Synthesis and validation of water-soluble cationic biodegradable starch as a flocculant

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Abstract

All efforts must be made to preserve water's purity for the present and the future because it is necessary for environment's sustenance and for all living things including humans, vegetation and animals. This project is an experiment to synthesize a flocculant for industrial effluent and as a result grafted starch-based biodegradable polymer is created to benefit both natural and synthetic polymers. This research focused on creating water-soluble, cationic, biodegradable starch to use as a flocculant.

The reactive groups of the starch, or hydroxyls, combine with the cations in the reagent to produce a complex. The complex can separate creating free radical sites on the polysaccharide backbone. The mechanism of free radical graft copolymerization of ethyl monomers onto starch is anticipated in the presence of molecular nitrogen. H+ may be replaced by Reactive group R i.e. $(CH_2\ CH_3)_3\ N$ - $(Et_3)N$ in highly Alkaline medium. The effect of flocculant is validated on industrial effluent by jar test with various coagulation treatments.

Keywords: Cationic, Biodegradable, Starch, Flocculant, Polymer.

Introduction

This research focused on creating water-soluble, cationic, biodegradable starch to be used as a flocculant[7]. The reactive groups of the starch, or hydroxyls, combine with the cations in the reagent to produce a complex.[9] The complex can separate, creating free radical sites on the polysaccharide backbone.[5] In the presence of molecular nitrogen, H+ may be replaced by Reactive group R i.e. $(CH_2\ CH_3)_3\ N$ - $(Et_3)N$ in a highly alkaline medium.[3,6]

Material and Methods

Materials: All the chemicals employed in this work were of analytical grade and used as received. $(CH_2\ CH_3)_3\ N$ - $(Et_3)N$ (Reagent) and iso propyl Alcohol were supplied by S. D. Fine Chem Ltd., Mumbai. Merck Ltd., Mumbai supplied methanol. Starch was procured from Anil Starch Products Ltd., Ahmedabad. Merck Ltd., Mumbai supplied NaOH, Na_2Co_3. Acetic Acid was procured from S. D. Fine Chem. Ltd., Mumbai.

Equipment: Glasswares were Supplied by Durasil Glassware, Vadodara.

Co-polymerization of starch: 150 gm starch was dispersed in 500 ml water to make a slurry in 3-necked RBF. It was placed in a water bath at 40°C. 1gm NaOH + 1gm Na_2CO_3 in 20 ml water were added in the solution under stirring through the funnel to the stirred slurry for ½ hr. duration. It was kept under stirring condition for another ½ hr. The 12 gm reagent (65%) was taken in 18 ml water to make a total of 30 ml. and added slowly for ½ hr to the alkylated starch. The bath temperature was slowly raised to 55°C in two hours and kept under stirring conditions for four more hours at 55°C. The pH was continuously checked to keep the solution alkaline. Then it was cooled down, filtered and kept for air-drying.

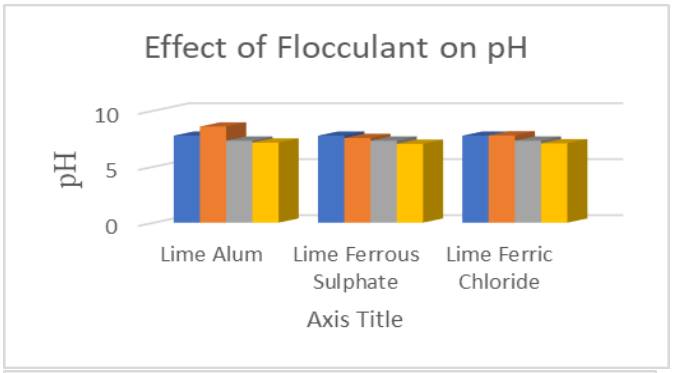
The experiments were carried out by changing different parameters such as Reaction Time, Reaction Temperature, % Reagent and % Alkalinity, by keeping three constant and one parameter changing.

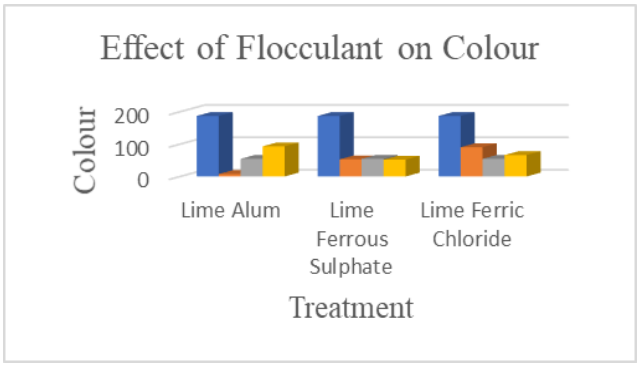
Application of flocculant: A sample of produced polymer is flocculated with three different types of industrial wastewater collected from three Central Effluent Treatment Plants (CETPs). First, they were given four treatments: Lime - alum, Lime – Ferrous Sulfate, Lime – Ferric Chloride and no treatment (raw wastewater).

