COMPARATIVE ADSORPTION STUDIES OF NI (II) IONS ON MAGNETIC-CHITOSAN GRAFTED (ALKYL ACRYLATE) COMPOSITE PARTICLES

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Introduction/motivation

Heavy metals

→ are toxic to human health;

→ mainly produced by industrial activities;

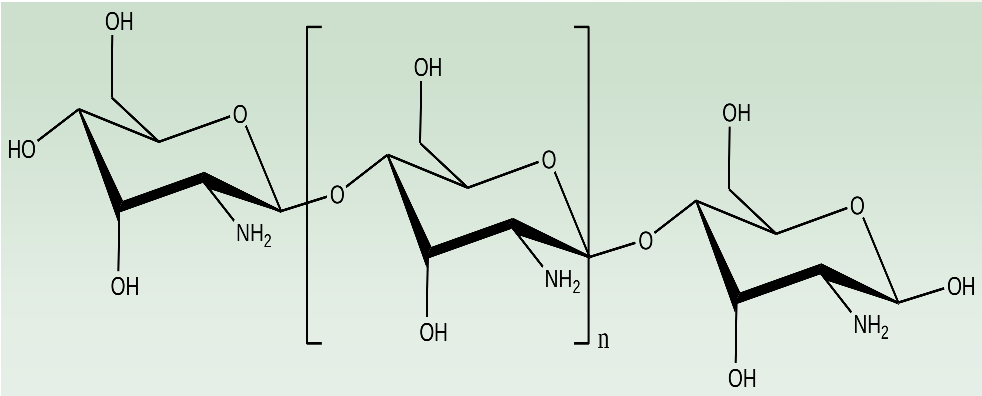
Removal of heavy metals

→ chemical precipitation, membrane filtration, coagulation and flocculation, electrochemical methods, **adsorption;**

Magnetic adsorbents

→ magnetic iron oxide particles, magnetic nanocomposite adsorbents with polymeric supports, magnetic composites containing agricultural waste;

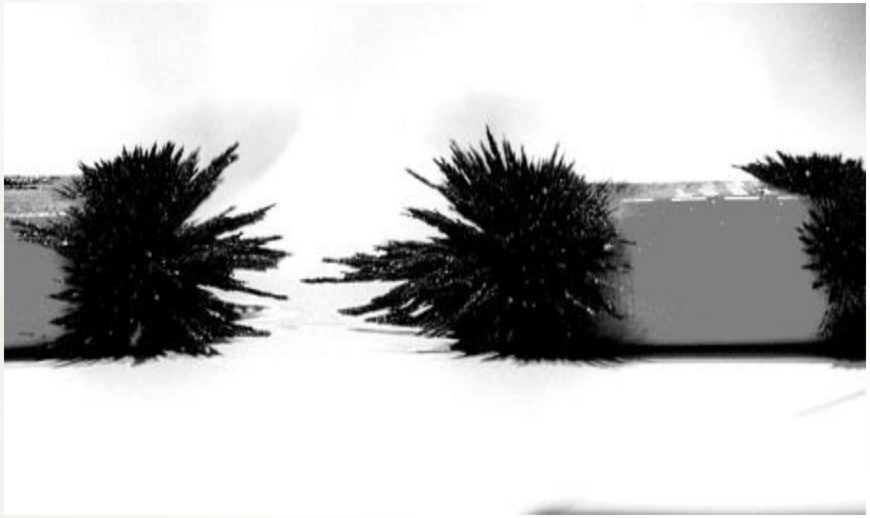
Introduction/motivation



Chitosan → *readily available, inexpensive, biodegradable*

Novel Magnetic

Adsorbent Materials



Magnetite → *excellent way to resolve separation problems*

Objectives and Outline

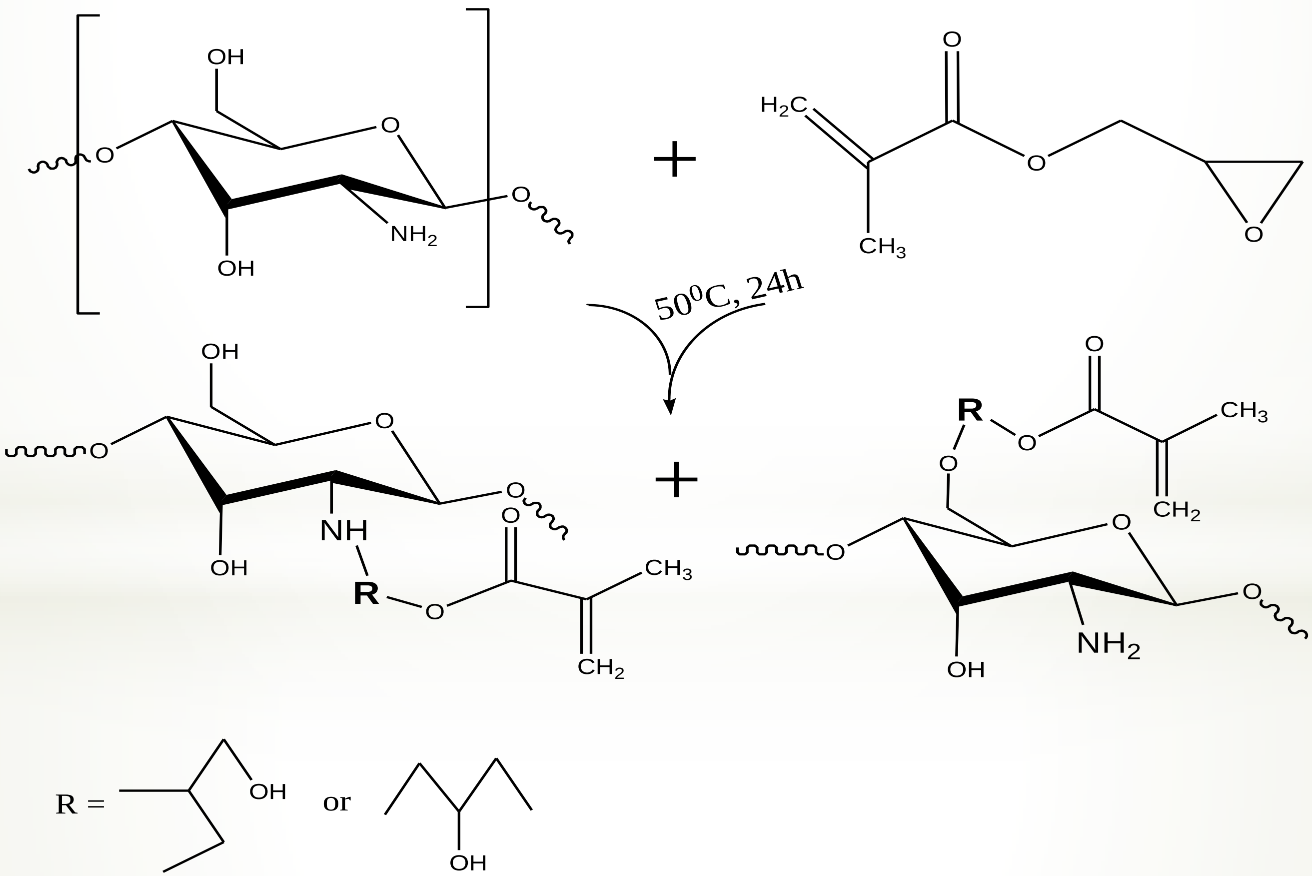
Main objective: Prepare magnetic chitosan grafted alkyl acrylate derivatives composite particles as a novel magnetic adsorbent material.

