1   **Supplemental information**

2   **Granular Activated Carbon for Bromacil Removal: Experimental and Predictive**

3   **Techniques**

4   J. R. González-Rodríguez, N. Ariza-Castro, A. Lazo-Páez, L.G. Romero-Esquivel

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6 **Table S1. Characteristics of the tested water matrices for bromacil adsorption.**

Parameter	Pital	Veracruz	ASA-5
Bromacil (µg/L)	1.30 ± 0.31 (n=7)	0.73 ± 0.39 (n=38)	0.12 ± 0.04 (n=14)
Conductivity (µS/cm)	152 ± 27 (n=5)	55.7 ± 18.3 (n=51)	271 (n=1)
pH	6.65 ± 0.38 (n=5)	5.38 ± 0.43 (n=52)	6.56 (n=4)
Turbidity (NTU)	0.48 ± 0.51 (n=5)	1.39 ± 2.30 (n=39)	0.75 (n=3)
Dissolved organic carbon (mg C/L)	0.90 ± 0.61 (n=3)	2.40 (n=1)	1.55 (n=1)
UV254 (cm^{-1})	0.0010 (n=1)	< 0.0001 (n=1)	0.0001 (n=1)
SUVA (L/mg-m)	0.21 (n=1)	N.D. (n=1)	0.06 (n=1)
Total Hardness (mg CaCO$_3$/L)	67.0 ± 10.9 (n=4)	13.5 ± 4.0 (n=30)	109 (n=1)
Calcium (mg/L)	17.2 ± 2.1 (n=4)	3.02 ± 1.30 (n=30)	20.9 (n=1)
Magnesium (mg/L)	5.88 ± 1.48 (n=4)	1.51 ± 0.79 (n=30)	13.7 (n=1)
Sodium (mg/L)	6.05 ± 1.35 (n=4)	2.31 ± 0.70 (n=24)	10 (n=1)
Potassium (mg/L)	1.83 ± 0.39 (n=4)	1.24 ± 0.33 (n=24)	3.4 (n=1)
Iron (µg/L)	11.7 ± 5.7 (n=3)	23.8 ± 22.8 (n=6)	306 (n=1)
Alkalinity (mg CaCO$_3$/L)	82.5 ± 10.7 (n=4)	13.3 ± 3.7 (n=30)	102 (n=1)
Chloride (mg/L)	1.94 ± 0.41 (n=2)	2.31 ± 0.36 (n=24)	4.05 (n=1)
Nitrate (mg/L)	3.74 ± 1.15 (n=2)	6.6 ± 4.1 (n=24)	Not measured
Sulfate (mg/L)	1.28 ± 0.05 (n=2)	1.23 ± 0.11 (n=12)	9.9 (n=1)

7 N.D: Not detected.

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9 **Text S1. Description of characterization techniques**

10 Particle size distribution was performed following ASTM D2862-16 standard (ASTM, 2016).

11 Bulk density was obtained following ASTM D2854-09 standard(ASTM, 2019). Particle density

12 and material density were determined according to Sontheimer et al. (1988).

13 Bulk porosity and particle porosity were computed based on Equations 1 and 2, as described by

14 Worch (Worch, 2021).

$$\varepsilon_B = 1 - \frac{\rho_B}{\rho_P} \tag{1}$$

$$\varepsilon_P = 1 - \frac{\rho_P}{\rho_M} \tag{2}$$

15 Where ε_B and ε_P are the bulk porosity and particle porosity, ρ_B, ρ_P, and ρ_M are the bulk density,

16 particle density, and material density, respectively (kg/m^3).

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18 **Table S2. Particle characteristics of utilized granular activated carbons**

Parameter	Coconut	Bituminous
Particle density (g/cm^3)	0.97	0.90
Bulk density (g/cm^3)	0.50	0.53
Material density (g/cm^3)	1.95	1.79
Particle porosity (%)	0.50	0.50
Effective diameter, D10 (mm)	0.90	0.60
Uniformity coefficient, UC	1.44	2.07
Mean particle diameter (mm)	1.20	1.07

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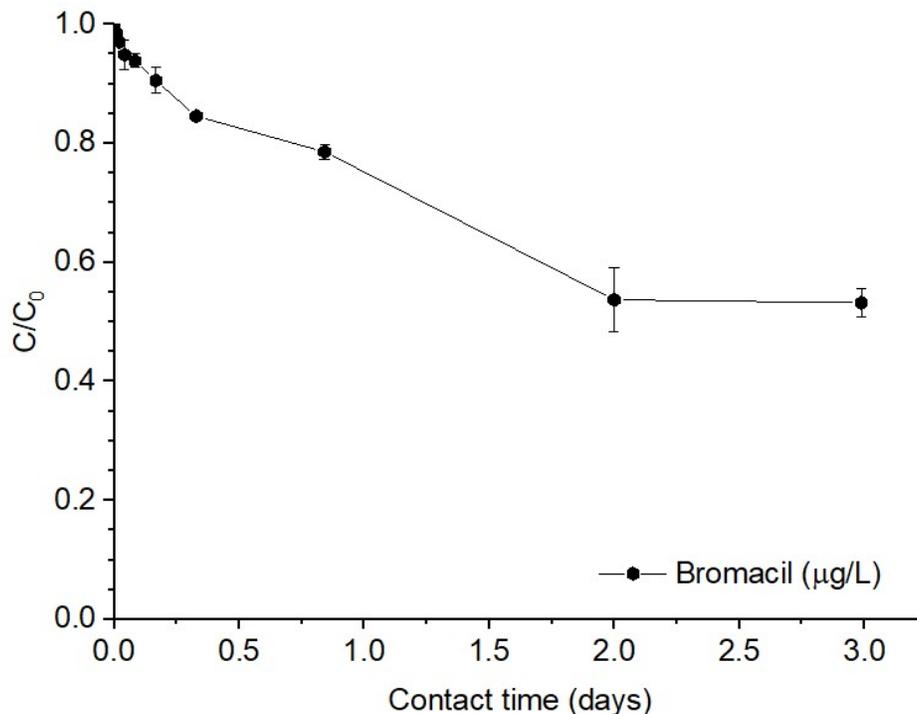
Figure S1. Bromacil adsorption kinetics (C$_0$: 5 μg/L, pH: 6.68± 0.13, 20°C, adsorbent dose: 4.1 mg/L). Error bars represent standard deviation of duplicate test.

