Supplementary Material

Capabilities of Novel Carbon Nano Adsorbents in Evaluating the Extraction of 2-Nitrophenol and Heavy Metal from aqueous solutions

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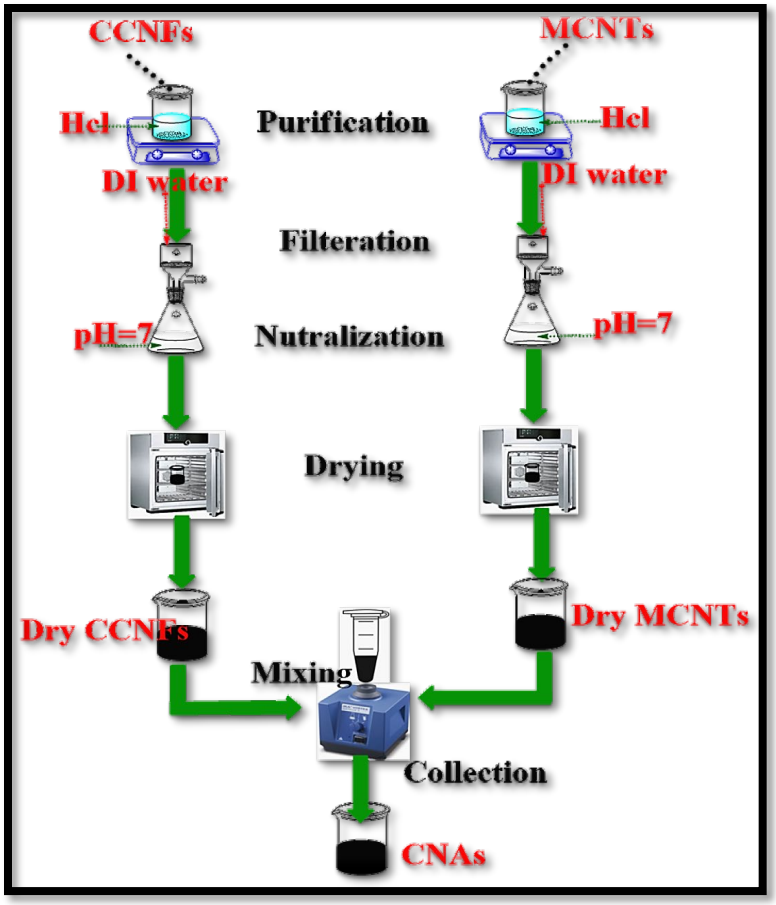


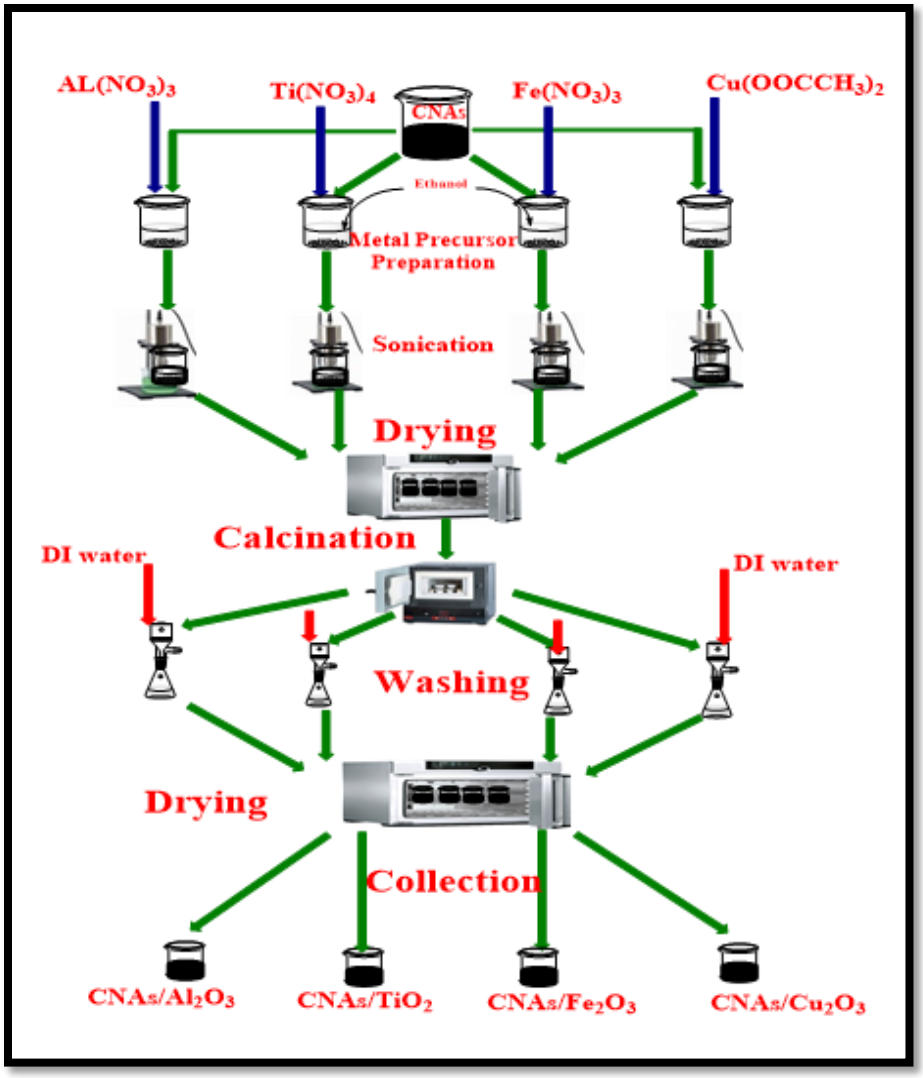
Appendix A1: Diagrammatic method for integrating the elements of the CNAs Composite.

