

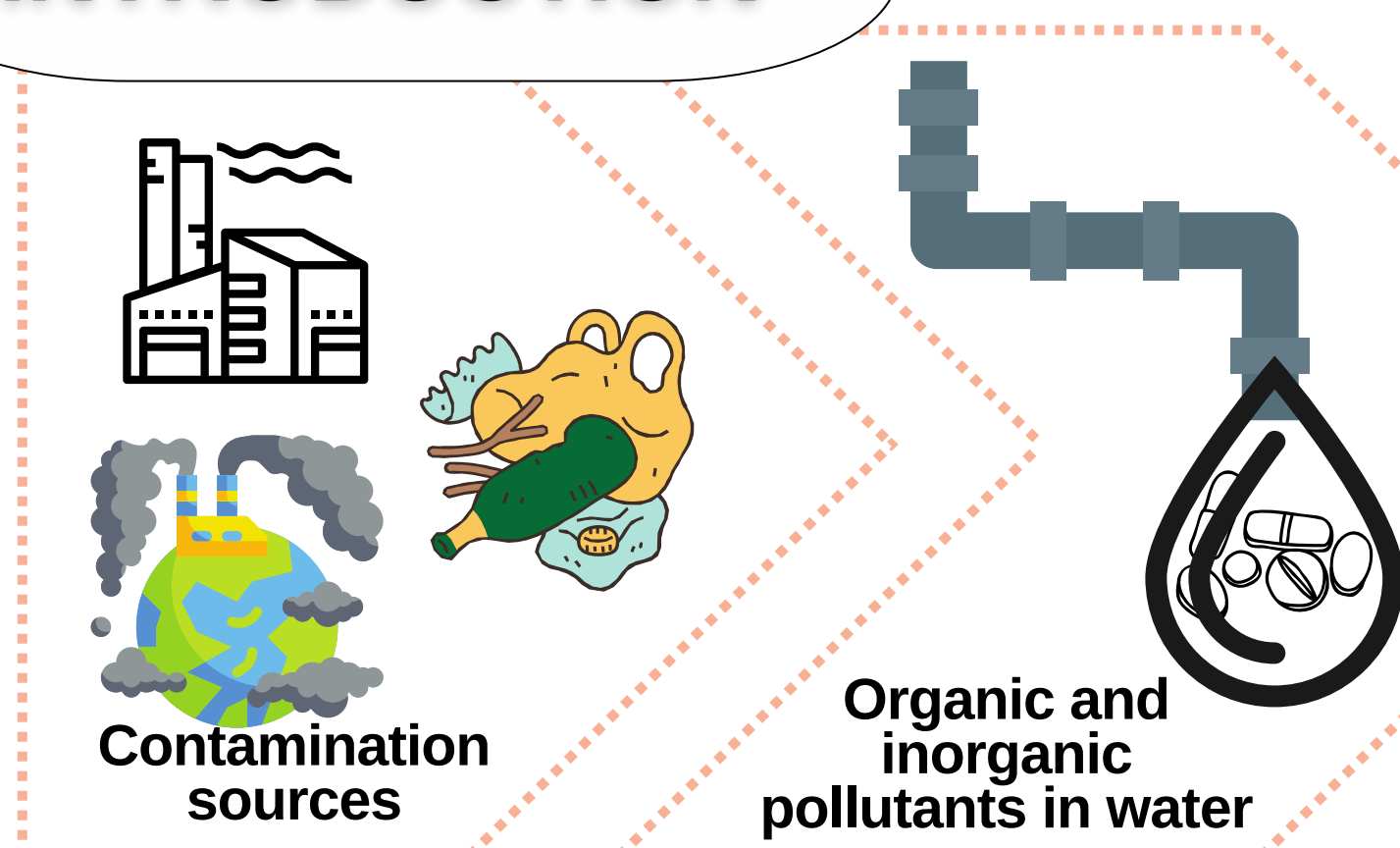
SODIUM ALGINATE-ACTIVATED CARBON COMPOSITE BEADS: ADSORPTION STUDIES TOWARDS THE REMOVAL OF ORGANIC AND INORGANIC POLLUTANTS IN ENVIRONMENTAL WATER SAMPLES

