Supplementary Materials for

Differentiating Nanomaghemite and Nanomagnetite and Discussing Their Importance in Arsenic and Lead Removal from Contaminated Effluents: A Critical Review

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List of acronyms

TABLE S1

γ-Fe_2O_3@starch	: starch functionalized nano-γ-Fe_2O_3.
MBC	: magnetized biochar (vegetal carbon) composite.
MtZ	: nano-Fe_3O_4-zeolite composite.
CMnano	: nano-γ-Fe_2O_3 plus concrete.
PVA – SPIONs	:polyvinyl alcohol-Superparamagnetic iron-oxide NPs (nano-Fe_3O_4 with possible oxidation towards nano-γ-Fe_2O_3, stabilized by PVA).
bilayer–OA@FeO NPs	: bilayer-oleic coated iron-oxide NPs (γ-Fe_2O_3 and Fe_3O_4).
FeO_x-GO-80	: amorphous iron-oxide-graphene oxide-80 wt% of amorphous iron-oxide.
iMNP	: magnetic NPs from iron-containing sludge. It mainly contained γ-Fe_2O_3.
GM	: graphene oxide supported Fe_3O_4.
γ-Fe_2O_3@CTF-1	: γ-Fe_2O_3/covalent triazine framework.
Fe_2O_3-ZrO_2/BC	: Fe_2O_3-zirconium oxide/black cumin.
BCA-Fe	: activated biochar covered with nano-Fe_3O_4.
HFe10k	: halloysite containing sample with iron-oxide particles in a 10% proportion and calcined.
BC-Fe	: bamboo Fe biochar, it contains Fe_3O_4.
γ-Fe_2O_3-TiO_2-GO	: γ-Fe_2O_3-titanium dioxide- graphene oxide.
MBP	: bio-based substances-stabilized Fe_3O_4 /γ-Fe_2O_3 after pyrolysis.
Fe_3O_4:S	: Sulfur doped nano-Fe_3O_4.
c-MNPs	: coated magnetic NPs (FeOOH coated γ-Fe_2O_3).
Fe_3O_4@CuO&GO	: Fe_3O_4/copper oxide and graphene oxide.
BMN nanocompositte	: biomass-derived magnetic nanocomposite (γ-Fe_2O_3, α-Fe_2O_3 and zero valent iron).
20%FBC	: iron-impregnated biochar with 20% Fe to biomass ratio, it contains γ-Fe_2O_3 and α-Fe_2O_3.

TABLE S2

HA	: humic acid.
GO/Fe_3O_4/HA	: graphene/Fe_3O_4/humic acid.
HA-Fe_3O_4	: humic acid grafted Fe_3O_4.
NC-MA/L-Fe_3O_4	: nanocellulose-maleic anhydride/(ethylenediamine-ethylenediaminetetraacetic acid-ethylenediamine)- Fe_3O_4.
Fe_3O_4/NOG	: Fe_3O_4/non-oxidative graphene.
Fe_3O_4@sand	: Fe_3O_4 coated sand.
PAN/GO/γ-Fe_3O_4	: polyacrylonitrile/graphene oxide/γ-Fe_2O_3.

TABLE S3

$\gamma - Fe_2O_3@SiO_2$	: γ-Fe_2O_3 NPs functionalized with silica.
$\gamma - Fe_2O_3 - SBA15$	: γ-Fe_2O_3 NPs functionalized with mesoporous silica.
$\gamma - Fe_2O_3@OA$	: γ-Fe_2O_3 NPs functionalized with oleic acid.
$\gamma - Fe_2O_3@LA$	: γ-Fe_2O_3 NPs functionalized with lauric acid.
$\gamma - Fe_2O_3@L{-}arg$	: γ-Fe_2O_3 NPs functionalized with L-arginine.
$\gamma - Fe_2O_3$@HAp	: γ-Fe_2O_3 NPs functionalized with hydroxyapatite.
$\gamma - Fe_2O_3$@MWCNTs	: γ-Fe_2O_3 NPs functionalized with carbon nanotubes.
$\gamma - Fe_2O_3 - EDTA1$	: γ-Fe_2O_3 NPs functionalized with ethylenediaminetetraacetic acid.

$\gamma - Fe_2 0_3 - EDTA2$: γ-Fe_2O_3 NPs functionalized with ethylenediaminetetraacetic acid.

$\gamma - Fe_2 0_3 - EDTA3$: γ-Fe_2O_3 NPs functionalized with ethylenediaminetetraacetic acid.

$L - Cyst - Fe_3 0_4$: L-cysteine functionalized Fe_3O_4 NPs.

$Fe_3 0_4 - NH_2$: amine functionalized Fe_3O_4 NPs.

$Fe_3 0_4$@PDA : Fe_3O_4 NPs functionalized with polydopamine.

Fe_3O_4-ETT : Fe_3O_4-epoxy-triazinetrione (ETT).

Fe_3O_4-PEI/β-CD : Fe_3O_4- polyethyleneimine /β-cyclodextrin.

Fe_3O_4@Si02@PEI-NTDA : Fe_3O_4/Silicon dioxide/polyethylenimine-1,4,5,8-naphthalenetetracarboxylic-dianhydride.

Fe_3O_4-g- C_3N_4 : Fe_3O_4-graphitic carbon nitride.

Fe_3O_4-SO_3H : sulfonated magnetic NP adsorbents.

Fe_3O_4@APS : 3-aminopropyltriethoxysilane functionalized magnetic NPs.

Fe_3O_4@ APS@AA-co-CA : 3-aminopropyltriethoxysilane - acrylic acid and crotonic acid copolymer functionalized magnetic NPs. CNTs/ Fe_3O_4 : thiol-functionalized multiwall carbon nanotube/ Fe_3O_4 nanocomposites.

MPTS-CNTs/ Fe_3O_4 : 3-mercaptopropyltriethoxysilane (MPTS)-the as-synthesized thiol-functionalized CNTs/ Fe_3O_4.

Fe_3O_4@C@TiO_2 : γ-Fe_2O_3/carbon particles/titanium dioxide.

Fe_3O_4 -$FeMoS_4$-MgAl-LDH : Fe_3O_4- $FeMoS_4^{2-}$ magnesium-aluminum layered double hydroxide.

SH-mSi@ Fe_3O_4 : thiol-functionalized magnetic mesoporous silica material.

mHAP-oMWCNTs : magnetic hydroxyapatite-immobilized oxidized multi-walled carbon nanotubes.

GFMNPECABs : glycine-functionalized magnetic NPs-entrapped calcium alginate beads.

GFMNPS: Glycine functionalized magnetic NPs.

RT: room temperature.

p.z.c. point of zero charge.

qe or qm: Langmuir's maximum adsorption capacity (mg g^{-1}).

k_F: Freundlich adsorption constant (L mg^{-1}).

k_s. Sips constant (L $mg^{-1})^m$.

K_T: equilibrium binding constant (L mg^{-1}).

k_L: Langmuir adsorption constant (L mg^{-1}).

q_{mDR}: Dubinbin–Radushkevich's maximum adsorption capacity.

DLS: Dynamic light scaterring.

AFM: Atomic Force Microscopy.

SEM: Scanning Electron Microscopy.

SAXS: Small-angle X-ray scattering.

EDS: Electron Dispersive X-ray Spectroscopy.

FESEM: Field Emission Scanning Electron Microscope.

BET: Brunauer-Emmett-Teller.

Table S1. Structure and adsorption parameters of magnetic nanohybrids used for As(III) and As(V) adsorption.