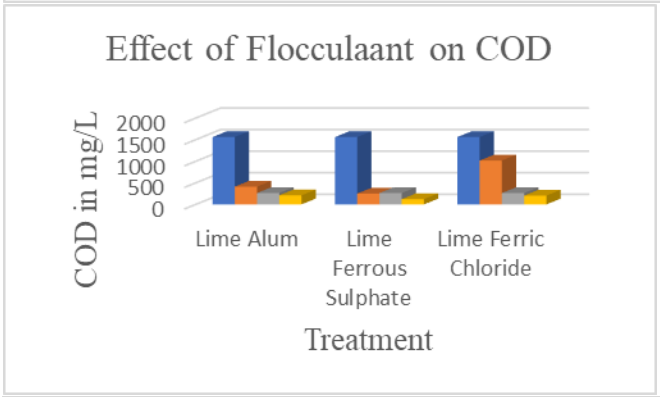
Table I
Effect of Developed flocculant on parameters of Effluent C

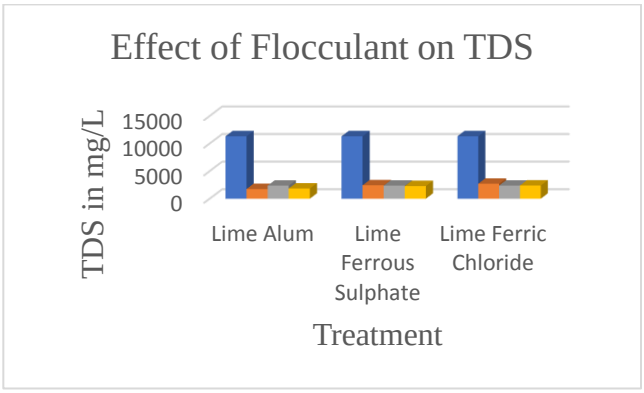
Effluent C	**Developed**							
	W/O Floc	**Lime Alum**	**Lime Ferrous Sulphate**	**Lime Ferric Chloride**	**T_1F**	**T_2F**	**T_3F**	**T_4F**
pH	7.77	8.58	7.56	7.79	7.32	7.15	7.04	7.08
Colour	187.00	7.48	52.94	90.37	54.55	93.05	51.87	66.31
COD(mg/L)	1560.00	411.00	251.00	1016.00	262.82	210.26	120.51	203.53
TSS(mg/L)	196.00	39.80	105.61	70.41	72.45	65.31	109.18	54.08
TDS(mg/L)	11322.00	1757.23	2434.61	2711.71	2371.54	1852.57	2294.75	2386.38

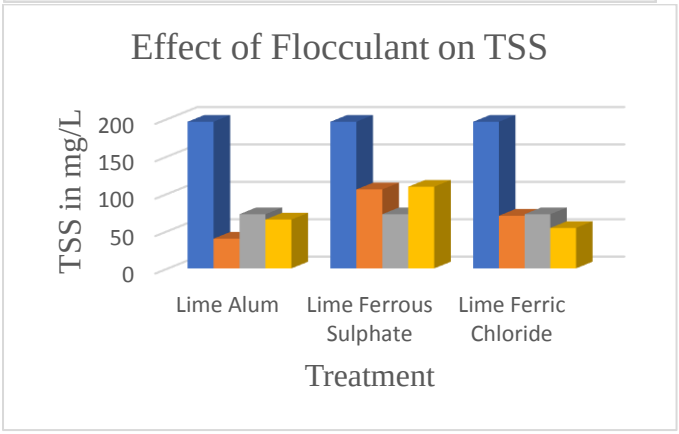
T_1 – Without Treatment; T2 - Lime – Alum; T3 – Lime - Ferrous Sulphate; T4 - Lime - Ferric Chloride; F – Developed flocculant











Remarks:

pH	Appreciable
Colour	Excellent for Lime – Alum
COD	Excellent
TSS	Outstanding
TDS	Excellent

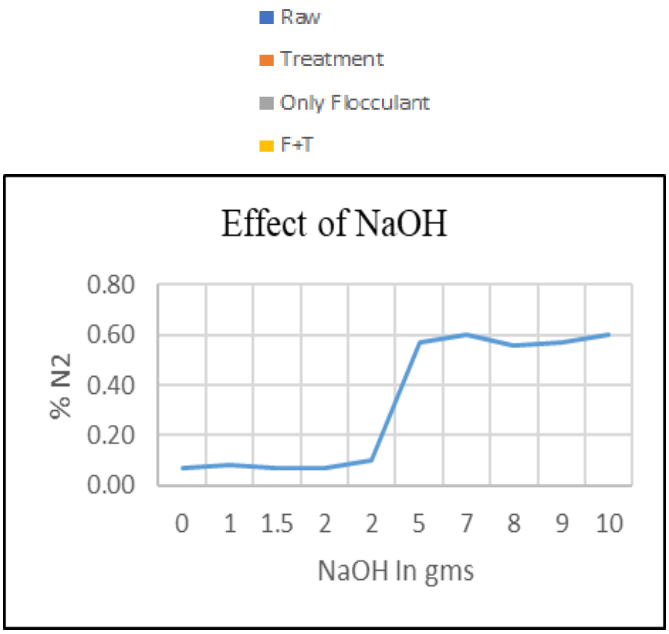


Fig. 1: Effect of amount of NaOH on Nitrogen content

Table II
% N2 content in different batches

NaOH in gms	0	1	1.5	2	2	5	7	8	9	10
$\%N_2$	0.07	0.08	0.07	0.07	0.1	0.57	0.6	0.56	0.57	0.6

Furthermore, after flocculation, it was allowed to settle for 24 Hrs. Then different parameters were tested like COD, TDS, TSS, Colour and pH for three different effluents by giving four different types of treatments to each and using eight different types of flocculants.

Results and Discussion

The N_2 content increase drastically by increasing alkalinity. The effect of time, temperature and reagent is negligible compared to alkalinity and after a specific limit, there will be no further effect of alkalinity. The best result is found with 5 gms of NaOH.

Conclusion

Developed cationic flocculant is a fast-acting, effective flocculant, biodegradable and eco-friendly used in industrial wastewater treatment. It combines the low sludge production characteristics of organic flocculants.

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