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ABSTRACT

Sodium alginate is anionic polymer that can be obtained naturally from seaweed. Apart from being biodegradable, it also has high adsorption affinity and can act as an adsorbent. As for activated carbons, these compounds have properties of high thermal resistance and highly porous structure, making them an excellent adsorbent. Thus, sodium alginate and activated carbon composites can be utilized as an alternative adsorbent material for water remediation. In this study, sodium alginate was cross-linked with activated carbon with the presence of calcium chloride as a coagulating agent to form a composite beads. Non-steroidal anti inflammatory drugs (NSAIDs) which are acetylsalicylic acid (ASA) and heavy metal ion (Cu(II)) were selected as targeted model analytes. The adsorption setup is simple by utilizing 200 mg of adsorbent beads in a stirred 20 mL sample solution for analyte adsorption process. The used adsorbent beads were discarded after single use to avoid any analyte carry-over effect. Several important adsorption parameters, such as effect of sample pH, initial concentration and contact time were comprehensively optimized. Based on the data obtained, sodium alginate with 0.10% w/v activated carbon shows highest adsorption with >80% removal under optimum adsorption condition for both Cu(II) (pH 6, 25 ppm of initial concentration and 90 min adsorption time) and NSAIDs (pH 4, 5 ppm of initial concentration and 240 min adsorption time). The adsorption isotherm follows Freundlich model and fitted with pseudo-second-order kinetics model for both ASA and Cu(II) solutions. Hence, this composite beads is beneficial in adsorption in terms of simplicity of the adsorbent preparation, ease of experimental setup, low consumption of organic solvent and it delivers significant cost advantages.

INTRODUCTION



REMOVAL USING ADSORPTION TECHNOLOGY BY BEAD SORBENTS

- Economically attractive (sodium alginate is biodegradable, activated carbon is abundantly available)
- Easy bead's preparation (no activation required)
- Good removal efficiency

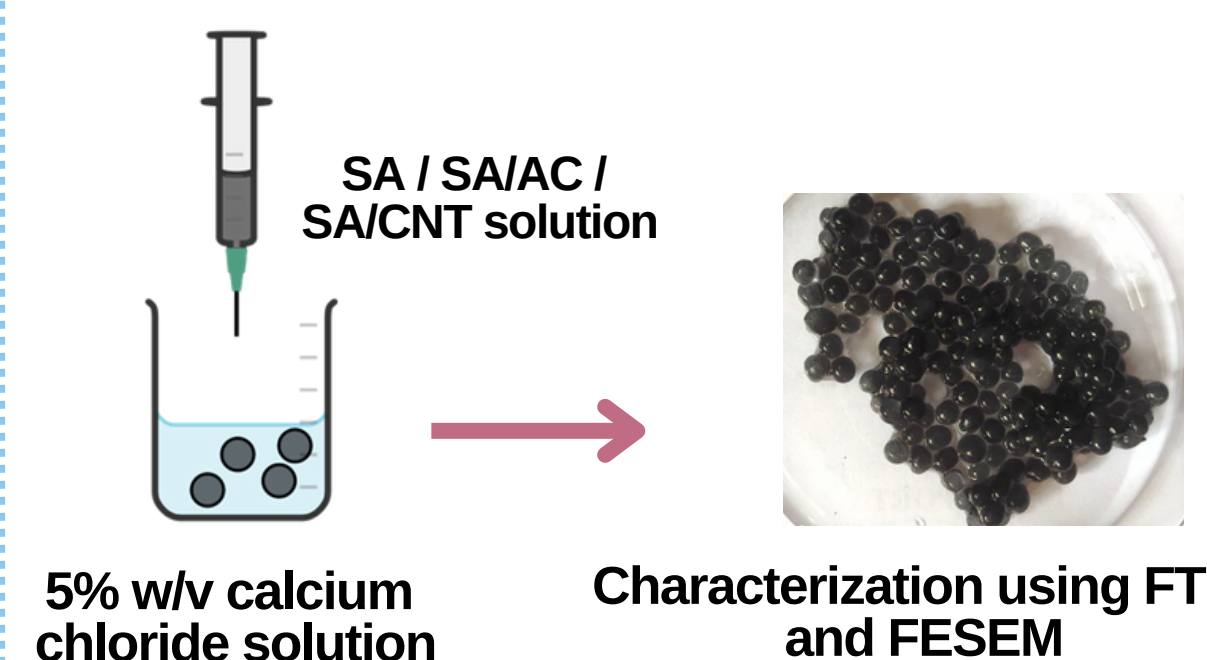
RESEARCH OBJECTIVES

to prepare and characterize sodium alginate-based composite beads (activated carbon and carbon nanotubes)

to study the optimum adsorption parameters for the removal of ASA and Cu(II) in aqueous solution

to determine the adsorption mechanism of the developed sorbent beads with model analytes using kinetic and isotherm study