Adsorbent	Synthesis method	Size and shape	Surface area	Saturation magnetization (RT)	Adsorbates	Initial concentration (C_0) and equilibrium time (t_e)	Concentration range in isotherm experiments	Adsorption conditions	Kinetic and isothermal parameters	Ref.
γ-Fe_2O_3@starch	Coprecipitation	TEM: 9.7 nm XRD: 8.1 nm spherical NPs	-	-	As(III)	C_0=1 mg L^{-1}	1.0-6.0 mg L^{-1}	T=27 °C pH=7 dose=1 g L^{-1}	**Pseudo-second order:** q_e=1.02 mg g^{-1} k_2=11.55 g mg^{-1} min^{-1} R^2=0.98 **Langmuir:** q_m=8.6 mg g^{-1} k_L=9.1 L mg^{-1} R^2=0.98 **Freundlich:** k_F=16.5 mg g^{-1} (L mg^{-1})$^{1/n}$ n=1.60 R^2=0.98 **Removal:** 99 %	[58]
MBC	Coprecipitation	STEM: 18.1 nm (Fe_3O_4) clustered or aggregated on the surface (2-7 μm)	320.1 m^2 g^{-1}	-	As(III)	C_0=10 mg L^{-1} t_e=1 - 1.5 h	1-12 mg L^{-1}	T=25 °C pH=7 dose=2 g L^{-1}	**Pseudo-second order:** q_e=3.75 mg g^{-1} k_2=0.319 g mg^{-1} min^{-1} R^2=0.9999 **Sips:** q_s=5.49 mg g^{-1} k_s=1.14 L mg^{-1} R^2=0.9889 **Langmuir:** q_m=5.06 mg g^{-1} k_L=0.96 - 0.22 L mg^{-1} R^2<0.9889 **Removal:** 68.4 %	[59]
MtZ	Alkaline precipitation and coating	SEM: 77 nm Fe_3O_4	38 m^2 g^{-1}	-	As(V)	C_0=100 mg L^{-1} t_e=3 h	1-450 mg L^{-1}	T=25 °C pH=5.5 dose=10 g L^{-1}	**Pseudo-second order:** q_e=1.35 mg g^{-1} k_2=0.109 g mg^{-1} min^{-1} R^2=0.904 **Langmuir:** q_m=6.211 mg g^{-1} k_L=0.009 L mg^{-1} R^2=0.995 **Freundlich:**	[60]

									k_F=0.209 mg g^{-1} n=1.877 R^2=0.957	
CMnano	Coprecipitation	SEM: ~20 nm XRD: 17 nm round shaped	-	3.45 emu g^{-1}	As(V)	C_0=12.5 mgL^{-1} t_e= 72 h	0.1-1300 mg L^{-1}	T=30 °C pH=5 dose=20 g L^{-1}	**Pseudo-second order:** q_e=0.618 mg g^{-1} k_2=0.436 g mg^{-1} h^{-1} R^2=0.991 **Langmuir:** q_m=11.12 mg g^{-1} R^2=0.995 **Gunary:** q_m=8.82 mg g^{-1} R^2=0.998 **Removal:** 85 %	[61]
PVA - SPIONs	Coprecipitation	TEM: 9 nm (SPIONs), SEM:9.5 nm (SPIONs), XRD: 10 nm (SPIONs), a=8.367 Å (SPIONs) a=8.38 Å (SPIONs in membrane)	-	74 emu g^{-1}	As(V)	C_0=0.86 mg L^{-1} t_e=6 h	0.15-1.1 mg L^{-1}	T=25 °C pH=3 dose=8.4 mg L^{-1}	**Langmuir:** q_m=52 mg g^{-1} k_L=0.496 L mg^{-1} R^2=0.991 **Freundlich:** k_F=0.03 mg g^{-1} n=0.94 R^2=0.985	[44]
bilayer–OA@FeO NPs	Coprecipitation	SEM: 20-40 nm	6.53 m^2 g^{-1}	-	As(V)	C_0=0.03 mg L^{-1} t_e= 2 h	0.001-0.15 mg L^{-1}	T=25 °C pH=7 dose=1 g L^{-1}	**Pseudo-second order:** q_e=11.9 μg g^{-1} k_2=2 g mg^{-1} min^{-1} R^2=0.968 **Langmuir:** q_m=0.0328 mg g^{-1} k_L=0.72 L g^{-1} R^2=0.93 **Freundlich:** k_F=1.8 L mg^{-1} n=1.82 R^2=0.99	[63]
FeO_x-GO-80	Coprecipitation	TEM: 5 nm amorphous	341 m^2 g^{-1}	-	As(III)	C_0=400 mg L^{-1} t_e= ~250 min	25-1200 mg L^{-1}	T=23 °C pH=7 dose=0.8 g L^{-1}	**Pseudo-second order:** q_e=110 mg g^{-1} k_2=0.001 g mg^{-1} min^{-1} R^2=1.000 **Langmuir:** q_m=147 mg g^{-1} k_L=0.011 L mg^{-1} R^2=0.991 **Removal:**	[64]

									>99.98 %	
					As(V)	C_0=300 mg L^{-1} t_e= ~1450 min	25-350 mg L^{-1}	T=23 °C pH=3 dose=0.8 g L^{-1}	**Pseudo-second order:** q_e=114 mg g^{-1} k_2=0.001 g mg^{-1} min^{-1} R^2=1 **Langmuir:** q_m=113 mg g^{-1} k_L=0.295 L mg^{-1} R^2=0.994 **Removal:** >99.98 %	
iMNP	Coprecipitation	TEM: 14.3-45.1 nm (avg.=23.5 nm) quasi-spherical	145.5 m^2 g^{-1}	35.5 emu g^{-1}	As(V)	C_0=400 µg L^{-1} t_e=60 min	1-10 mg L^{-1}	T=25 °C pH=6.6 dose=0.2 g L^{-1}	**Pseudo-second order:** q_e=1.879 mg g^{-1} k_2=0.4753 g mg^{-1} min^{-1} R^2=0.9996 **Langmuir:** q_m=12.74 mg g^{-1} k_L=6.025 L mg^{-1} R^2=0.8976 **Freundlich:** k_F=10.50 L g^{-1} 1/n=0.100 R^2=0.7236 **Removal:** >90 %	[65]
GM	Coprecipitation	TEM: 5.5-12.5 nm spherical, agglomerated and deposited on an irregular shaped and paper-like GO	-	-	As(III)	C_0=5 mg L^{-1}	-	T=22 °C pH=9 dose=333 mg L^{-1}	As loading=23-29 mg g^{-1} Removal >90 %	[66]
					As(V)	C_0=5 mg L^{-1}	-	T=22 °C pH=3 dose=333 mg L^{-1}	As loading=10.4-41.7 mg g^{-1} Removal >90 %	
γ-Fe_2O_3@CTF-1	Coprecipitation	STEM: 5-7 nm	1049 m^2 g^{-1}	-	As(III)	C_0=0.1 mg L^{-1}		T=25 °C pH=7 dose=4 g L^{-1}	**Pseudo-second order:** q_e=2.554 mg g^{-1} k_2=-2.688 mg min g^{-1} R^2=0.9999 **Langmuir:** q_m=198.0 mg g^{-1} **Removal:** Maximum removal efficiency=97.1 %	[67]
					As(V)	C_0=0.1 mg L^{-1} t_e<24 h (few minutes)			**Pseudo-second order:** q_e=1.859 mg g^{-1} k_2^{-1}=-3.709 mg min g^{-1} R^2=0.9999	

									Langmuir: q_m=102.3 mg g^{-1} **Removal:** 96.6 %	
Fe_2O_3-ZrO_2/BC	Coprecipitation	TEM: 17-22 nm XRD: 54nm irregular shape	-	-	As(III)	C_0=1.0 mg L^{-1} t_e=~2 h	0-0.12 mg L^{-1}	T=27 °C dose= 2 g L^{-1}	**Pseudo-second order:** q_e=0.4586 mg g^{-1} k_2=45.0 g mg^{-1} min^{-1} R^2=1 **Langmuir:** q_m=1.01 mg g^{-1} k_L=6.48 L mg^{-1} R^2=0.97 **Freundlich:** k_F=1.98 mg^{-1} $(Lmg^{-1})^{1/n}$ n=1.433 R^2=0.99 **Sips:** q_s=0.99 mg g^{-1} k_s=0.996 L mg^{-1} R^2=0.98 **Redlich-Peterson:** k_r=2.897 L mg^{-1} R^2=0.99 **Removal:** 90 %	[68]
BCA-Fe	Coprecipitation (BCA is synthetized by another method)	TEM-EDS: 10-25 nm for Fe_3O_4 porous	482.4 m^2 g^{-1}	-	As(V)	C_0=10 mg L^{-1} t_e=1 h	2.5-1000 mg L^{-1}	T=25 °C pH=7 dose=2 g L^{-1}	**Pseudo-second order:** q_e=11.36 mg g^{-1} k_2=0.02 g mg^{-1} min^{-1} R^2=0.99 **Langmuir:** q_m=85 mg g^{-1} **Removal:** 86 %	[69]
HFe10k	Coprecipitation and calcination	XRD: 20 nm (nanoγ-Fe_2O_3) spherical in ~50 nm clusters	65.4 m^2 g^{-1}	-	As(V)	-	0.01-25 mmol L^{-1}	T=22 °C pH=5 dose=20 gL^{-1}	**Langmuir:** q_m=178.5 mmol kg^{-1} R^2>0.99	[70]
Fe_3O_4	Coprecipitation	DLS: 248 nm	35 m^2 g^{-1}	-	As(III)	C_0=2 mg L^{-1} t_e=~5 h	2-400 mg L^{-1}	T=27 °C pH=7 dose=4 g L^{-1}	**Freundlich:** k_F=1.79 mg g^{-1} n=2.05	[71]
					As(V)	C_0=2 mg L^{-1} t_e=~5 h	2-400 mg L^{-1}	T=27 °C pH=7 dose=4 g L^{-1}	**Freundlich:** k_F=3.38 mg g^{-1} n=1.5	
BC-Fe	Coprecipitation	-	28.9 m^2 g^{-1}	-	As(V)	t_e=2 h	0.1-1 mg L^{-1}	T=25 °C pH=7	**Langmuir:** q_m =90 mg g^{-1}	[72]