- Composite particles synthesis
- Characterization
- Sorption Experiments
- Desorption and Regeneration Studies
- Conclusions and future work

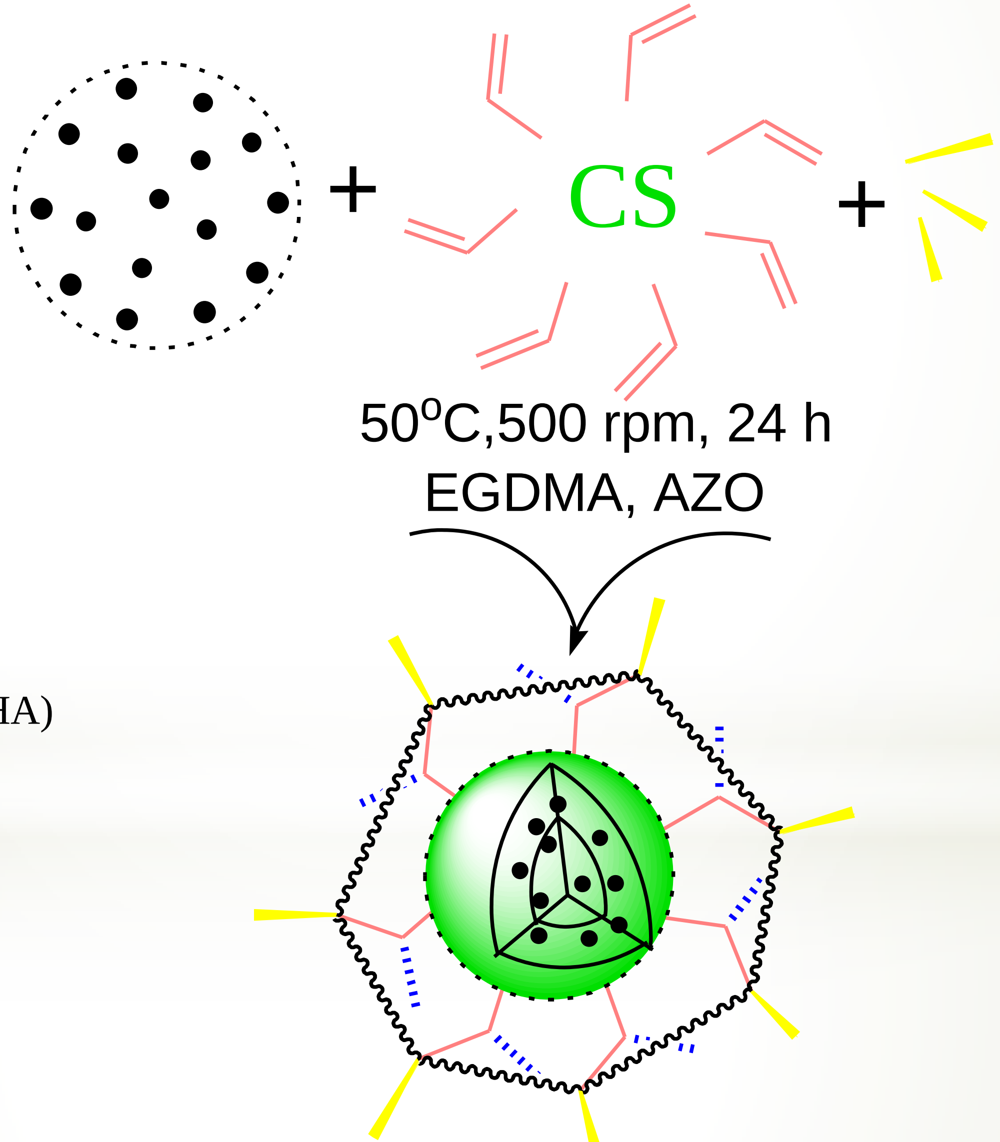
Magnetite nanoparticles preparation

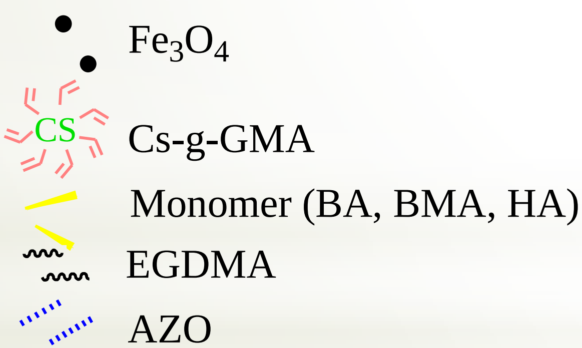
$$Fe^{2+} + 2Fe^{3+} + 8HO^{-} = Fe_3O_4 + 4H_2O$$

Synthesis of chitosan grafted with GMA (CS)