Appendix A-1:

$$\text{Yield (Dried)}\% = \left(\frac{The\ mass\ of\ the\ mixture\ after\ Oven\ Drying}{Initial\ dried\ mass\ of\ the\ Mixture}\right) * 100\% \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (1)$$

$$\text{Yield (Calcined)}\% = \left(\frac{The\ mass\ of\ the\ Mixture\ after\ Calcination}{The\ mass\ of\ the\ mixture\ after\ Oven\ Drying}\right) * 100\% \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\text{Yield (Impregnation)}\% = \left(\frac{Mass\ of\ metal\ loded\ adsorbent - mass\ of\ unloaded\ \ adsorbent}{The\ mass\ of\ the\ metal\ salte\ used}\right) * 100\% \ldots\ldots (3)$$

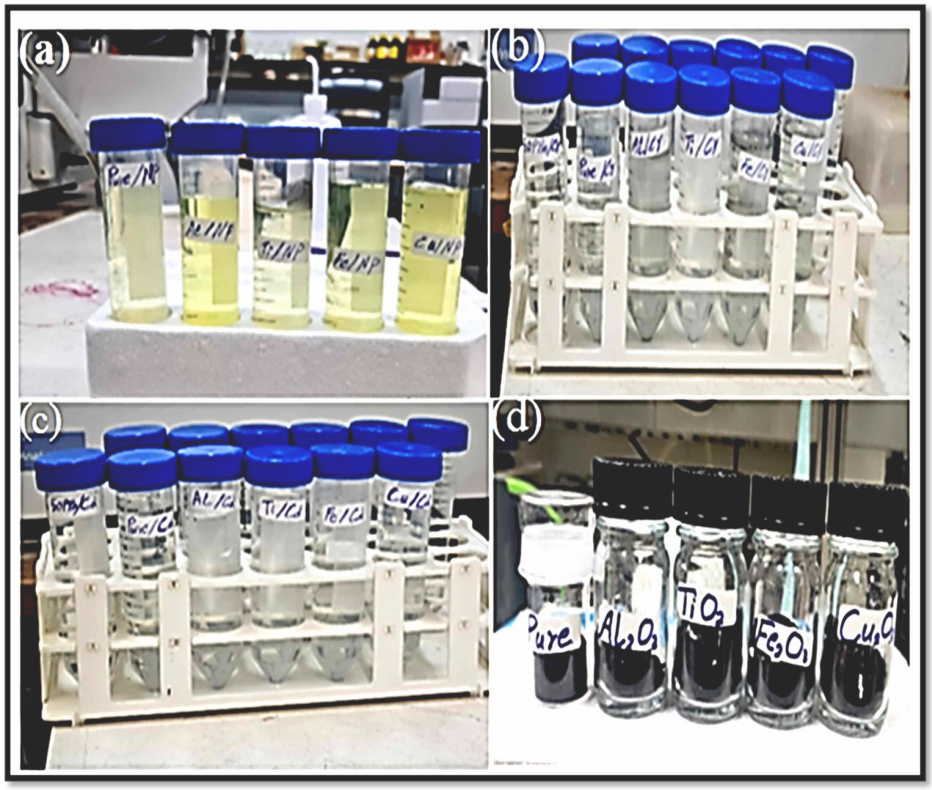


Appendix A2: The Synthesis Procedure in this study of the Hybrid CNAs Composite with (1) Al_2O_3(2) TiO_2(3) Fe_2O_3 and (4) Cu_2O_3