γ-Fe_2O_3-TiO_2-GO	Coprecipitation	TEM: 9 nm (γ-Fe_2O_3) spherical γ-Fe_2O_3 Agglomerate TiO_2 (50 nm) and well defined using GO XRD: 9 nm a=8.3789 Å for γ-Fe_2O_3 a=3.7867 Å and b=9.4393 Å for TiO_2	82 $m^2 g^{-1}$	60 emu g^{-1}	As(III)	C_0=33 mg L^{-1} t_e=20 h	1-400 mg L^{-1}	T=25 °C pH=6.5 dose=0.56 g L^{-1}	**Pseudo-second order:** q_e=25.3 mg g^{-1} k_2=0.0013 g mg^{-1} min^{-1} R^2=0.9998 **Langmuir:** q_m=110.4 mg g^{-1} k_L=0.06 L mg^{-1} R^2=0.986 **Freundlich:** k_F=13.7 mg g^{-1} n=2.27 R^2=0.949 **Sips:** q_s=121.1 mg g^{-1} k_s=0.07 (L mg^{-1})^m m_S=0.88 R^2=0.984 **Redlich-Peterson:** A=7.9 L g^{-1} B=0.14 L mg^{-1} R^2=0.983 **Removal:** 73 %	[42]
					As(V)	C_0=33 mg L^{-1} t_e=20 h	1-400 mg L^{-1}	T=25 °C pH=6.5 dose=0.56 g L^{-1}	**Langmuir:** q_m=127.2 mg g^{-1} k_L=0.13 L mg^{-1} R^2=0.997 **Freundlich:** k_F=45.8 mg g^{-1} n=5.39 R^2=0.93 **Sips:** q_s=130.1 mg g^{-1} k_s=0.159 (L mg^{-1})^m m=0.88 R^2=0.998 **Redlich-Peterson:** A=21.1 L g^{-1} B=0.217 L mg^{-1} R^2=0.996 **Removal:** 85 %	
MBP	Coprecipitation	TEM: 10 nm	-	45 emu g^{-1}	As(III)	-	5-300	T=25 °C pH=6 dose=2 g L^{-1}	**Langmuir:** q_m=17.2 mg g^{-1} k_L=0.4 L mg^{-1} R^2=0.954 **Freundlich:** k_F=7.4 mg g^{-1}	[73]

					As(V)	-	5-300	T=25 °C pH=6 dose=2 g L^{-1}	n=5.7 R^2=0.843 **Langmuir:** q_m=43.9 mg g^{-1} k_L=1.2 L mg^{-1} R^2=0.832 **Freundlich:** k_F=18.6 mg g^{-1} n=4.8 R^2=0.900	
Fe_3O_4	Chemical Precipitation	XRD: 84 nm a=8.38523 Å	12 m^2 g^{-1}	-	As(V)	-	0.1-8	T=20 °C pH=7 dose=1 g L^{-1}	**Langmuir:** q_m=1.386 mg g^{-1} k_L=8.06 L mg^{-1} R^2=0.9963 **Freundlich:** k_F=1.045 mg g^{-1} n=6.35 R^2=0.9867	[46]
Fe_3O_4:S	Novel chemical synthesis method, like chemical precipitation	TEM: 4.34-13.46 nm (avg. 7.84 nm)	-	37.1 and 39.9 emu g^{-1} before and after adsorption	As(V)	C_0=20 mg L^{-1} t_e=24 h	5-50 mg L^{-1}	T=30 °C pH=6 dose=0.5 g L^{-1}	**Pseudo-second order:** q_e=42.44 mg g^{-1} k_2=0.00193 g mg^{-1} min^{-1} R^2=0.999 **Langmuir:** q_m=58.38 mg g^{-1} k_L=0.971 L mg^{-1} R^2=0.990	[75]
cellulose@Fe_2O_3	Coprecipitation	TEM: 5-100 nm XRD: 61 nm a=8.3515 Å	113 m^2 g^{-1}	13.2 emu g^{-1}	As(III)	-	0-~27 mg L^{-1}	T=25 °C pH=7 dose=1 g L^{-1}	**Langmuir:** q_m=23.16 mg g^{-1} k_L=0.48 L mg^{-1} R^2=0.9959 **Freundlich:** k_F= 9.64 mg g^{-1} n= 3.78 R^2=0.9656	[47]
					As(V)	-	0-~27 mg L^{-1}		**Langmuir:** q_m=32.11 mg g^{-1} k_L=0.039 L mg^{-1} R^2=0.9836 **Freundlich:** k_F= 3.25 mg g^{-1} n= 2.06 R^2=0.9961	

MNPs (γ-Fe_2O_3)	Coprecipitation	TEM: 23.5 nm XRD: 5.9 nm irregular shaped	145.5 $m^2 g^{-1}$	35.5 emu g^{-1}	As(V)	C_0=0.4 mg L^{-1} t_e=~1 h	0-10 mg L^{-1}	T=25 °C pH=6.6 dose=0.2 g L^{-1}	**Langmuir:** q_m=12.74 mg g^{-1} k_L=6.03 L mg^{-1} R^2=0.898 **Removal:** 95 %	[77]
c-MNPs	Coprecipitation and heterogeneous nucleation technique	TEM: 37.0 nm XRD: 4.9 nm irregular shaped	157.1 $m^2 g^{-1}$	36.4 emu g^{-1}	As(V)	C_0=0.4 mg L^{-1} t_e=~1 h	0-15 mg L^{-1}		**Langmuir:** q_m=26.05 mg g^{-1} k_L=0.34 L mg^{-1} R^2=0.901 **Removal:** >95 %	
Fe_3O_4	Chemical precipitation	TEM: 5 nm XRD: 5 nm	179 $m^2 g^{-1}$	40 emu g^{-1}	As(III)	-	0-70 mg L^{-1}	T=27 °C pH=7 dose=60 mg L^{-1}	**Langmuir:** q_m=46.06 mg g^{-1} k_L=0.1686 L mg^{-1} **Removal:** Maximum removal=97.5 %	[78]
					As(V)	-	0-50 mg L^{-1}	T=27 °C pH=7 dose=60 mg L^{-1}	**Langmuir:** q_m=16.56 mg g^{-1} k_L=1.42 L mg^{-1} **Removal:** 97.5 %	
Fe_3O_4@CuO&GO	A modified precipitation method	TEM: 20 nm spherical and packed	159.60 $m^2 g^{-1}$	30 emu g^{-1}	As(III)	C_0=15 mg L^{-1} t_e=12 h	0-~80 mg L^{-1}	T=25 °C pH=7 dose=120 mg L^{-1}	**Langmuir:** q_m=70.36 mg g^{-1}	[79]
					As(V)	C_0=15 mg L^{-1} t_e=12 h	0-~80 mg L^{-1}	T=25 °C pH=7 dose=120 mg L^{-1}	**Langmuir:** q_m=62.60 mg g^{-1}	
Starch-bridged Fe_3O_4	A modified coprecipitation method	TEM: 26.6 nm spherical shape	-	-	As(V)	t_e=4 h	0-400 mg L^{-1}	T=21 °C pH=5 dose=1.7 g L^{-1}	**Langmuir:** q_m=248.0 mg g^{-1} k_L=0.5 L mg^{-1} **Removal:** >98 %	[80]
γ-Fe_2O_3	Commercial	TEM: 18.4 nm	51 $m^2 g^{-1}$	71.7 emu g^{-1}	As(V)	t_e=~20 h	1-11 mg L^{-1}	T=23 °C pH=7 dose=250 mg L^{-1}	**Langmuir:** q_m=5 mg g^{-1}	[81]
γ-Fe_2O_3	Sol-gel	TEM: 12.1 nm	90.4 $m^2 g^{-1}$	64.3 emu g^{-1}	As(V)			T=23 °C pH=7 dose=100 mg	**Langmuir:** q_m=11.1 mg g^{-1}	