Composite particles synthesis





TEM

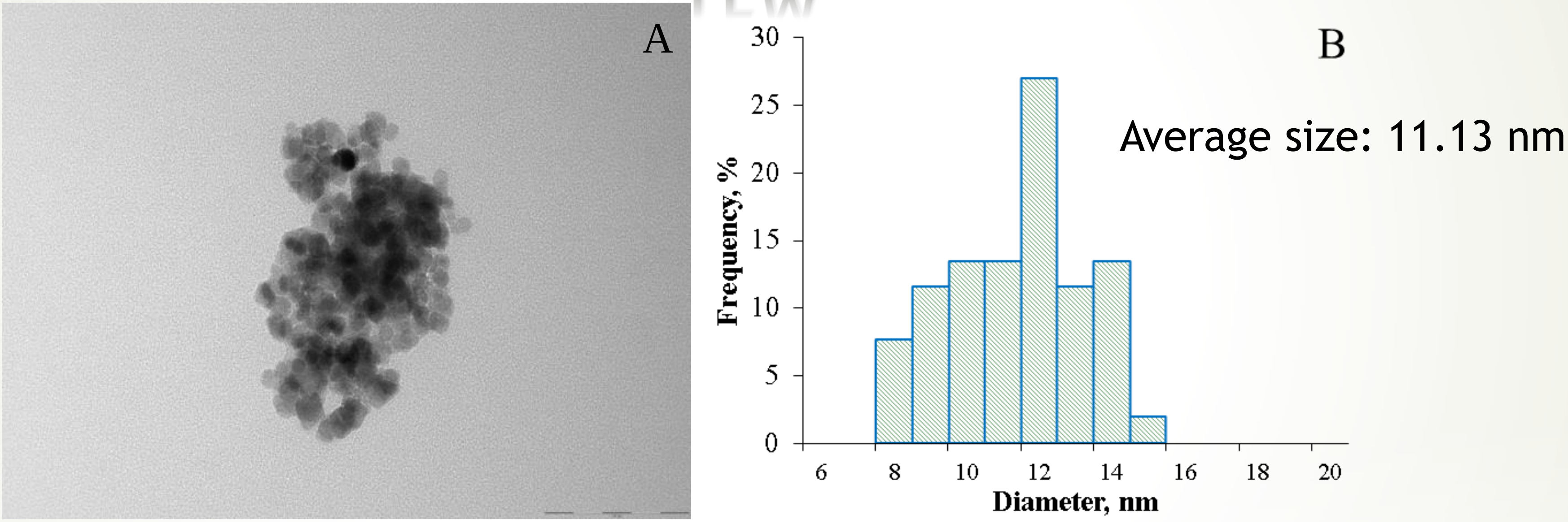


Figure 1. TEM picture (A) and size distribution histogram (B) of Fe_3O_4-CS-BMA

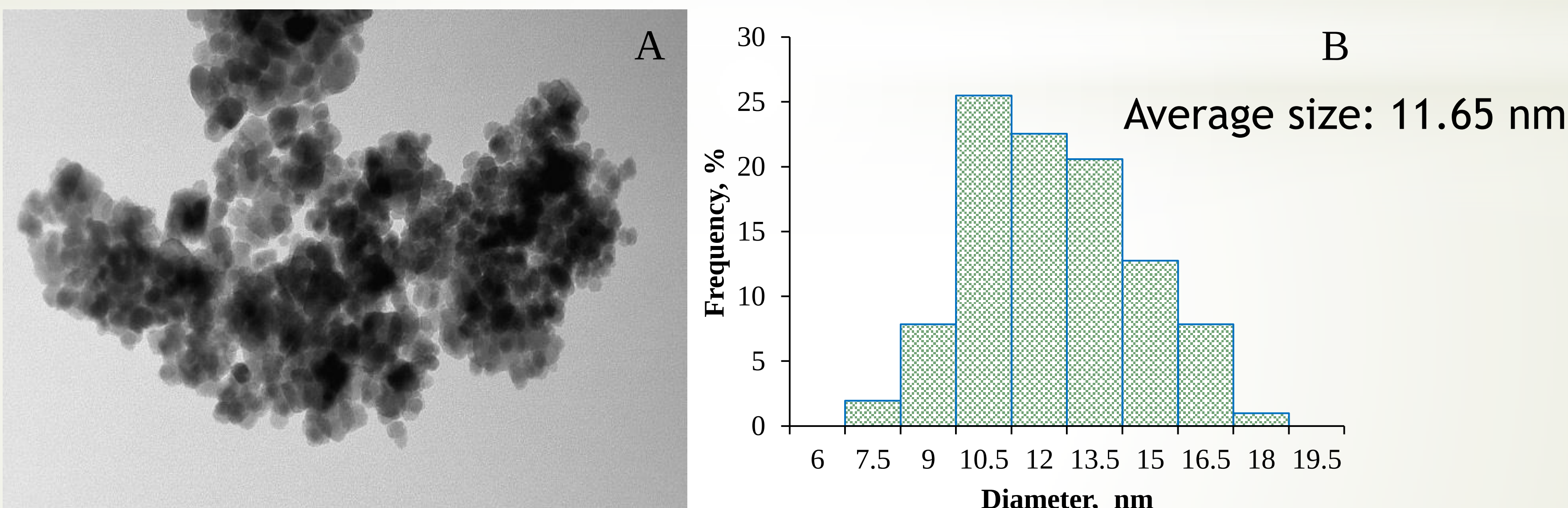
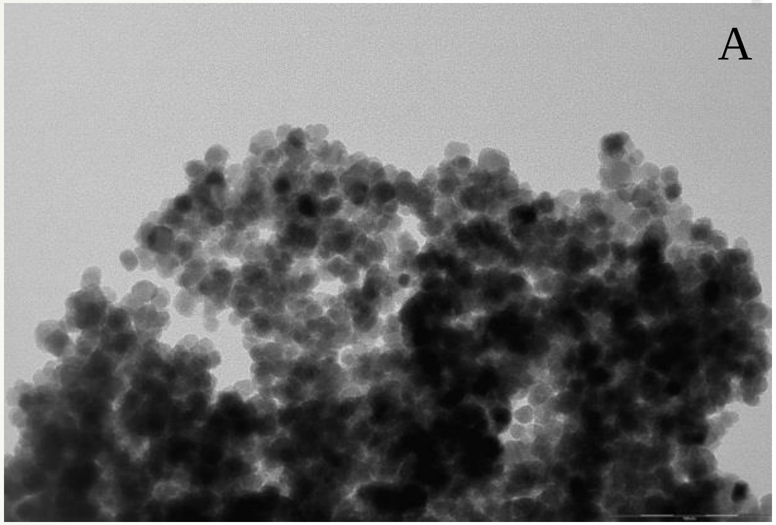