METHODOLOGY



STEP 01 Preparation of SA, SA/AC, SA/CNT beads

Characterization of SA, SA/AC, SA/CNT beads

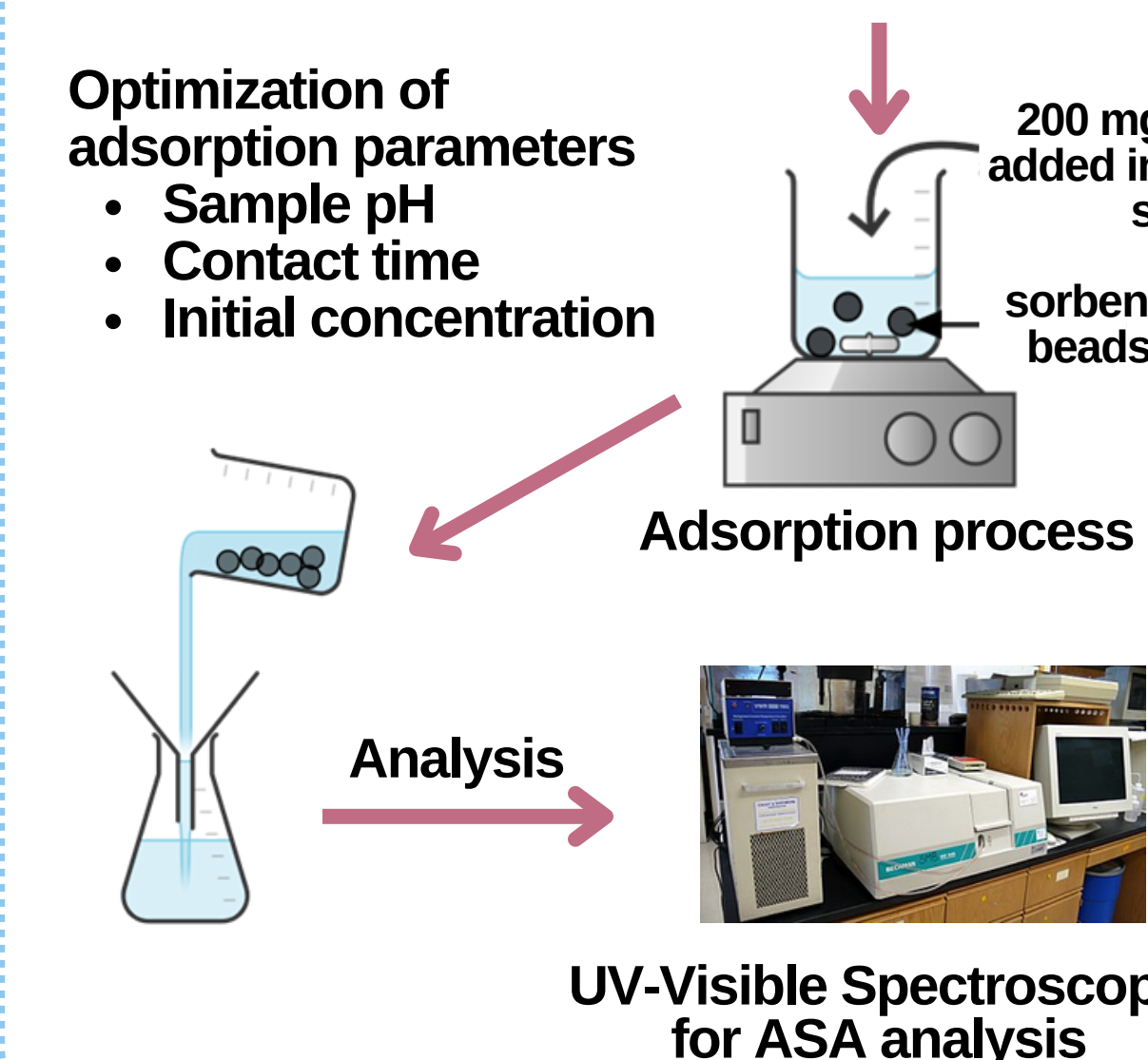
STEP 02

STEP 03 Preliminary adsorption study using four type of sorbent beads

Optimization of adsorption study using SA/AC beads