Appendix A-2:

$$Q = \left(\frac{C_{i-}\, C_e}{M_{adsorbent}}\right) * V_{sol} \qquad (3)$$

Where Q is the amount of adsorption capacity (mg/g), Ci is the original concentration of the adsorbate in liquid (mg/L), and Ce is the equilibrium concentrations of the adsorbates 2-NP, Cr, and Cd (mg/L) in the solution, V_{sol} is the total adsorbate solution used volume (L) and $M_{adsorbent}$ (g) is the CNAs/MO mass, respectively.



Appendix A3: The Contaminated solutions of (a) 2-NP, (b) Cd, and (c) Cr were filtered after the adsorption process, employing (d) Pure CNAs, CNAs/AL_2O_3, CNAs/TiO_2, CNAs/Fe_2O_3 and CNAs/Cu_2O_3 respectively.

Appendix. B1 Calculation of the Actual impregnation yield of the CNAs/MO

SN	Source of impregnated metal (Metal salt)	Mass of metal -salt (g)	Weight of unloaded CNAs (g)	Total mass of the dry Mixture (g)	Mass of loaded-adsorbent after oven Drying. (g)	Dried Yield (%)	mixture weight after Calcination (g)	Calcined Yield (%)	Impregnation Yield (%)
1	$AL(NO_3)_3$	5.561	2.00	7.561	6.6553	88.021	5.7975	87.11	68.28
2	$Fe\ (NO_3)_3$	2.890	2.00	4.890	3.9132	80.02	3.3542	85.71	46.85
3	$Ti\ (NO_3)_4$	2.473	2.00	4.473	4.1548	92.88	3.6610	88.11	67.16
4	$Cu\ (OOCCH_3)_2$	1.257	2.00	3.257	2.7235	83.62	2.5087	81.93	40.46

Appendix. B2 EDS analysis of Pure CNAs and Modified CNAs samples

CNAs Sample	Pure CNA	CNA/Al_2O_3	CNA/TiO_2	CNA/Fe_2O_3	CNA/Cu_2O_3
Element in sample	Weight %	Weight %	Weight %	Weight %	Weight %
C	90.85	84.90	84.56	76.84	96.08
O	9.15	5.19	2.34	7.29	2.41
AL	-	**9.91**	-	-	-
Ti	-	-	**13.10**	-	-
Fe	-	-	-	**15.87**	-
Cu	-	-	-	-	**1.51**
Total%	100	100	100	100	100

Appendix. B3 (a) Adsorption Capacity of 2-NP

Sr	Adsorbent	Absorbance	Ce(ppm)	Qe(mg/g)
1	Blank Sample	3.4014	50	----------
2	Pure CNAs	3.0640	45.0403	24.7985
3	CNAs/ AL_2O_3	2.7260	40.0717	49.6415
4	CNAs /TiO_2	2.9272	43.0293	35.8535
5	CNAs/Fe_2O_3	3.06620	44.90626	25.4687
6	CNAs/Cu_2O_3	2.9480	43.3351	33.3245

Appendix. B3 (b) Adsorption Capacity and of Cd^{+2}

Sr	Adsorbent	Absorbance^10^3	Ce(ppm)	Qe(mg/g)
1	Blank sample	880	50	---------
2	Pure CNAs	845	48.1093	9.4531
3	CNAs/AL_2O_3	842	47.8409	11.1795
4	CNAs /TiO_2	840	47.7273	11.3635
5	CNAs/Fe_2O_3	842	47.8409	10.7955
6	CNAs/Cu_2O_3	841	47.7841	11.0795

Appendix. B3 (c) Adsorption Capacity of Cr^{3+}

Sr	Adsorbent	Absorbance^10^3	Ce(ppm)	Qe(mg/g)
1	Blank sample	202	50.000	----------
2	Pure CNAs	176	43.5643	32.1785
3	CNAs/ AL_2O_3	160	39.6039	51.9805
4	CNAs /TiO_2	163	40.3465	48.2675
5	CNA s/Fe_2O_3	170	42.0792	39.604
6	CNA s/Cu_2O_3	169	41.8317	40.8415