Figure 2. TEM picture (A) and size distribution histogram (B) of Fe_3O_4-CS-BA

TEM



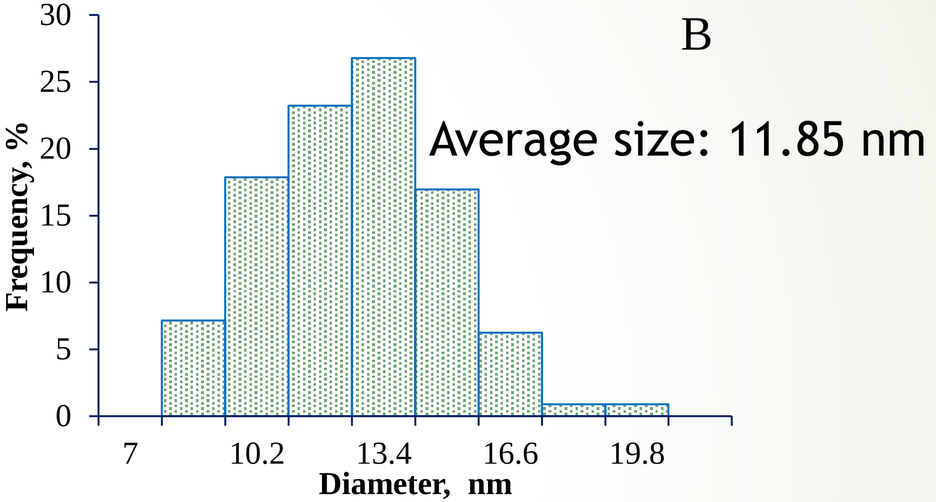
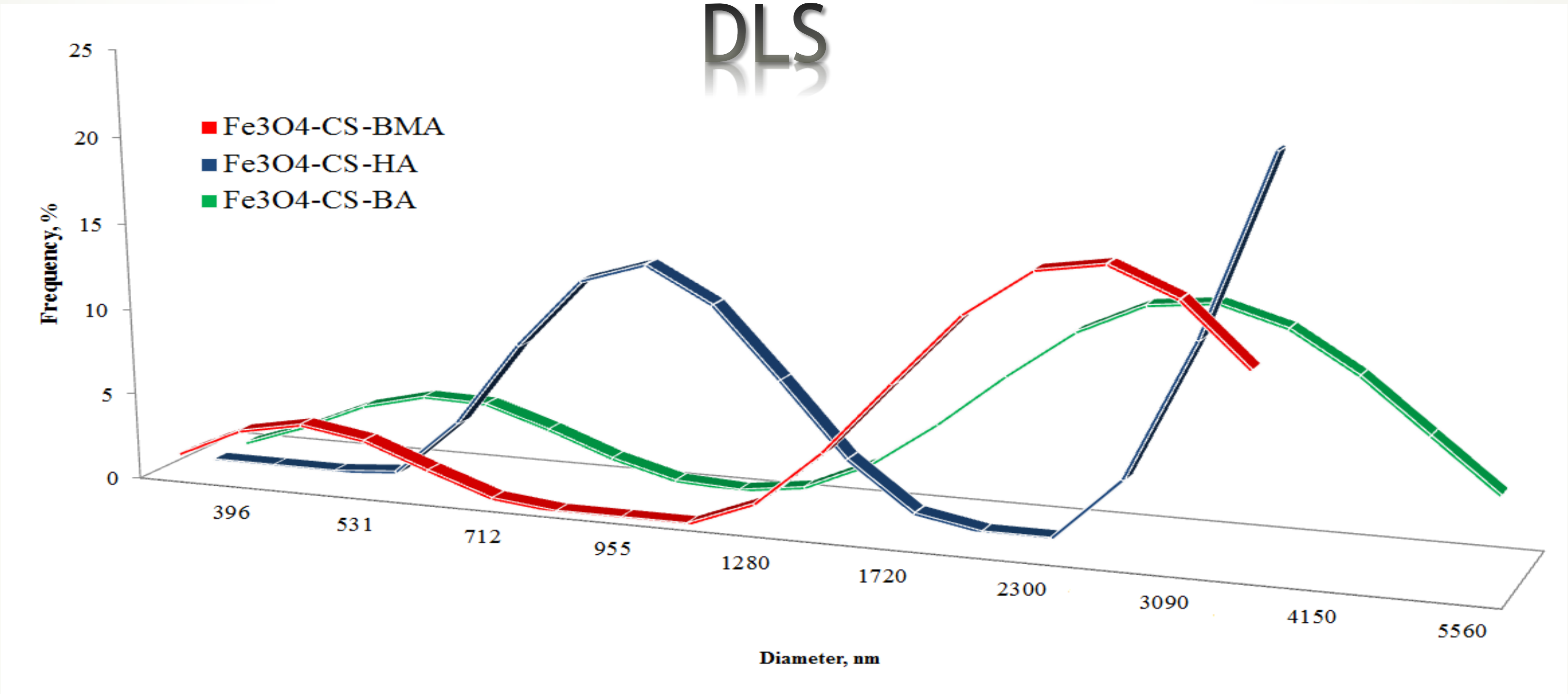
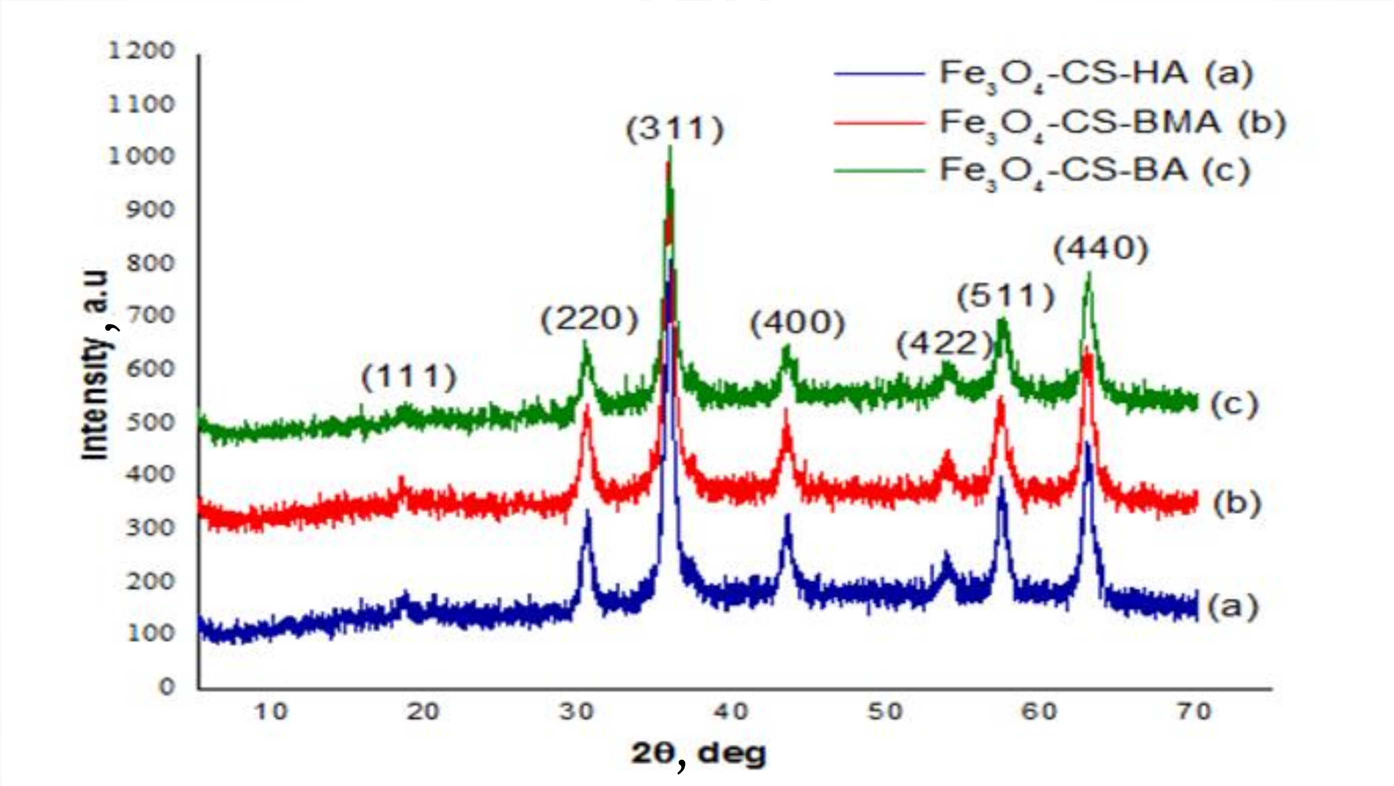