									L^{-1} T=23 °C pH=7 dose=60 mg L^{-1}	**Langmuir:** q_m=20 mg g^{-1}	
Fe_3O_4-γ-Fe_2O_3 mixture	Electrical wire explosion (EWE)	TEM: 34 nm a=8.3763 Å	12 m^2 g^{-1}	91.8 emu g^{-1}	As(III)	-	1-7 mg L^{-1}	T=25 °C pH=6 dose=1 g L^{-1}	**Langmuir:** q_m=2.9 mg g^{-1}	[82]
					As(V)	-	1-7 mg L^{-1}	T=25 °C pH=6 dose=1 g L^{-1}	**Langmuir:** q_m=3.1 mg g^{-1}	
Mesoporous γ-Fe_2O_3	A described in the reference hydrothermal process	spherical shape	35.7 m^2 g^{-1}	16.6 emu g^{-1}	As(V)	-	0-80 mg L^{-1}	dose=0.1 g L^{-1}	**Langmuir:** q_m=73.2 mg g^{-1} k_L=0.39 L mg^{-1}	[83]
BMN nanocomposites	A one-step pyrolysis process	TEM: 20 nm	-	-	As(III)	C_0=10 mg L^{-1} t_e=6 h	0.5-50 mg L^{-1}	T=25 °C pH=7 dose=2 g L^{-1}	**Langmuir:** q_m=16.23 mg g^{-1} **Removal:** 90 %	[84]
20%FBC	Thermal pyrolysis	-	297.13 m^2 g^{-1}	67.2 emu g^{-1}	As(V)	C_0=10 mg L^{-1} t_e=24 h	0.25-100 mg L^{-1}	T=25 °C pH=7 dose=5 g L^{-1}	**Langmuir:** q_m=6.8 mg g^{-1} **Removal:** 86.48 %	[85]
Fe_3O_4@TiO_2 magnetic nanosheets	Sol-gel method and a hydrothermal assisted crystallization strategy	AFM: ~1.5 nm (thickness) XRD: 9 nm nanosheets	89.4 m^2 g^{-1}	20 emu g^{-1}	As(III) +UV	C_0=0.91 mg L^{-1} t_e=2 h	0-55 mg L^{-1}	T=27 °C pH=7 dose=0.32 g L^{-1}	**Pseudo-second order:** q_e=3.07 mg g^{-1} k_2=0.031 g mg^{-1} min^{-1} R^2=0.994 **Langmuir:** q_m=30.96 mg g^{-1} k_L=0.6538 L mg^{-1} R^2=0.997 **Removal:** >90 %	[86]
					As(V)	C_0=1.06 mg L^{-1} t_e=2 h	0-55 mg L^{-1}		**Pseudo-second order:** q_e=3.35 mg g^{-1} k_2=0.147 g mg^{-1} min^{-1} R^2=0.999 **Langmuir:** q_m=36.36 mg g^{-1} k_L=0.5288 L mg^{-1} R^2=0.995 **Removal:** >90 %	
Fe_3O_4		TEM: 50 nm		38.9 emu g^{-1}	As(V)	-	2-75 mg L^{-1}	T=27 °C	**Langmuir:**	[87]

	A one-pot hydrothermal process		30.1 m^2 g^{-1}					pH=7 dose=0.1 g L^{-1}	q_m=92.85 mg g^{-1} k_L=0.046 L mg^{-1} R^2=0.90 **Freundlich:** k_F=9.10 mg^{1+n} g^{-1} L 1/n=0.49 R^2=0.96	
Fe_3O_4	Obtained from red mud	TEM: 8-13 nm (9 nm) XRD (SAXS): 9.77 nm spherical shape	-	55.3 emu g^{-1}	As(V)	C_0=50 µg L^{-1} t_e=45 min	10-1000 µg L^{-1}	T=25 °C pH=2.5 dose=8 g L^{-1}	**Pseudo-second order:** q_e=5.21 µg g^{-1} k_2=0.08 g mg^{-1} min^{-1} R^2=0.999 **Langmuir:** q_m=400 µg g^{-1} k_L=0.003 L μg^{-1} R^2=0.968 **Removal:** 99.2 %	[88]

Table S2: Adsorption parameters for removal of arsenic and other pollutants from water using diverse magnetic nanohybrids.

Adsorbent	Synthesis method	Size and shape	Surface area	Saturation magnetization	Adsorbates	Initial concentration (C_0) and equilibrium time (t_e)	Concentration range in isotherm experiments	Adsorption conditions	Other pollutants	Kinetic and isothermal parameters	Ref.
Fe_3O_4	Co-precipitation	TEM: 10 nm spherical NPs	-	-	As(III)	C_0=10 µmol L^{-1} t_e=24 h	-	T=27 °C pH=6-8 dose=1 g L^{-1}	HA 5 mg L^{-1}	Removal=90%	[90]
						C_0=100 µmol L^{-1} t_e=24 h			HA 5 mg L^{-1}	Removal=94.3%	
						C_0=10 µmol L^{-1} t_e=24 h			HA 50 mg L^{-1}	Removal=90.1%	
						C_0=100 µmol L^{-1} t_e=24 h			HA 50 mg L^{-1}	Removal=89.3%	
GO-Fe_3O_4-HA	Co-precipitation	TEM: Fe_3O_4 (8 nm) assembled along the GO sheets.	0.9060 m^2 g^{-1}	-	As(III)	C_0=10 mg L^{-1} t_e=24 h	1 - 10 mg L^{-1}	T=23 °C pH=7 dose=0.2 g L^{-1}	HA 2 g L^{-1}	**Langmuir:** q_m=16 mg g^{-1} k_L=0.787 L mg^{-1}	[91]
					As(V)	C_0=10 mg L^{-1} t_e=24 h	1 - 10 mg L^{-1}	T=23 °C pH=7 dose=0.2 g L^{-1}	HA 2 g L^{-1}	**Langmuir:** q_m=16 mg g^{-1} k_L=0.787 L mg^{-1}	
HA-Fe_3O_4	Co-precipitation	TEM: 10.6 nm	-	68.1 emu g^{-1}	As(III) As(V)	C_0=0.2 mg L^{-1} As(III) C_0=0.2 mg L^{-1} As(V) t_e= 3 h	1 - 10 mg L^{-1}	T=25 °C pH=6.6 dose=0.2 g L^{-1}	-	**Pseudo-second order:** q_e=0.96 mg g^{-1} As(III) k_2=0.35 g mg^{-1} min^{-1} R^2=0.99 q_e =0.99 mg g^{-1} As(V) k_2=1.31 g mg^{-1} min^{-1} R^2=0.99 **Langmuir:** q_m=12.2 mg g^{-1} As(III) k_L=3.46 L mg^{-1} R^2=0.96 q_m=12.6 mg g^{-1} As(V) k_L=4.88 L mg^{-1} R^2=0.94 **Freundlich:** k_F=2.96 L g^{-1} As(III) n=1.75 R^2=0.99 k_F=2.30 L g^{-1} As(V) n=3.57 R^2=0.99	[92]