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Text S3. Rapid small column tests
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RSSCTs were designed to simulate full-scale columns (182 cm height by 91.4 cm wide) packed with bituminous GAC (12x40). Mean particle diameter was used as scaling parameter as recommended by ASTM (2014). The column diameter and superficial rate remained constant, while the height of the GAC was adjusted to vary the empty bed contact time (EBCT). The

33 summary of the conditions for the RSSCTs is shown in Table 1. The EBCT of the small column

34 was computed following the constant diffusivity (CD) approach equation (Worch, 2021):

$$\frac{EBCT_{SC}}{EBCT_{LC}} = \left[\frac{d_{p,SC}}{d_{p,LC}}\right]^2 = \frac{t_{SC}}{t_{LC}}$$

35 Where EBCT is the empty bed contact time; d_p is the particle diameter, and t is the test elapsed

36 time. The subscripts of the parameters, SC and LC are for small column (*i.e*, RSSCT column) and

37 large column (*i.e*, full-scale column), respectively.

38 The particle size used in the RSSCT columns was ground with a mortar and pestle to a 60x80 size

39 fraction (mean geometric size of 0.164 mm). The GAC sample was wet sieved using ultrapure

40 water and thoroughly washed in a beaker until all fines were removed. The sample was kept under

41 ultrapure water until its use. Superficial loading rate was calculated using the equation:

$$\frac{v_{SC}}{v_{LC}} = \frac{d_{p,LC}}{d_{p,SC}} \times \frac{Re_{SC,min}}{Re_{LC}}$$

42 where v is the superficial rate; d_p is the particle diameter, Re and Re_{min} are the Reynolds number

43 and the Reynolds number. The subscripts of the parameters, SC and LC are for small column (*i.e*,

44 RSSCT column) and large column (*i.e*, full-scale column), respectively. The Re_{min} was set as one-

45 fourth of the Re_{LC} to minimize head loss in the column while maintaining a sufficient flow rate to

46 ensure a manageable sampling time frame (<4 hours).

47 The RSSCT apparatus, depicted in Figure S2, utilized polyethylene tubing with an internal

48 diameter of 0.4 cm for water conveyance and as the column material. Polyethylene fittings were

49 employed to connect the tubing. Before water entered the column, a bypass tube was installed to

50 serve as an air purging system, and a glass wool prefilter was added to remove particulate matter.

51 A manometer of 15 psi was installed at the entrance of the column to monitor head loss. A piston

52 pump (Fluid Metering Inc., QG55, Syosset, NY) was used to draw water from the inlet reservoir.

53 The column was packed using the wet method, beginning with a 3 cm layer of glass wool at the

54 bottom, followed by the gradual introduction of the ground absorbent using a dropper. Once filled,

55 the column was backwashed to remove fines, as recommended by Zeng et al. (2020).

56 Samples were collected twice daily in 1-liter amber glass bottles. Bromacil, turbidity, and pH were

57 monitored throughout the test. The RSSCT columns filtered approximately 200,000 bed volumes

58 (BV) before being stopped, corresponding to a bromacil relative concentration of ~0.5 at the outlet.

59 (C/C_0).
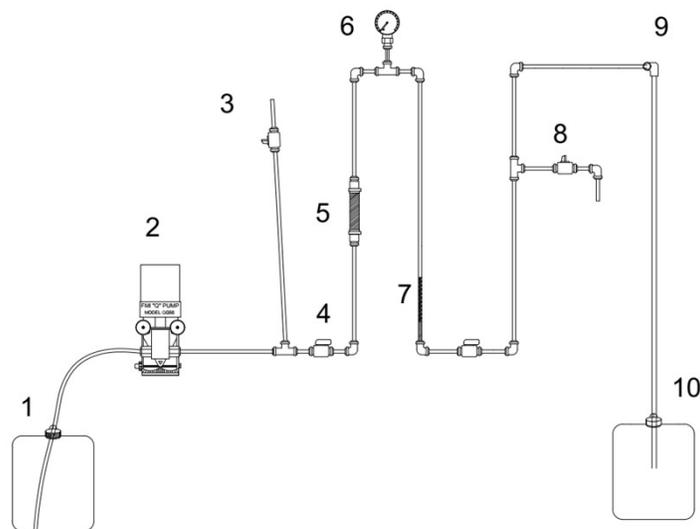
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61 **Figure S2. Diagram of small-scale columns for granular activated carbon where 1. Inlet**
62 **reservoir, 2. Ceramic piston pump, 3. Air bubble purge bypass, 4. Ball valve for air bubble**
63 **purge, 5. Glass fiber pre-filter, 6. Pressure gauge, 7. GAC 80x100 column, 8. Outlet sampling**
64 **point, 9. Outlet water collector, and 10. Treated water reservoir.**

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