STEP 04

STEP 05 Kinetic and Isotherm study

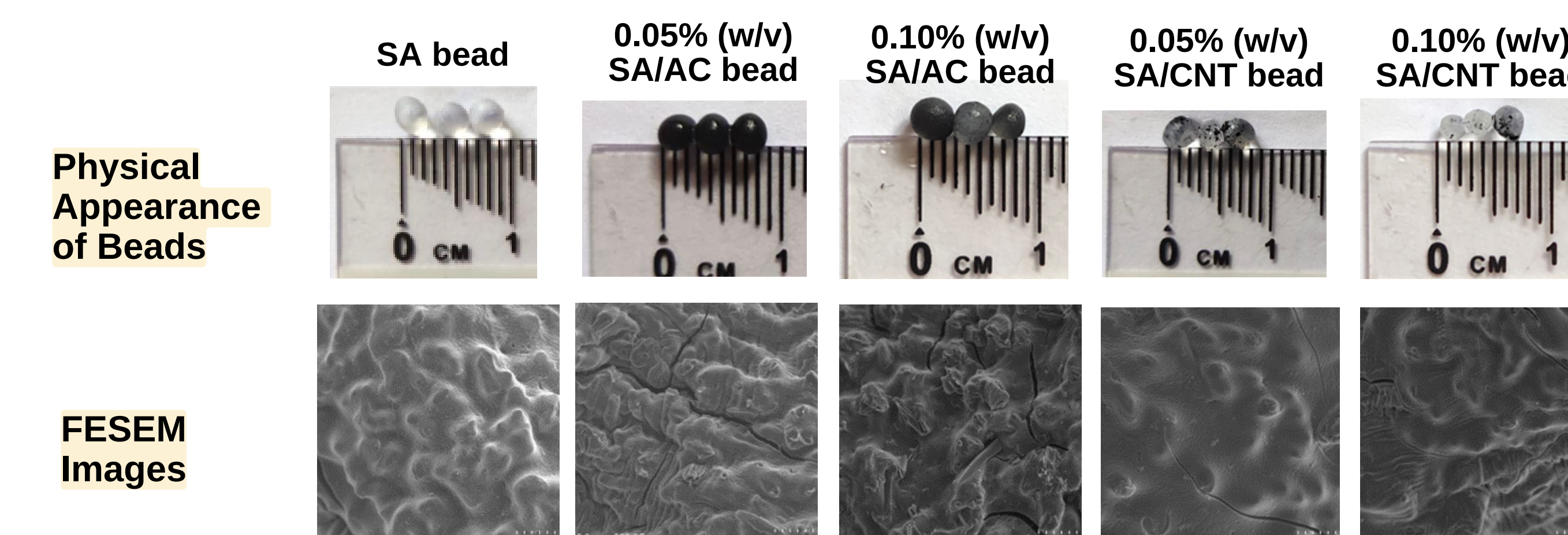


RESULTS & DISCUSSION

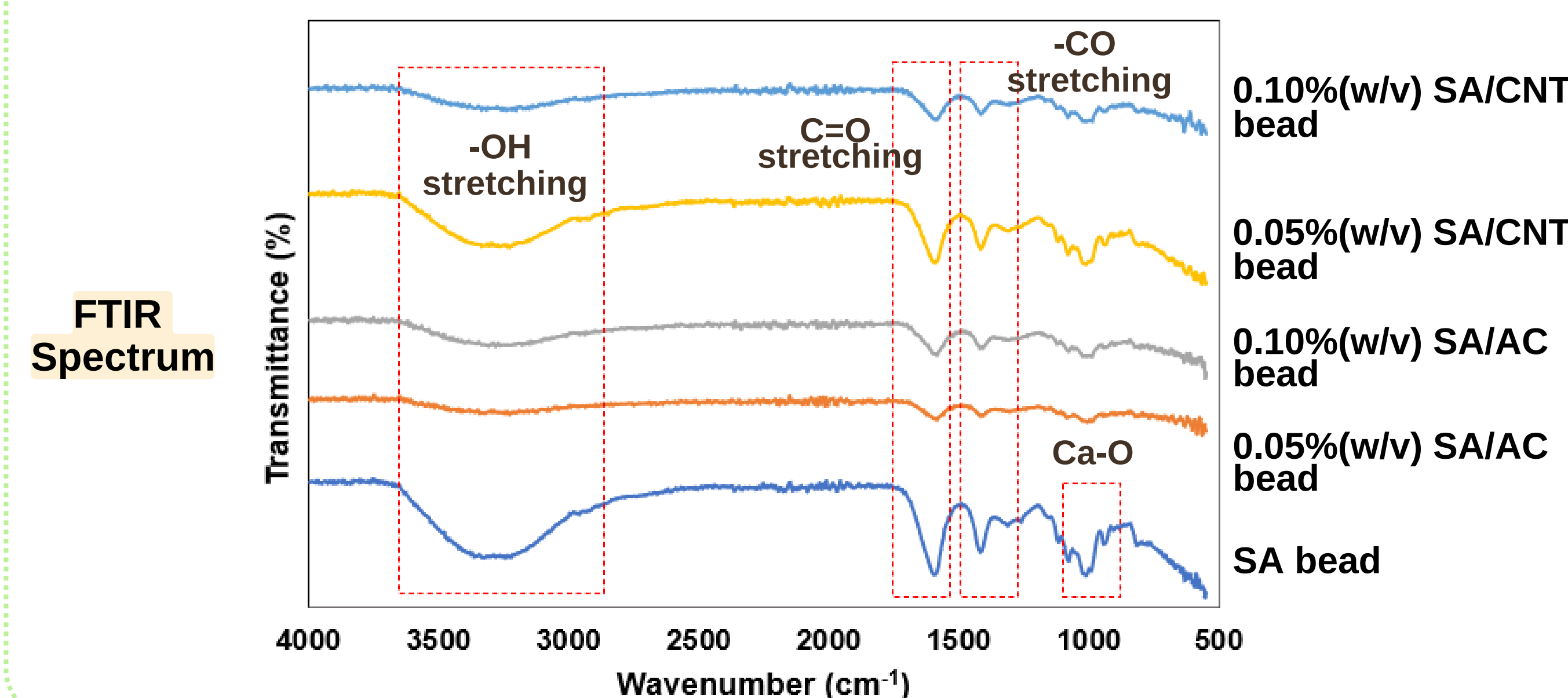
(i) Preliminary Adsorption Study

Adsorption condition		SA beads	0.05% (w/v) SA/AC beads	0.10% (w/v) SA/AC beads	0.05% (w/v) SA/CNT beads	0.10% (w/v) SA/CNT beads
200 mg beads, 20 ml of 10 mg/L ASA solution, 60 min, pH 5	Percentage removal of ASA (%)	5.1	11.1	20.3	0.0	5.4
200 mg beads, 20 ml of 10 mg/L Cu(II) solution, 60 min, pH 6	Percentage removal of Cu(II) (%)	64.6	74.2	78.4	67.2	73.5