Figure 3. TEM picture (A) and size distribution histogram (B) of Fe_3O_4-CS-HA

DLS

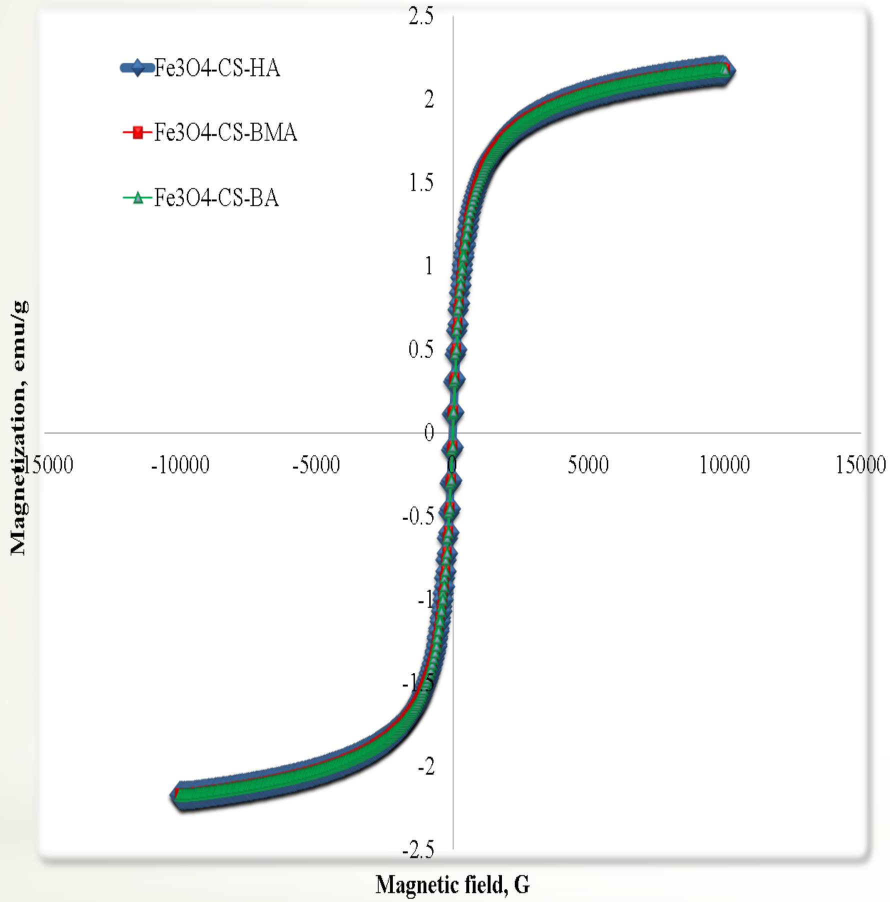


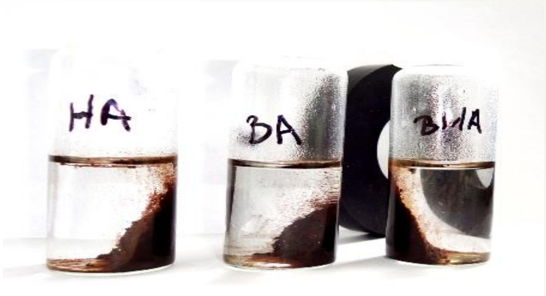
XRD



Material	Average size (TEM) (nm)	Size (XRD) (nm)
Fe_3O_4-CS-HA	11.84	10.8
Fe_3O_4-CS-BMA	9.84	11.3
Fe_3O_4-CS-BA	11.65	13.42

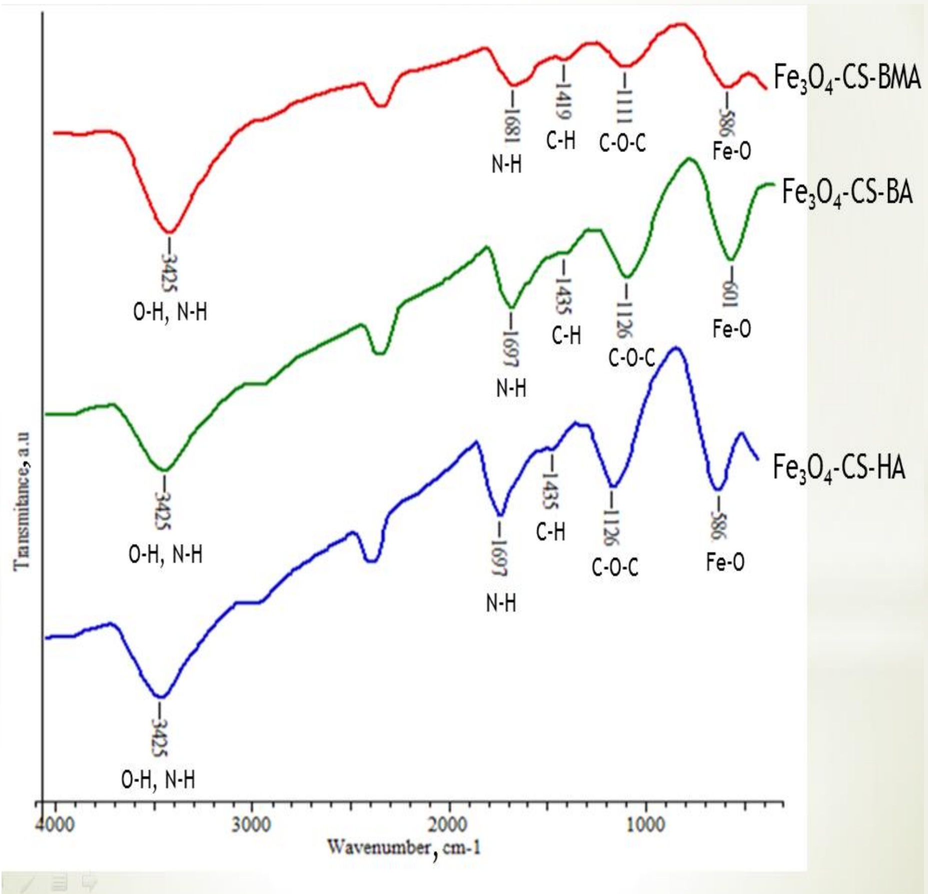
Magnetization





Particles show remanent magnetization.

FTIR



The chitosan and acrylates peaks are overlapped therefore, an exact estimation of chemical structure was not possible.

Adsorption Experiments

We varied the following parameters:

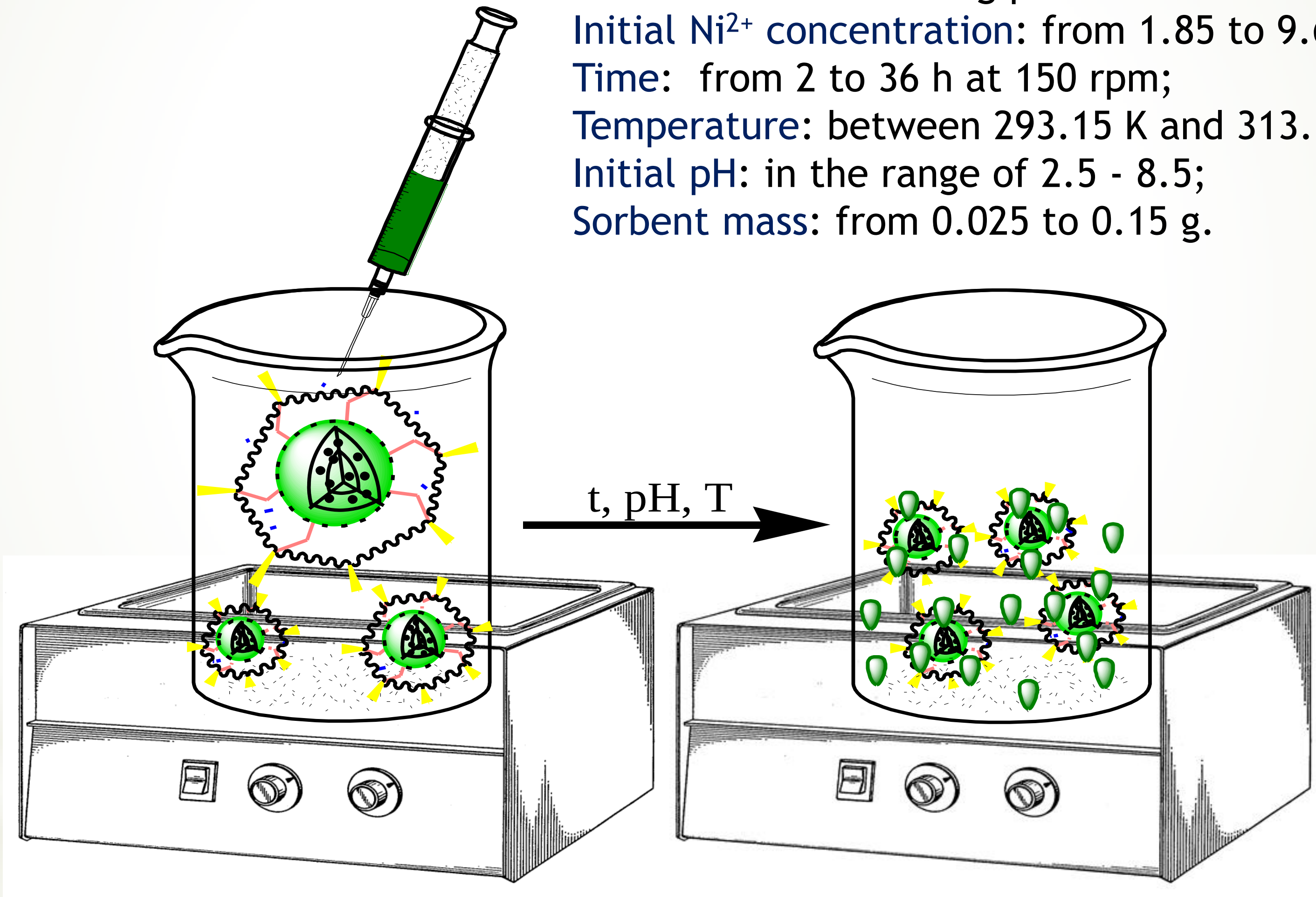
Initial Ni^{2+} concentration: from 1.85 to 9.6 mg/mL;

Time: from 2 to 36 h at 150 rpm;

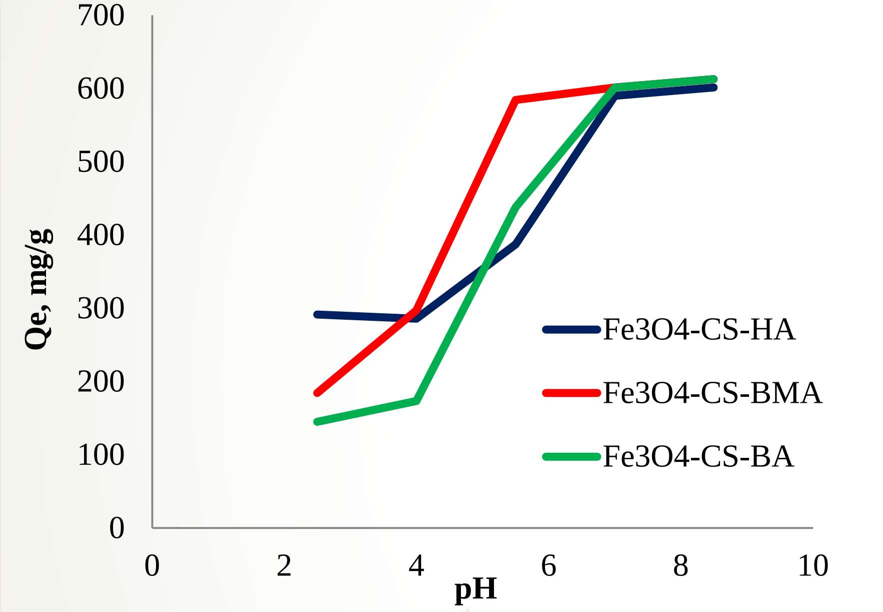
Temperature: between 293.15 K and 313.15 K;

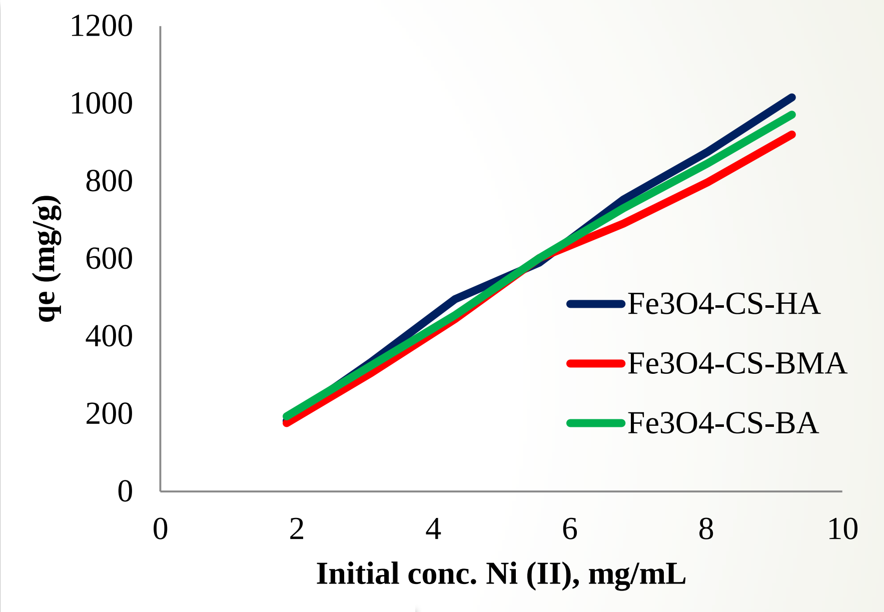
Initial pH: in the range of 2.5 - 8.5;