							-	T=25 °C pH=6.6 dose=0.2 g L^{-1}	Fe^{2+} (1.0 mg L^{-1})	Removal=97% As(III) Removal=98% As(V)	
						C_0=0.2 mg L^{-1} As(III) C_0=0.2 mg L^{-1} As(V) t_e= 3 h	-	T=25 °C pH=6.6 dose=0.2 g L^{-1}	Cl^- (1.0 mmol L^{-1}) NO_3^- (1.0 mmol L^{-1}) SO_4^{2-}(1.0 mmol L^{-1})	Removal>95% As(III) Removal>98% As(V)	
							-	T=25 °C pH=6.6 dose=0.2 g L^{-1}	PO_4^{3-}(1.0 mmol L^{-1})	Removal<85% As(III) Removal<95% As(V)	
							-	T=25 °C pH=6.6 dose=0.2 g L^{-1}	CO_3^{2-}(1.0 mmol L^{-1})	Removal>95% As(III) Removal<30% As(V)	
NC-MA /L-Fe_3O_4	Magnetic stirring and ultrasonic treatment	XRD: 22 nm Fe_3O_4 TEM: 22 nm of grain sizes of Fe_3O_4 present on NC-MA /L surface Pore diameter: 15.2 nm Pore volume: 0.71 cm^3 g^{-1}	85.3 m^2 g^{-1}	-	As(V)	C_0=10 mg L^{-1} t_e= 90 min	0.1 - 20 mg L^{-1}	T=25 °C pH=6 dose=0.1 g L^{-1}	-	**Pseudo-second order:** q_e=1.0463 mg g^{-1} k_2=0.189 g mg^{-1} min^{-1} R^2=0.997 **Freundlich:** k_F=0.2412 mol g^{-1} (L $mol^{-1})^{1/n}$ n=1.779 R^2=0.995 **Adsorption capacities:** 85.3 mg g^{-1}	[93]
					As(V)	C_0=10 mg L^{-1} t_e= 90 min	-	T=25 °C pH=6 dose=0.1 g L^{-1}	PO_4^{3-}(5.6 mg L^{-1}) SO_4^{2-}(42.5 mg L^{-1}) Ca^{2+} (15.3 mg L^{-1}) Mg^{2+} (9.1 mg L^{-1}) SO_4^{4-}(5 mg L^{-1}) Cl^- (1.2 mg L^{-1}) HCO_3^- (856 mg L^{-1})	Adsorption capacities: 69.1 mg g^{-1}	
Fe_3O_4	Reduction-precipitation method	TEM: 25 nm spherical NPs	-	-	As(V)	C_0=13 mg L^{-1} t_e= 1 h	-	T=25 °C pH=2.5 dose=1 g L^{-1}	-	**Pseudo-second order:** q_e=5.94 mg g^{-1}	[94]

Produced from iron ore tailings									k_2=0.039 g mg^{-1} min^{-1} R^2=0.99 **Langmuir:** q_m=9.72 mg g^{-1} k_L=1.17 L mg^{-1} R^2=0.996 **maximum adsorption capacity:** 78.95 % 9.72 mg/g Contact time=6 h **Pseudo-second order:** q_e=5.97 mg g^{-1} k_2=0.070 g mg^{-1} min^{-1} R^2=0.99 **Langmuir:** q_m=9.79 mg g^{-1} k_L=2.30 L mg^{-1} R^2=0.999 **Maximum adsorption capacity:** 9.79 mg g^{-1} Adsorption order of metals can be arranged as: As^{5+}>Cu^{2+}>Zn^{2+}> Mn^{2+} Contact time=6 h	
				As(V)	C_0=13 mg L^{-1} t_e= 1 h	-	T=25 °C pH=5.5 dose=2 g L^{-1}	Cu^{2+} (13 mg L^{-1}) Zn^{2+} (13 mg L^{-1}) Mn^{2+} (13 mg L^{-1}) Simultaneous co-adsorption		
				As(V)	C_0=13.2 mg L^{-1} t_e= 1 h	-	T=25 °C pH=2.5 dose=1 g L^{-1}	Al^{3+} (13 mg L^{-1})	Removal=72.37 % As(V)	
				As(V)	C_0=13.4 mg L^{-1} t_e= 1 h	-	T=25 °C pH=2.5 dose=1 g L^{-1}	Al^{3+} (103 mg L^{-1})	Removal=68.14 % As(V)	
				As(V)	C_0=13.3 mg L^{-1} t_e= 1 h	-	T=25 °C pH=2.5 dose=1 g L^{-1}	Fe^{3+}(13.4 mg L^{-1})	Removal=70.83 % As(V)	
				As(V)	C_0=13.4 mg L^{-1} t_e= 1 h	-	T=25 °C pH=2.5 dose=1 g L^{-1}	Fe^{3+}(104.5 mg L^{-1})	Removal=65.25 % As(V)	
Co-precipitation with sodium	XRD: 8 nm Pore radius: 5.5 nm Pore volume: 0.29 cm^3 g^{-1}	137.4 m^2 g^{-1}	65.8 emu g^{-1}	As(III) Pb(II) Cd(II)	C_0=20 g L^{-1} t_e= 20 min	20–150 mg L^{-1}	T=27 °C pH=5.5 dose=5 g L^{-1}-	-	**Pseudo-second order:** q_e=0.43 mg g^{-1} As(III) k_2=1.56 g mg^{-1} min^{-1} R^2=0.9997	[95]

Fe_3O_4	hydroxide using an aqueous extract lemon peel as surfactant (green Fe_3O_4 nanoparticles)				simultaneous					q_e=0.88 mg g^{-1} Pb(II) k_2=2.24 g mg^{-1} min^{-1} R^2=0.9999 q_e=0.42 mg g^{-1} Cd(II) k_2=0.54 g mg^{-1} min^{-1} R^2=0.9923 **Langmuir:** q_m=25.91 mg g^{-1} As(III) k_L=0.07 L mg^{-1} R^2=0.9905 q_m=9.01 mg g^{-1} Pb(II) k_L=0.01 L mg^{-1} R^2=0.9932 q_m=25.84 mg g^{-1} Cd(II) k_L=0.08 L mg^{-1} R^2=0.9949 **Freundlich:** k_F=0.24 L mg^{-1} As(III) n=3.31 R^2=0.9861 k_F=2.10 L mg^{-1} Pb(II) n=1.58 R^2=0.988 k_F=0.29 L mg^{-1} Cd(II) n=5.60 R^2=0.8756 **Adsorption capacities:** 98.8 Pb(II) 46.0 Cd(II) 48.2 As(III) Contact time=2 h	
					As(III) Pb(II) Cd(II) simultaneous	C_0(As(III))=129 g L^{-1} C_0(Pb(II))= 0.9 g L^{-1} C_0(Pb(II))= 0.9 g L^{-1} t_e= 20 min	-	T=27 °C pH=5.5 dose=5 g L^{-1}	Cl^- (28.6 mg L^{-1}) NO_3^- (1.5 mg L^{-1}) PO_4^{3-}(3 mg L^{-1}) SO_4^{2-}(3.5 mg L^{-1}) Ca^{2+}(49.1 mg L^{-1}) Mg^{2+}(16.6 mg L^{-1}) Na^+(105 mg L^{-1}) K^+(1.04 mg L^{-1})	Removal>95% As(III) Removal<5% Pb(II) Removal<2.5% Cd(II)	
Fe_3O_4/nOG	Obtained by physical exfoliation method using thermal treatment at	TEM: 5-9 nm Fe_3O_4	189.94 m^2 g^{-1}	-	As(III) As(V)	C_0(As(III))=1 mg L^{-1} C_0(As(V))=1 mg L^{-1}	-	T=25 °C pH=7 dose=0.1 g L^{-1}		**Pseudo-second order:** q_e=5.18 mg g^{-1} As(III) k_2=0.0031 g mg^{-1} min^{-1} R^2=0.998 q_e=3.84 mg g^{-1} As(V) k_2=0.0098 g mg^{-1} min^{-1} R^2=0.999 **Langmuir:**	[96]

600 °C for 1 h						q_m=24.6 mg g^{-1} As(III) k_L=0.6 L mg^{-1} R^2=0.856 q_m=9.44 mg g^{-1} As(V) k_L=0.78 L mg^{-1} R^2=0.767 **Freundlich:** k_F=7.49 mg g^{-1} (L mg^{-1})$^{1/n}$ As(III) n=3.45 R^2=0.974 k_F=3.82 mg g^{-1} (L mg^{-1})$^{1/n}$ As(V) n=4.76 R^2=0.981 **Maximum adsorption capacity:** 38 mg L^{-1} As(III) 14 mg L^{-1} As(V)
					-	
As(III) As(V)	C_0(As(III))=5 mg L^{-1} C_0(As(V))=5 mg L^{-1} t_e= 24 h	-	T=25 °C pH=7 dose=0.1 g L^{-1}	-		**Adsorption capacities:** 11.3 mg g^{-1} As(III) 5.5 mg g^{-1} As(V) control without competitive anion
As(III) As(V)	C_0(As(III))=5 mg L^{-1} C_0(As(V))=5 mg L^{-1} t_e= 24 h	-	T=25 °C pH=7 dose=0.1 g L^{-1}	Cl^- (1 mmol L^{-1}) NO_3^- (1 mmol L^{-1}) HCO_3^-(1 mmol L^{-1})		Adsorption capacities<11 mg g^{-1} As(III) Adsorption capacities<5.5 mg g^{-1} As(V) 94-98% compared to the control
As(III) As(V)	C_0(As(III))=5 mg L^{-1} C_0(As(V))=5 mg L^{-1} t_e= 24 h	-	T=27 °C pH=7 dose=0.1 g L^{-1}	SO_4^{2-}(1 mmol L^{-1})		Adsorption capacities<8 mg g^{-1} As(III) Adsorption capacities<4 mg g^{-1} As(V) 65–72% compared to the control
As(III) As(V)	C_0(As(III))=5 mg L^{-1} C_0(As(V))=5 mg L^{-1} t_e= 24 h	-	T=25 °C pH=7 dose=0.1 g L^{-1}	PO_4^{3-}(1 mmol L^{-1})		Adsorption capacities<3.8 mg g^{-1} As(III) Adsorption capacities<3 mg g^{-1} As(V) 31% As(III) 52% As(V) compared to the control