(ii) Preparation and Characterization of sorbent beads

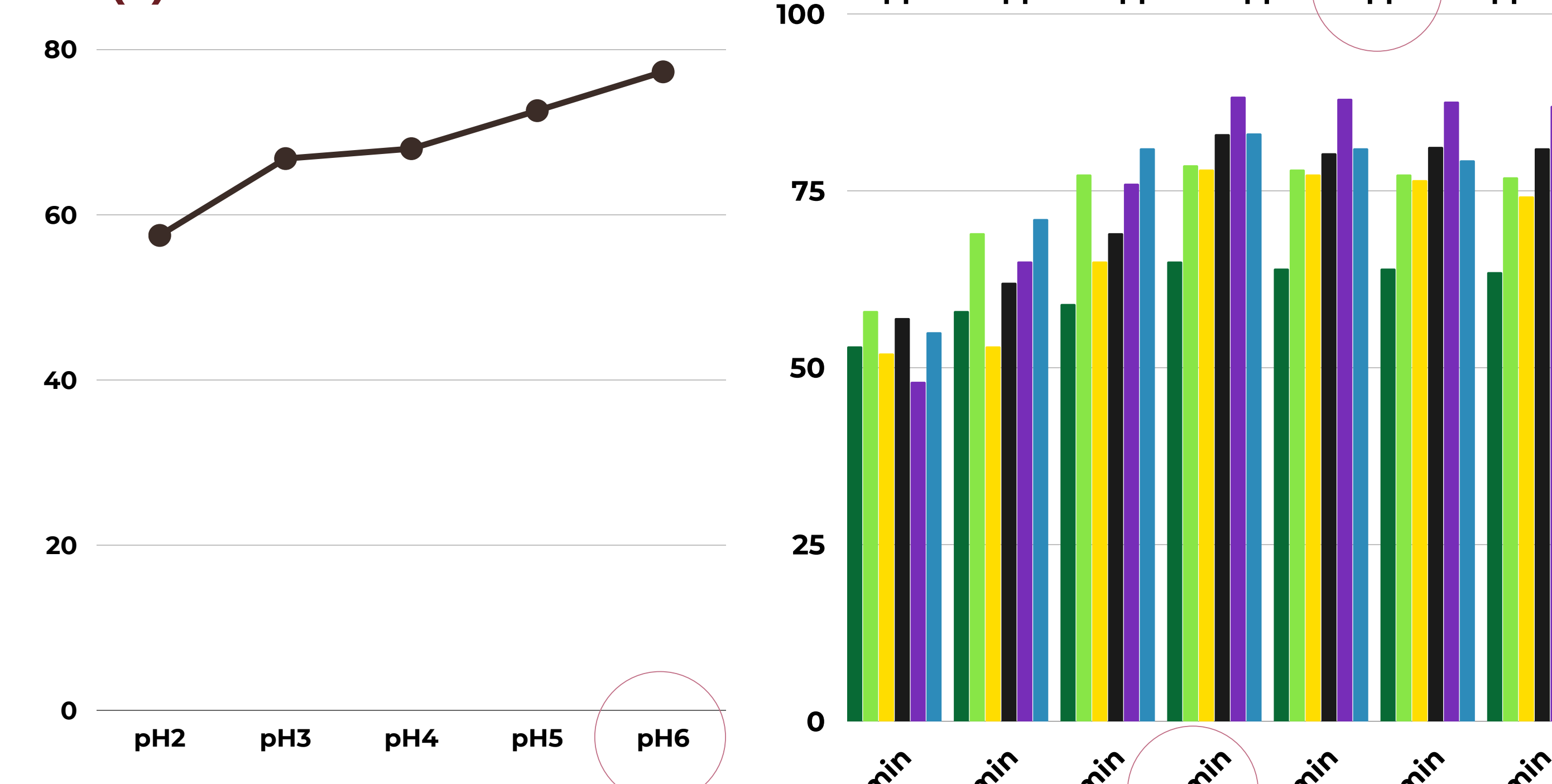


- The non-smoothness and many wrinkles on the beads' surfaces indicate the presence of many functional groups and more active adsorption sites on the sorbent material.
- Showing a triple network structure between SA with AC and CNT have been successfully synthesized.



