Supplementary Materials:

Cationic Dye Removal Using Novel Magnetic/Activated Charcoal/β-Cyclodextrin/Alginate Polymer Nanocomposite

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Figure S1. (A) The chemical structure of Methylene Blue Dye.

[Chemical structure image]

**Figure S1. (B) Scheme outlining all the steps involved in the synthesis of Fe₃O₄/AC, Fe₃O₄/AC/CD and Fe₃O₄/AC/CD/Alg nanocomposite from preparation to analysis.**

1. **Fe²⁺/Fe³⁺ (1:2) Hydrated ferrous/ferric salt**
2. Co-precipitation pH-10, Temp.80 °C
3. Stirrer/2 h
4. Fe₃O₄/AC nanoparticle
   - 1) Dried 90 °C/12 h
   - 2) 500 °C/Calcination

5. β-CD
6. Stirred/2 h
7. Fe₃O₄/AC calcined nanoparticle

8. Fe₃O₄/AC/CD
9. 24 h dried in air oven 90 °C

10. Alg
11. Fe₃O₄/AC/CD nanocomposite
12. 1) Stirred/2 h/ Added 2% CaCl₂
13. Fe₃O₄/AC/CD/Alg polymer gel beads

All prepared sample characterization by XRD, FTIR, SEM-EDX, HR-TEM, BET, and VSM analysis.
Figure S2. (A) Fe₃O₄/AC/CD/Alg polymer gel beads (B) image of Fe₃O₄/AC/CD/Alg nanocomposite attracted by a magnet (C) Before and after adsorption of MB solution by dry powder beads and (D) polymer gel beads.
Figure S3. Effect of the dye solution pH range from 2 to 8 on the amount of dye adsorption capacity (initial dye concentration = 5 ppm, dosage Fe₃O₄/AC/CD/Alg polymer beads = 0.2 g/10ml dye solution, agitation speed = 150 rpm, room temperature), with contact time = 90 min (A), 60 min (B) and 120 min (C).
Figure S4. (A) Effect of adsorbent dosage on the adsorption of MB by polymer gel beads and dry powder beads (mass of catalyst= 0.04–0.5 g, pH= 6).

Figure S4. (B) Effect of adsorbent dosage on the adsorption capacity and % removal of MB for Fe3O4/AC/CD/Alg polymer beads (initial dye concentration = 5 ppm, pH = 6, contact time = 90 min).
Figure S5. Effect of contact time on MB adsorption by polymer gel beads and dry powder beads (initial MB concentration = 5 mg/L; adsorbent dose = 0.02g; pH = 6).

Figure S6. Fit of Freundlich isotherm on MB adsorption on Fe₃O₄/AC/CD/Alg polymer gel beads and dry powder polymer beads.