					As(III) As(V)	C_0(As(III))=5 mg L^{-1} C_0(As(V))=5 mg L^{-1} t_e= 24 h	-	T=25 °C pH=7 dose=0.1 g L^{-1}	HA (1 mg L^{-1})	Adsorption capacities=8 mg g^{-1} As(III) Adsorption capacities=5 mg g^{-1} As(V)	
Fe_3O_4@sand	Coprecipitation	FESEM: 20-60 nm size of Fe_3O_4 NPs	-	-	As(V)	C_0=100 mg L^{-1} t_e= 330 min	1 – 15.35 mg L^{-1}	T=30 °C pH=2-7 dose=1 g L^{-1}	Cr^{3+}(100 mg L^{-1}) Mg^{2+}(100 mg L^{-1}) Ni^{2+}(100 mg L^{-1}) Pb^{2+}(100 mg L^{-1}) Cd^{2+}(100 mg L^{-1}) Zn^{2+}(100 mg L^{-1}) Fe^{3+}(100 mg L^{-1})	**Pseudo-second order:** q_e=0.0406 mg g^{-1} k_2=3.754 g mg^{-1} min^{-1} R^2=0.990 **Langmuir:** q_m=0.639 mg g^{-1} k_L=216.99 L mg^{-1} R^2=0.993 **Freundlich:** k_F=2.065 mg g^{-1} n=2.39 R^2=0.984 **Adsorption capacities:** 2.06 mg g^{-1} As(V) 94%< As(V)<99% Effect removal efficiency Cr^{3+}> Mg^{2+}> Ni^{2+}> Pb^{2+}> Cd^{2+}>Zn^{2+} >Fe^{3+} Contact time: 420 min	[97]
PAN/GO/γ-Fe_2O_3	Electrospinning technique	TEM: 6-10 nm γ-Fe_2O_3 PAN diameter: 250-400 nm	30.24 m^2 g^{-1}	3.90 emu g^{-1}	As(V)	C_0=5 mg L^{-1} t_e= 90 min	1 - 50 mg L^{-1}	T=30 °C pH=4 dose=0.6 g L^{-1}	-	**Pseudo-second order:** q_e=8.904 mg g^{-1} k_2=0.006 g mg^{-1} min^{-1} R^2=0.9933 **Langmuir:** q_m=36.1 mg g^{-1} k_L=0.62 L g^{-1} R^2=0.9947 **Freundlich:** k_F=2.76 mg g^{-1} n=2.27 R^2=0.9393 **Adsorption capacities:** $q_{e,exp}$=7.95 mg g^{-1} 95.72% Contact time: 2 h **Maximum adsorption capacity:** 36.1 mg g^{-1}	[98]

					As(V)	C_0=5 mg L^{-1} t_e= 90 min	-	T=30 °C pH=4 dose=0.6 g L^{-1}	Cl^- NO_3^- SO_4^{2-}	Adsorption capacities=7.95 mg g^{-1}
					As(V)	C_0=5 mg L^{-1} t_e= 90 min	-	T=30 °C pH=4 dose=0.6 g L^{-1}-	PO_4^{3-}	Adsorption capacities< 5 mg g^{-1}

Table S3. Lead, other metals, and pollutants adsorption parameters for magnetic nanohybrids.

Adsorbent	Synthesis method	Size and shape	Surface area	Saturation magnetization	Adsorbates	Initial concentration (C_0) and equilibrium time (t_e)	Concentration range in isotherm experiments	Adsorption conditions	Kinetic and isothermal parameters	Ref.
$\gamma - Fe_20_3 - 1$	Co-precipitation	TEM: 4 - 10nm	77.5-214 m^2 g^{-1}	12 – 62 emu g^{-1}	Pb(II)	C_0=50 mg L^{-1} t_e=7 h	0–50 mg L^{-1}	T=25 °C pH=7 dose=0.56 g L^{-1}	**Langmuir:** q_m=57.3-88.2 mg g^{-1}	[43]
					Cu(II)	C_0=40 mg L^{-1} t_e=7 h				
$\gamma - Fe_20_3 - 2$		XRD: 7.1 nm								
$\gamma - Fe_20_3@SiO_2$		XRD: 10 nm								
$\gamma - Fe_20_3 - SBA15$		XRD: 6.2 nm								
$\gamma - Fe_20_3@OA$		XRD: 5.9 nm								
$\gamma - Fe_20_3@LA$		XRD: 4.5 nm								
$\gamma - Fe_20_3@L - arg$		XRD: 5.9 nm								
$\gamma - Fe_20_3@HAp$		XRD: 8.0 nm								
$\gamma - Fe_20_3 - EDTA1$		XRD: 3.0 nm								
$\gamma - Fe_20_3@MWCNTs$		XRD: 7.3 nm								

Fe_3O_4	Co-precipitation	TEM: 8-13 nm-spherical	-	-	Pb(II)	C_0=50 mg L^{-1} t_e=25 min	10-50 mg L^{-1}	T=25 °C pH=5.0 dose=0.02 g L^{-1}	**Pseudo- First order:** k_1=0.053 g mg^{-1} h^{-1} R^2=0.0184 **Pseudo Second order:** k_2=0.05 g mg^{-1} h^{-1} R^2=0.99387	[106]
$\gamma - Fe_2O_3 - EDTA1$ $\gamma - Fe_2O_3 - EDTA2$ $\gamma - Fe_2O_3 - EDTA3$	Co-precipitation	TEM: 4 nm $\gamma - Fe_2O_3 - EDTA1$ TEM: ~7.6 nm $\gamma - Fe_2O_3 - EDTA2$ TEM: ~7 nm $\gamma - Fe_2O_3 - EDTA2$	272 m^2g^{-1}	16.3 emu g^{-1}	Pb(II)	C_0=50 mg L^{-1} t_e=7 h	0–50 mg L^{-1}	T=70 °C, 80 °C pH=5.5 dose=0.5 g L^{-1}	-	[30]
Fe_3O_4	Co-precipitation	TEM: 8-13 nm	12.7 m^2 g^{-1}	65.3-75.8 emu g^{-1}	Pb(II) Cr(II)	C_0=25,50,100 mg L^{-1} t_e=3 h	-	T=25 °C, 35 °C, 45 °C, pH=5.0 dose=0.2 g L^{-1} T=25 °C, 35 °C, 45 °C, pH=2.0, dose=0.1 g L^{-1}	**Langmuir:** q_m=52.9 mg g^{-1} (25 °C) q_m=52.8 mg g^{-1} (35 °C) q_m=53.2 mg g^{-1} (45 °C) R^2=0.955-0.981 **Langmuir:** q_m=20.2 mg g^{-1} (25 °C) q_m=26.8 mg g^{-1} (35 °C) q_m=34.9 mg g^{-1} (45 °C)	[107]
GFMNPECABs	Co-precipitation	-	-	1.7 emu g^{-1}	Pb(II)	C_0=10-80 mg L^{-1} t_e=100 min	10-80 mg L^{-1}	T=40 °C, 50 °C, 60 °C, pH=6.0, dose=10 g L^{-1}	**Langmuir:** q_m=473.9 mg g^{-1} (40 °C) R^2=0.993 (40 °C) k_L=0.0011 L mg^{-1} (40 °C) q_m =555.5 mg g^{-1} (50 °C) R^2=0.998 (50 °C) k_L=0.0016 L mg^{-1} (50 °C) q_m =555.5 mg g^{-1} (60 °C) R^2=0.998 (60 °C) k_L=0.0016 L mg^{-1} (60 °C) **Freundlich:** k_F=2.139 L mg^{-1} (40 °C) R^2=0.953 (40 °C) k_F=2.280 L mg^{-1} (50 °C) R^2=0.968 (50 °C)	[108]

