Analysis | Value | Unit |
| pH | 7.1 | pH units |
| BOD | 4 | mg/L |
| Solids Suspended at 105 oC by Gravimetry | 13 | mg/L |
| Solids Suspended at 500 oC by Gravimetry | 5 | mg/L |
| Aluminium as Al by ICPOES[[1]](#footnote-1) | <0.2 | mg/L |
| Iron as Fe by ICPOES | <0.45 | mg/L |
| Manganese as Mn by ICPOES | <0.08 | mg/L |
| Copper as Cu by ICPOES | <0.004 | mg/L |
| Zinc as Zn by ICPOES | 0.0102 | mg/L |
| Lead as Pb by ICPOES | 0.0265 | mg/L |
| Cadmium as Cd by ICPOES | <0.003 | mg/L |
| Chromium as Cr by ICPOES | <0.024 | mg/L |
| Nickel as Ni by ICPOES | <0.01 | mg/L |
| Nitrogen Total Oxidised as N by Colorimetry | 2.0 | mg/L |
| Ammonia as N by Colorimetry | 13 | mg/L |
| Chloride as Cl- by Colorimetry | 48 | mg/L |
| Phosphorus Tot as P by ICPOES | 0.530 | mg/L |



**(b)**

**(a)**



Peristaltic Pump

Set of filters with different configurations

**Figure S1.** (a) A photo of actual column experiment apparatus; (b) packing arrangement of columns for single (left) and double layers (right) of adsorbent.

**Table S4.** Target compounds and their structures, main m/z ions, fragmentor and collision energy voltages, and average retention time for LC-MS analysis.

|  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Drug** | **Chemical**  **Structure** | **Precursor m/z** | **ID Product m/z** | | **Qualifier Product m/z** | **Fragmentor Voltage (kV)** | **Collision Energy Voltages (kV)** | **Average**  **RT (min)** |
|  |  |  |  |  | |  |  |  |
| **Atenolol** | Atenolol.svg | 267.2 | 145.1 | 190.1 | | 100 | 29 & 17 | 1.71 |
| **Carbamazepine** | Carbamazepine.svg | 237.1 | 194.1 | 179.1 | | 140 | 21 & 35 | 2.58 |
|  |  |  |  |  | |  |  |  |
|  |  |  |  |  | |  |  |  |
|  |  |  |  |  | |  |  |  |
| **Ciprofloxacin** | Ciprofloxacin.svg | 332.1 | 288.2 | 314.1 | | 100 | 17 & 21 | 5.28 |
|  |  |  |  |  | |  |  |  |
|  |  |  |  |  | |  |  |  |
|  |  |  |  |  | |  |  |  |
| **Diclofenac** | Diclofenac.svg | 296.0 | 214.1 | 250.0 | | 80 | 35 & 9 | 7.03 |
|  |  |  |  |  | |  |  |  |
|  |  |  |  |  | |  |  |  |
|  | ÙØªÙØ¬Ø© Ø¨Ø­Ø« Ø§ÙØµÙØ± Ø¹Ù âªgemfibrozil structureâ¬â |  |  |  | |  |  |  |
| **Gemfibrozil** |  | 251.2 | 129.1 | 55.1 | | 60 | 9 & 33 | 7.41 |
|  |  |  |  |  | |  |  |  |
|  |  |  |  |  | |  |  |  |
|  |  |  |  |  | |  |  |  |
| **Ibuprofen** | ÙØªÙØ¬Ø© Ø¨Ø­Ø« Ø§ÙØµÙØ± Ø¹Ù âªIbuprofen structureâ¬â | 207.1 | 161.0 | 119.1 | | 60 | 9 & 21 | 6.63 |
|  |  |  |  |  | |  |  |  |

Concentration (mg/L)

0.5

1

2

3

5

2

4

6

8

10

12

Sand Dosages (g)

ATL Concentration

CIP Concentration

DCF Concentration

**Figure S2.** ATL, CIP, and DCF adsorption onto sand at different dosages after 24 hrs.

1. ICPOES - Inductively coupled plasma - optical emission spectrometer [↑](#footnote-ref-1)