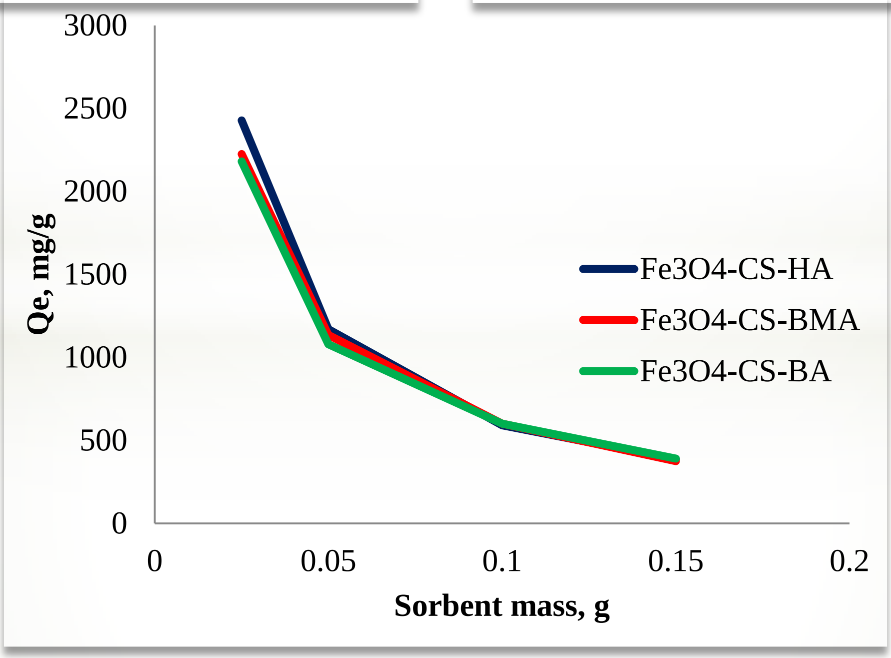
Sorbent mass: from 0.025 to 0.15 g.



Sorption Experiments







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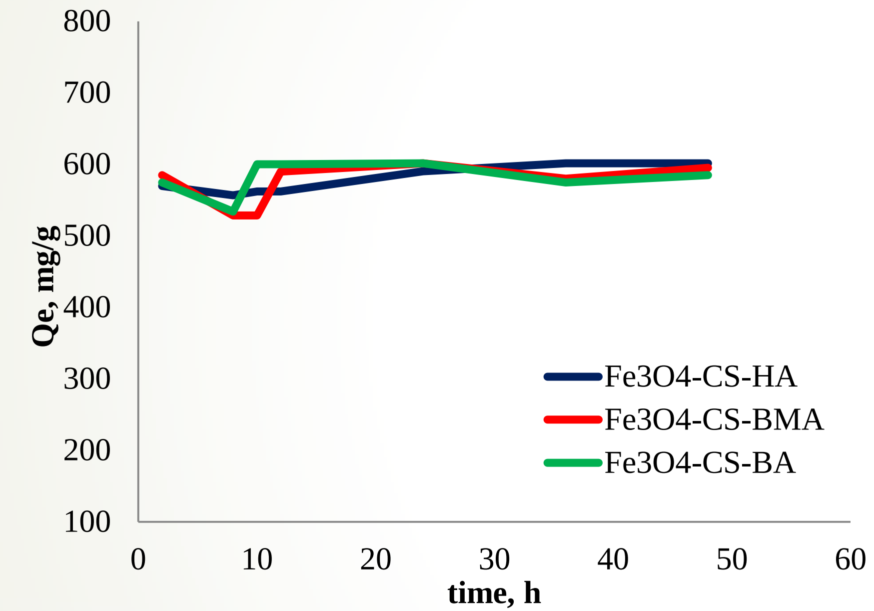
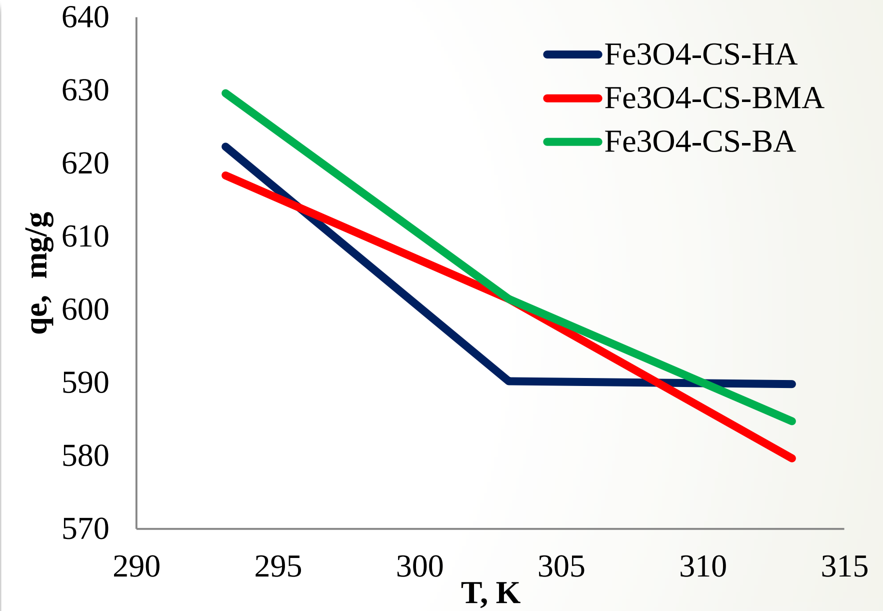




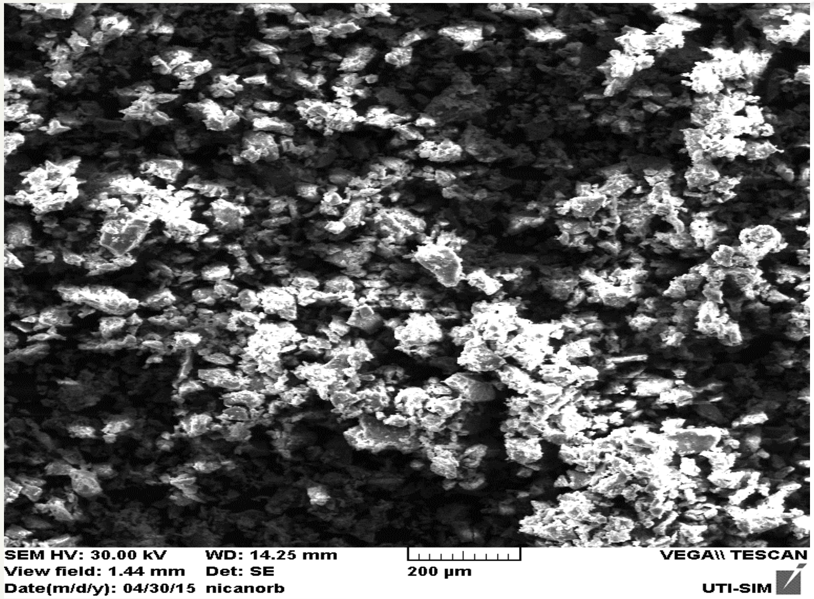
Desorption and Regeneration Studies

Material	Desorption in 0.1 M HCl solution (%)
Fe_3O_4-CS-HA	40.5 - 97.5
Fe_3O_4-CS-BMA	34.8 - 73.81
Fe_3O_4-CS-BA	38.77 - 100

