Supplementary materials

**Synergistic effect of a spinel ferrite on the adsorption capacity of nano bio-silica for the removal of methylene blue**

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**Kinetic studies**

Equations that define these models are listed below; pseudo-first order (S1), pseudo-second order (S2) and Elovich (S3).

$q\_{t}=q\_{e}\left[1-exp\left(-k\_{1}t\right)\right]$ S1

$q\_{t}= q\_{e}- \frac{q\_{e}}{\left[k\_{2 }\left(q\_{e}\right)t+1\right]}$ S2

$q\_{t}=\frac{1}{β}(1+αβt)$ S3

where $α$ and $β$ are the initial adsorption rate (mg g-1 min-1) and extent of surface coverage (g mg-1) respectively. And $q\_{t}$ and $q\_{e}$ are amount of MB adsorbed at time ‘t’ and at equilibrium time respectively, $k\_{1}$and$k\_{2 }$are the rate constant of pseudo-first order and second order kinetic models respectively.

**Adsorption isotherm**

Equation S4 (Langmuir) and equation S5 (Freundlich).

$q\_{e}= \frac{q\_{maxC\_{eK\_{L }}}}{(1+K\_{LC\_{e}})}$ S4

$q\_{e}=K\_{F}C\_{e}^{1/n\_{F}}$ S5

In these equations, $C\_{e}$ stands for the equilibrium concentration in bulk solution (mg L-1), $q\_{e}$ is the amount of methylene blue that was adsorbed (mg g-1), $q\_{max}$ is the maximum adsorption capacity (mg g-1) of the adsorbent, $K\_{L}$ is equilibrium constant of Langmuir (L g-1), $K\_{F}$ is the Freundlich constant (mg g-1 (mg L-1)-1/nF ), $n\_{F}$ is the dimensionless exponent of Freundlich.

The nature of adsorption was determined by using the linear form of Dubinin–Radushkevich (D–R) isotherm in equations below.

$lnq\_{e}=lnq\_{DR}-k\_{DR}ε^{2}$ S6

$ε^{2}=RTln(1+\frac{1}{C\_{e}})$ S7

$E= \frac{1}{\sqrt{-2k\_{DR}}}$ S8

The parameters in the equations are defined as follow: $q\_{DR}$ is D-R adsorption capacity (mg g-1), $k\_{DR}$ is D-R constant ($mol^{2}$ J-2), ε Polanyi potential, E is the mean energy of adsorption (kJ mol-1), R is gas constant (J mol-1 K-1), T is temperature (K). Mean energy of adsorption was evaluated from the slope of the plot of $lnq\_{e}$ versus $ε^{2}$ (Fig. **S2**).



**Fig. S1:** Electrostatic attraction between MB and the adsorbents.





**Fig. S2.** D-R isotherm for the adsorption of MB on BSIL, SCOF100 and SCOF 700.



**Fig. S3.** Effect of ionic strength on the adsorption of MB on SIL and SCOF.



**Fig. S4.** Monomer and dimers molecules of MB.



**Fig. S5**: Pictures of BSIL before adsorption (A), after adsorption (B) and after MB-loaded BSIL was calcined.