									k_F=2.917 L mg^{-1} (60 °C) R^2=0.973 (60 °C) **Temkin:** K_t=5.150 L mg^{-1} (40 °C) R^2=0.919 (40 °C) K_t=5.340 L m^{-1} g^{-1} (50 °C) R^2=0.940 (50 °C)	
L-Cyst-Fe_3O_4	Co-precipitation	XRD: 15 nm	-	-	Pb(II)	C_0=50 mg L^{-1} t_e=1 h	10-100 mg L^{-1}	T=25 °C, 35 °C, 45 °C, pH=6.0, dose=2.0 g L^{-1}	K_t=10.39 L mg^{-1} (60 °C) R^2=0.940 (60 °C) **Langmuir:** q_e=18.8 mg g^{-1} q_m=7.00 mg g^{-1} (25 °C) q_m=11.6 mg g^{-1} (35 °C) q_m=18.8 mg g^{-1} (45 °C)	[109]
					Cr(VI)			T=25 °C,, 35 °C, 45 °C, dose=2.0 g L^{-1}, pH=2.0	**Langmuir:** q_e=34.5 mg g^{-1} q_m=11.6 mg g^{-1} (25 °C) q_m=23.5 mg g^{-1} (35 °C) q_m=34.5 mg g^{-1} (45 °C)	
					Pb(II)			T=25 °C, 35 °C, 45 °C, pH=6.0, dose=2.0 g L^{-1}	**Freundlich:** k_F=19.16 mg g^{-1} (25 °C) k_F=23.88 mg g^{-1} (35 °C) k_F=31.19 mg g^{-1} (45 °C)	
					Cr(VI)			T=25 °C, 35 °C, 45 °C, pH=2.0, dose=2.0 g L^{-1}	**Freundlich:** k_F=25.98 mg g^{-1} (25 °C) k_F=30.27 mg g^{-1} (35 °C) k_F=41.05 mg g^{-1} (45 °C)	
Fe_3O_4-NH_2	Solvent thermal	TEM: 100 nm	-	80 emu g^{-1}	Pb(II)	C_0=25, 35, 45 mg L^{-1}	30-300 mg L^{-1}	T=25 °C, 35 °C, 45 °C, pH=5.5	**Langmuir:** q_m=257 mg g^{-1}	[110]
					Cd(II)				**Langmuir:** q_m=129.5 mg g^{-1}	

Fe_3O_4	-	TEM: 260 nm	-	69.4 emu g^{-1}	Pb(II)	C_0=10 mg L^{-1} t_e=3 h	0-80 mg L^{-1}	T=25 °C, 40 °C, 55 °C, pH=5.0, dose=0.2 g L^{-1}	**Langmuir:** q_e=41.04 mg g^{-1} (25 °C) q_e=46.69 mg g^{-1} (40 °C) q_e= 55.84 mg g^{-1} (55 °C) **Freundlich:** k_F=18.28 $mL^{1/n}$ $\mu g^{1-1/n}$ (25 °C) k_F=19.44 $mL^{1/n}$ $\mu g^{1-1/n}$ (40 °C) k_F=20.58 $mL^{1/n}$ $\mu g^{1-1/n}$ (55 °C)	[111]
					Cu(II)		0-70 mg L^{-1}	T=25 °C, 40 °C, 55 °C, pH=6.0, dose=0.2 g L^{-1}	**Langmuir:** q_e=21.14 mg g^{-1} (25 °C) q_e=31.92 mg g^{-1} (40 °C) q_e=42.85 mg g^{-1} (55 °C) **Freundlich:** k_F=2.32 $mL^{1/n}$ $\mu g^{1-1/n}$ (25 °C) k_F=3.65 $mL^{1/n}$ $\mu g^{1-1/n}$ (40 °C) k_F=4.16 $mL^{1/n}$ $\mu g^{1-1/n}$ (55 °C)	
Fe_3O_4@PDA	-	TEM: 260-300 nm	-	49 emu g^{-1}	Pb(II)	C_0=10 mg L^{-1} t_e=3 h	0-70 mg L^{-1}	T=25 °C, 40 °C, 55 °C, pH=5.0, dose=0.2 g L^{-1}	**Langmuir:** q =57.25 mg g^{-1} (25 °C) q_e=71.08 mg g^{-1} (40 °C) q_e=101.96 mg g^{-1} (55 °C) **Freundlich:** k_F=28.43 $mL^{1/n}$ $\mu g^{1-1/n}$ (25 °C) k_F=36.19 $mL^{1/n}$ $\mu g^{1-1/n}$ (40 °C) k_F=41.96 $mL^{1/n}$ $\mu g^{1-1/n}$ (55 °C)	[111]
					Cu(II)		0-70 mg L^{-1}	T=25 °C, 40 °C, 55°C, pH=6.0, dose=0.2 g L^{-1}	**Langmuir:** q_e=86.35 mg g^{-1} (25 °C) q_e=104.81 mg g^{-1} (40 °C) q_e=112.48 mg g^{-1} (55 °C) **Freundlich:** k_F= 22.35 $mL^{1/n}$ $\mu g^{1-1/n}$ (25 °C) k_F=24.73 $mL^{1/n}$ $\mu g^{1-1/n}$ (40 °C) k_F=30.88 $mL^{1/n}$ $\mu g^{1-1/n}$ (55 °C)	

Fe_3O_4	-	-	-	-	Pb(II) Cd(II)	C_0=100 mg L^{-1} t_e=20 min	50-200 mg L^{-1}	T=25 °C, pH=5.5, dose=5.0 g L^{-1}	**Langmuir:** q_m=13.88 mg g^{-1} Pb(II) q_m=9.52 mg g^{-1} Cd(II) **Freundlich** k_F=2.99 L g^{-1} Pb(II) k_F =3.46 L g^{-1} Cd(II) **Dubinbin–Radushkevich:** q_{mDR}=12.88 mg g^{-1} Pb(II) q_{mDR}=10.07 mg g^{-1} Cd(II) **Pseudo- First order:** q_e=3.45 mg g^{-1} Pb(II) k_1=0.274 g mg^{-1} h^{-1} q_e=6.48 mg g^{-1} Cd(II) k_1=0.213 g mg^{-1} h^{-1} **Pseudo Second order:** q_e=11.11 mg g^{-1} Pb(II) k_2=0.090 g mg^{-1} h^{-1} q_e=10.6 mg g^{-1} Cd(II) k_2=0.214 g mg^{-1} h^{-1}	[112]
Fe_3O_4-ETT	Via epoxide ring opening reaction	FESEM: 25-52 nm TEM: spherical, mesoporous NPs	84.8 m^2 g^{-1}	30.7 emu g^{-1}	Pb(II)	C_0=50 mg L^{-1} t_e=20 min	-	T=19.85 °C, pH=5, dose=5 g L^{-1}	**Pseudo second order:** q_e= 28.98 mg g^{-1} k_2= 0.047 g mg^{-1} min^{-1} R^2 =0.9985 **Langmuir:** q_m= 21.05 mg g^{-1} k_L= 0.675 L mg^{-1} R^2 = 0.9729 **Freundlich:** k_F= 28.98 n=7.25 R^2= 0.9911 **Experimental:** $q_{e,\,exp}$= 39.7 mg g^{-1}	[113]
Fe_3O_4-PEI/β-CD	solvothermal method	TEM: spherical particle	17.5 m^2 g^{-1}	60.3 emu g^{-1}	Pb(II)	C_0=100 mg L^{-1} t_e=200 min	10 to 100 mg L^{-1}	T=30 °C pH=6 dose=0.5 g L^{-1}	**Pseudo Second order:** q_e= 40.0 mg g^{-1} k_2= 0.0009 g mg^{-1} h^{-1} R^2=0.924 **Langmuir:** q_m= 73.1 mg g^{-1} k_L= 0.021 L mg^{-1} R^2=0.98 **Freundlich:** k_F=3.6 n=1.7 R^2=0.97	[114]