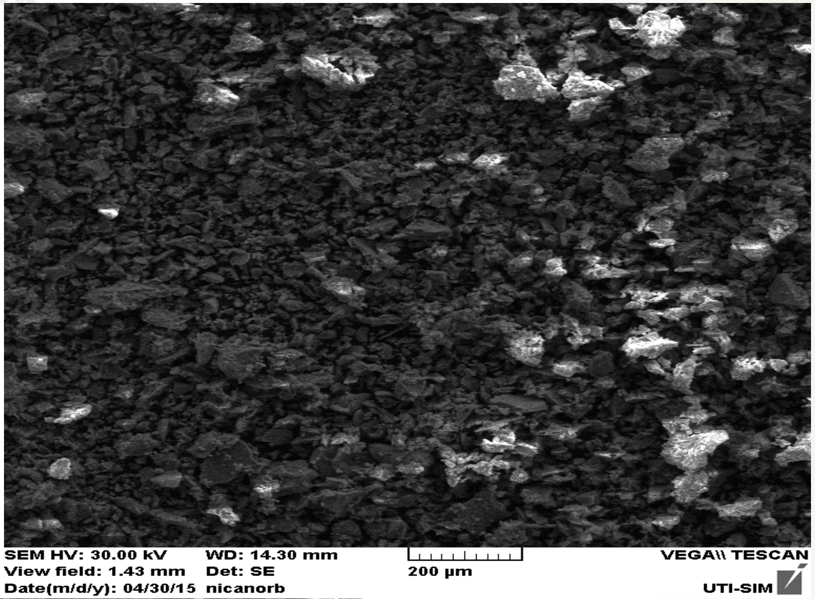
Adsorption Isotherms

Material/Metal ion		HA/Ni^{2+}	BMA/Ni^{2+}	BA/Ni^{2+}
Langmuir constants	R^2	0.88	0.89	0.95
$\frac{C_e}{q_e} = \frac{1}{K_L \times q_m} + \frac{C_e}{q_m}$	q_m (mg/g)	5000	5000	5000
	K_L (mL/mg)	0.06	0.05	0.05
	R_L	0.75	0.8	0.77
Freundlich constants	R^2	0.98	0.98	0.99
$\log\ q_e = \log\ K_F + \frac{1}{n}\ \log\ C_e$	K_F	215	194	220.7
	n	0.9	0.95	0.98
Dubinin-Radushkevich constants	R^2	0.96	0.91	0.91
$\ln\ q_e = \ln\ X_m - K_{DR}\varepsilon^2$	X_m (mg/g)	998.8	919.1	887.7
	K_{DR} (mol^2/kJ^2)	0.56	0.58	0.48
	E_S	0.94	0.93	1.02

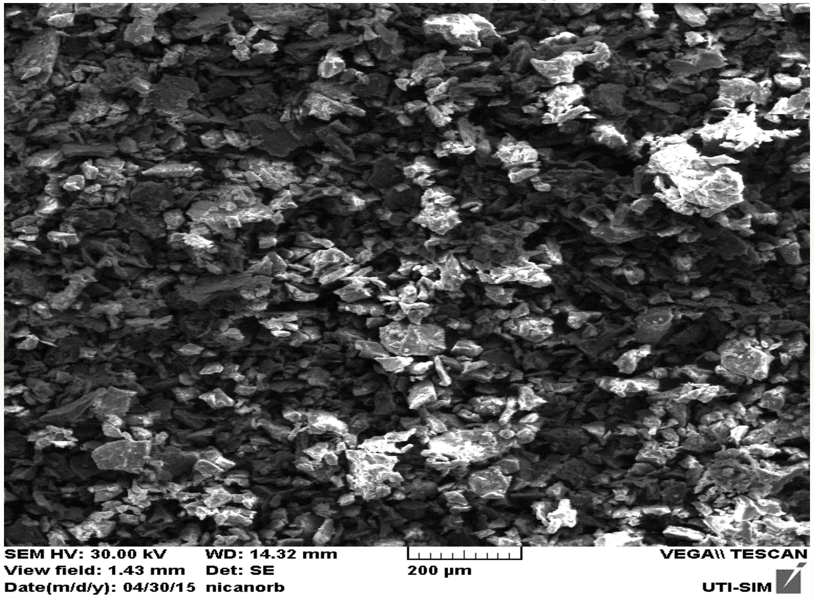
SEM



Fe_3O_4-CS-BMA



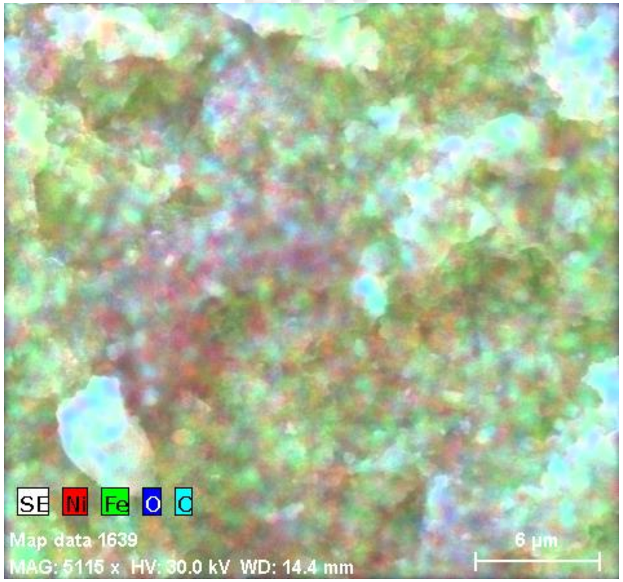
Fe_3O_4-CS-BA



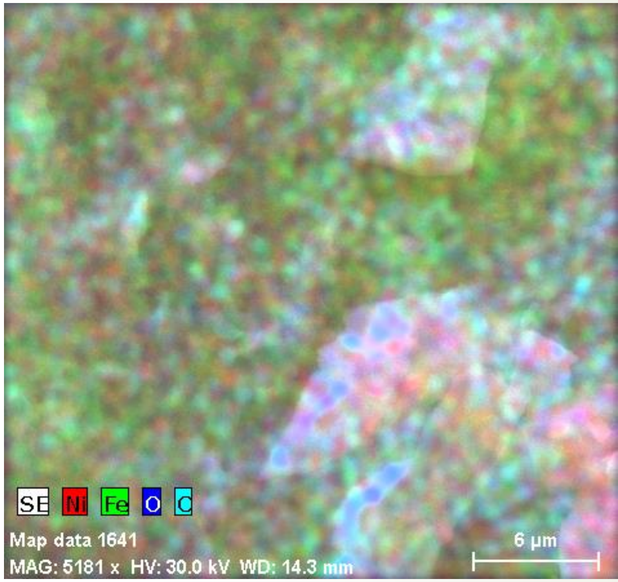
Fe_3O_4-CS-HA

EDX

Fe_3O_4-CS-BMA



Fe_3O_4-CS-BA



Fe_3O_4-CS-HA

Element	Fe_3O_4-CS-BMA		Fe_3O_4-CS-BA		Fe_3O_4-CS-HA	
	Atomic %	Wt. %	Atomic %	Wt. %	Atomic %	Wt. %
Oxygen	59.35	35.32	61.15	39.06	60.02	36.45
Iron	13.81	28.69	14.66	32.69	12.24	25.95
Carbon	13.02	5.81	15.24	7.31	13.65	6.22
Nickel	13.81	30.16	8.93	20.94	14.08	31.37

Conclusions and future work

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Future work: Competitive adsorption of heavy metal ions.

Acknowledgements

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THANK YOU FOR YOUR ATTENTION!