(iii) Optimization of adsorption study of using 0.10%(w/v) SA/AC bead

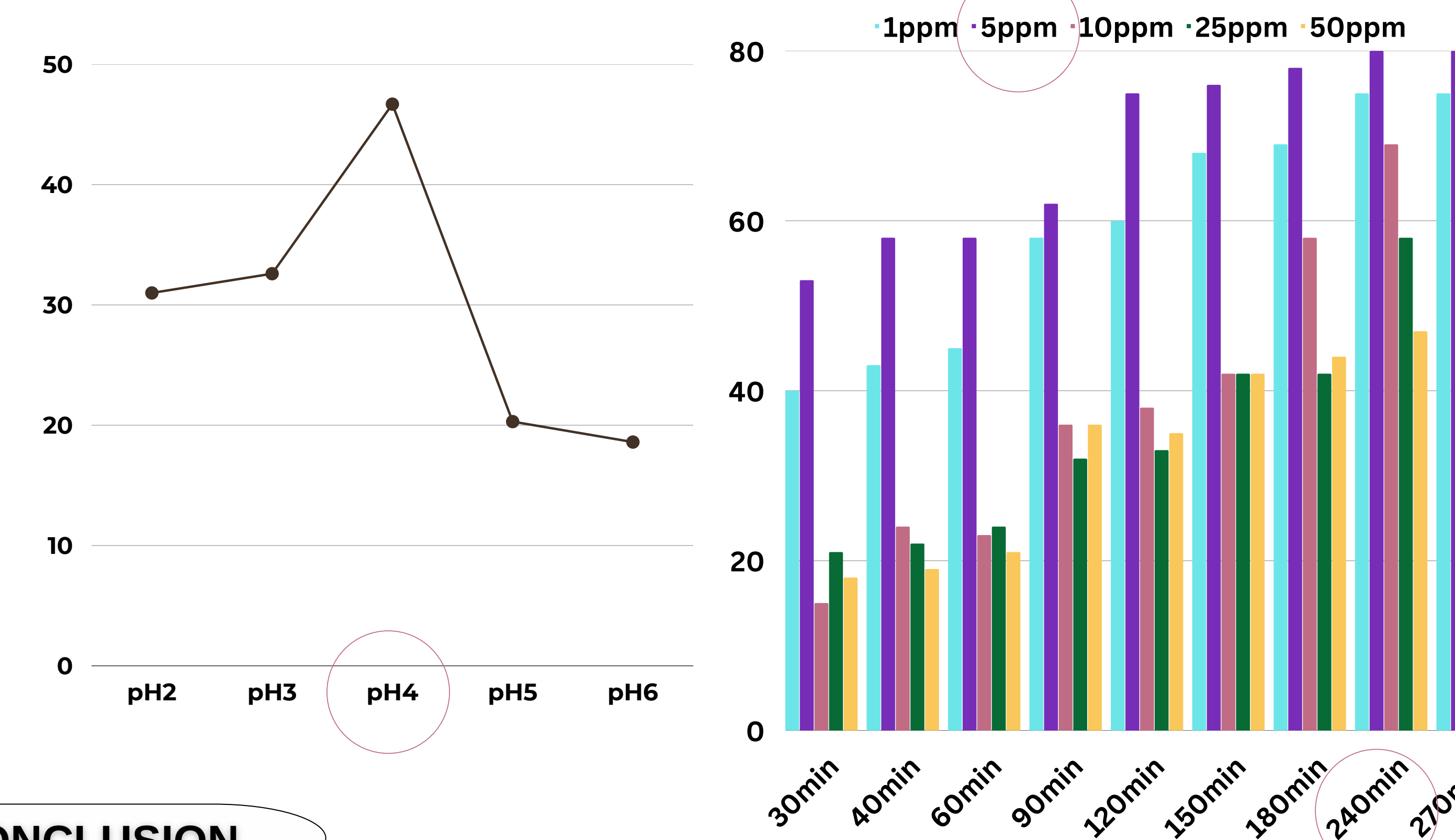
Cu(II) ion solution



- Fitted with Freundlich isotherm
- Pseudo-second order kinetic

-Removal percentage = 88.3%
-Multilayer adsorption of Cu(II) ions has occurred on the surface of adsorbent beads and suggests that Cu(II) adsorption by SA/AC is a chemical process, and the adsorption sites determine the adsorption rate.

ASA solution



- Fitted with Freundlich isotherm
- Pseudo-second order kinetic

-Removal percentage = 80.0%
-Multilayer adsorption of ASA has occurred on the surface of adsorbent beads and suggests that ASA adsorption by SA/AC is a chemical process, and the adsorption sites determine the adsorption rate.

CONCLUSION

- Sorbent beads were successfully synthesized using sodium alginate with activated carbon and carbon nanotubes.
- Based on FTIR analysis, the functional groups present for all beads are C=O, O-H and C-O.
- The surface images were observed using FESEM for all beads are rough and have pores.
- The optimum condition for adsorption of Cu(II) ion in an aqueous solution is at 75 minutes contact time, pH 6 and an initial concentration of 25 mg/L (>80% adsorption). Most fitted with Freundlich isotherms and pseudo-second order kinetics.
- The optimum condition for the adsorption of ASA in an aqueous solution is at 240 minutes contact time, pH 4 and initial concentration of 5 mg/L (>80% adsorption). Most fitted with Freundlich isotherms and pseudo-second order kinetics.