					methyl orange (MO)	C_0=100 mg L^{-1} t_e=100 min	25-200 mg L^{-1}	T=30 °C pH=3 dose=0.5 g L^{-1}	**Pseudo Second order:** q_e=131.1 mg g^{-1} k_2=0.0018 g mg^{-1} h^{-1} R^2=0.977 **Langmuir:** q_m=192.2 mg g^{-1} k_L=0.178 L mg^{-1} R^2=0.97	
					methyl orange (MO) Pb(II)	C_0(MO)=100 mg L^{-1} C_0(Pb)=50 mg L^{-1}	Pb(II) 10-50 MO 30 and 60 mg L^{-1}	T=30 °C pH=6	MO removal efficiencies=95.4 % Pb(II) removal efficiencies=82.9 % Maximum adsorption capacity Pb(II)=285.3 mg g^{-1}	
Fe_3O_4@SiO_2@PEI-NTDA	Fe_30_4 (Solvothermal method)	TEM: 200 -300 nm SEM: spherical particles	-	21.6 emu g^{-1}	Pb(II)	C_0=200 mg L^{-1} t_e=200 min	-	T=25 °C pH=6 dose=0.5 g L^{-1}	Maximum adsorption capacity Cd(II)=48.2 mg g^{-1} **Pseudo-second order:** q_e=277.7 mg g^{-1} k_2=0.00360 g mg^{-1} min^{-1} R^2=0.996 **Langmuir:** q_m=286.9 mg g^{-1} k_L=0.0786 L mg^{-1} R^2=0.999 **Freundlich:** k_F=74.77 mg g^{-1} n=4.20 R^2=0.756	[115]
Fe_3O_4-g- C_3N_4	Ultrasonic method Fe_3O_4 (precipitation)	SEM: 500 nm-2µm lamellar structure	-	8.4 emu g^{-1}	Pb(II)	C_0=200 mg L^{-1} t_e=20 min	40-240 mg L^{-1}	T=25 °C pH=6 dose=1 g L^{-1}	**Pseudo-second order:** q_e=103.47 mg g^{-1} k_2=0.0068 g mg^{-1} min^{-1} R^2= 0.9996 **Langmuir:** q_m=189.36 mg g^{-1} k_L=0.0059 L mg^{-1} R^2=0.998	[116]

Fe_3O_4-SO_3H	The modified Sto¨ber sol–gel process	SEM: 80 nm	18.3 $m^2 g^{-1}$	69 emu g^{-1}	Pb(II)	C_0=10 mg L^{-1} t_e=12 h	-	pH=7 dose=1 g L^{-1}	**Freundlich:** k_F=3.66 mg g^{-1} n=1.57 R^2= 0.982 maximum adsorption capacity: 80.9 mg g^{-1} **Pseudo-second order:** q_e=9.69 mg g^{-1} K_2=0.095 g mg^{-1} min^{-1} R^2=1 **Langmuir:** q_m=108.93 mg g^{-1} k_L= 0.373 L mg^{-1} R^2 =0.998 Adsorption capacities:166.1 mg g^{-1}	[117]
Fe_3O_4@APS Fe_3O_4@ APS@AA-co-CA	Coprecipitation method	TEM: 15-20 nm	-	79 emu g^{-1} 67 emu g^{-1} 52 emu g^{-1}	Pb(II)	C_0=100 mg L^{-1} t_e=45 min	-	pH=5.5 dose=0.05 g L^{-1}	**Second order:** q_e=78.8 mg g^{-1} K_2=0.0057 g mg^{-1} min R^2=0.9968 **Langmuir:** q_m=166.1 mg g^{-1} k_L=0.1379 L mg^{-1} R^2=0.9992 maximum adsorption capacity: 65.40 mg g^{-1}	[118]
CNTs/ Fe_3O_4 MPTS-CNTs/ Fe_3O_4	Thermal decomposition	TEM: 6 nm	88.4 $m^2 g^{-1}$ 97.2 $m^2 g^{-1}$	22.9 emu g^{-1} 29 emu g^{-1}	Pb(II)	C_0=50 mg L^{-1}	5–90 mg L^{-1}	pH=6.5 dose=1 g L^{-1}	**Pseudo-second order** q_e=48.28 mg g^{-1} K_2=0.0131 g mg^{-1} min R^2=0.9826 **Langmuir** q_m=65.40 mg g^{-1} k_L=0.0453 L mg^{-1} R^2=0.9935	[119]
Fe_3O_4@C@TiO_2 (0FeCTi)	Oil - phase cyclic magnetic adsorption (OCMA) method	BET: pore size adsorption=19.34 nm desorption=16.56 nm nanotubes	37 $m^2 g^{-1}$	-	Pb(II) Rhodamine B (RhB) simultaneous	C_0=100 mL mixed polluted water containing 2 mg Pb(II) 2 mg Rhb t_e=3 h	-	T=25 °C pH=7 dose=1 g L^{-1}	**Pseudo-first order model:** **Pb(II)** k_1=0.048 min^{-1} R^2=0.9874	[120]
Fe_3O_4@C@TiO_2 (1FeCTi)	Oil - phase cyclic magnetic adsorption (OCMA) method	BET: pore size adsorption=16.66 nm desorption=13.46 nm nanotubes	41.7 $m^2 g^{-1}$	2.1 emu g^{-1}	Pb(II) Rhodamine B (RhB) simultaneous	C_0=100 mL mixed polluted water containing 2 mg Pb(II) 2 mg Rhb t_e=3 h	-	T=25 °C pH=7 dose=1 g L^{-1}	Removal rate: 98% RhB, 92% Pb **Pseudo-first order model:** **Pb(II)** k_1=0.027 min^{-1} R^2=0.9991 **Adsorption--reaction model:**	

Fe_3O_4@C@TiO_2 (3FeCTi)	Oil - phase cyclic magnetic adsorption (OCMA) method	BET: pore size adsorption=16.08 nm desorption=8.66 nm nanotubes	50.3 $m^2 g^{-1}$	3.9 emu g^{-1}	Pb(II) Rhodamine B (RhB) simultaneous	C_0=100 mL mixed polluted water containing 2 mg Pb(II) 2 mg Rhb t_e=3 h	-	T=25 °C pH=7 dose=1 g L^{-1}	**Pb(II)** R^2=0.9766 **Pseudo-first order model:** **Pb(II)** k_1=0.023 min^{-1} R^2=0.9590 **Adsorption-reaction model:** **Pb(II)** R^2=0.9980 sonication time: 20 min	
Fe_3O_4 -$FeMoS_4$-MgAl-LDH	precipitation	FE-SEM: 35 nm SEM: layered morphology with often hexagonal crystal shape	-		60 emu g^{-1}	Pb(II) Cd(II) Cu(II) simultaneous	C_0(Pb(II))=20 mg L^{-1} C_0(Cd(II))=20 mg L^{-1} C_0(Cu(II))=20 mg L^{-1} t_e=60 min	10-300 mg L^{-1}	T=25 °C pH=5 dose=1.5 g L^{-1}	**For Pb(II)** **Pseudo-second order:** q_e=114.84 mg g^{-1} k_2= 0.0027 min^{-1} R^2=0.999 **Experimental:** q_e= 190.75 mg g^{-1} **Langmuir:** q_m=188.84 mg g^{-1} k_L =0.0546 L mg^{-1} R^2=0.9861 **Freundlich:** k_F=2.363 L mg^{-1} n=1.585 R^2=0.9106	[121]
SH-mSi@ Fe_3O_4	Modified Stöber method	SEM and TEM: 500 nm	321	$m^2 g^{-1}$	38.4 emu g^{-1}	Pb(II)	C_0=0-0.6 mg L^{-1} t_e=20 min	-	dose= 0.01 g L^{-1} pH=6.5	**Pseudo second order:** K_2: 0.430 g $mmol^{-1}$ min **Langmuir:** q_m :0.442 mmol g^{-1} k_L: 22.3 L $mmol^{-1}$ R^2=0.999	[122]
mHAP-oMWCNTs	Fe_30_4(Hydrothermal method)	SEM: spindly tubular structure with the average tube size of ~40 nm mHAP-oMWCNTs had the cylinder structure with opens at both ends.	212	$m^2 g^{-1}$	33 emu g^{-1}	Pb(II)	C_0=100 mg L^{-1} t_e=40 min	40–200 mg L^{-1}	T=25 °C pH=4.1 dose=0.1 g L^{-1}	**Pseudo-second order:** q_e = 472.84 mg g^{-1} k_2 = 0.1424 mg min g^{-1} R^2=0.9996 **Freundlich:** k_F= 502.2 mg g^{-1} n=2.42 R^2= 0.9204 **Langmuir:** q_m=681.2 mg g^{-1} k_L=2.599 L mg^{-1} R^2= 0.998	