Removal of Ammonia Nitrogen from wastewater of starch industry by Ion Exchange Technology using synthetic resin

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Abstract- *Ammonia nitrogen is one of the most hazardous water pollutants, discharging into water receptors from industrial effluents. Adverse environmental impacts of such chemical species in hydrosphere include accelerated eutrophication, water toxicity and harming the aquatics.The sources of ammonia are municipal, agricultural and industrial; contribute to accelerated eutrophication of lakes and rivers, dissolved oxygen depletion and fish toxicity inreceiving water.Ammonia also reacts with chlorine used for disinfection in wastewater treatment to produce chloramines. Chloramines are less effective disinfectants and are toxic to aquatic life in the receiving water. There are various methods available for removal of NH4 – N from wastewater like ammonia stripping, breakpoint chlorination, struvite precipitation, nitrification-denitrification, ion exchange etc. This paper presents a study of NH4– N removal by ion exchange method using synthetic resin from wastewater 0f starch industry. Much of the literature is concerned with clinoptilite, a naturally occurring zeolite however modern exchanger are polymer based. Clinoptilite is cheaper than synthetic resin but durability, ion exchange capacity and regeneration capacity of synthetic resin is higher than clinoptilite. Ammonium removal from aqueous solution by a ion-exchange resin was investigated by considering the factors affecting the ammonium-exchange capacity including the zeolites' particle size, the loading flow rates and the impact of a number of regenerations upon the ion-exchange capacity.The aim of this study was to investigate ammonium exchange capacity of synthetic resin named CSA9 Na from "DOSHION VEOLIA WATER SOLUTIONS PVT. Ltd."*

Keywords- Ammonical nitrogen removal - ion exchange –Natural zeolite – clinoptilite -synthetic resin- CSA9-Na.

I. INTRODUCTION

With the dramatic development of economy and improvement of human life, much more wastewater is producing nowadays. On the other hand, people are concerned about environmental protection more than ever and relevant legislations or regulations are becoming more critical. The ammonia sources, which are municipal, agricultural and industrial, contribute to accelerated eutrophication of lakes and rivers, dissolved oxygen depletion and fish toxicity in receiving water. Free ammonia (NH3) and ionized-ammonia (NH4+) represent two forms of reduced inorganic nitrogenwhich exist in equilibrium depending upon the pH andtemperature of the waters in which they are found. Of the two, the free ammonia form is considerably more toxic toorganisms. This free ammonia is a gaseous chemical, whereas the NH4+ form of reduced nitrogen is an ionized form that remains soluble in water.Ammonia nitrogen contributes to BOD (Biochemical Oxygen Demand) in water due to its biologic oxidation by nitrifying bacteria, which can have a significant dissolved oxygen requirement for the breakdown of NH3 into NO3-. Inaddition to the presence of nitrates, the principal end productof nitrification stimulates algal growth and eutrophication inwaterways [1].The maximum limit of ammonia set by the Bureau of Indian Standards for drinking water is 0.5 mg/l (IS 10500 : 2012). Discharge Standard set by central pollution control board of Ammonia Nitrogen in surface water, public sewer and marine/coastal areas is 50 mg/l.

A variety of biological and physicochemical methods andtechnologies have been proposed for the removal of ammonia from the environment and industrial water systems. Removal of ammonium can be accomplished through the use of airstripping, breakpoint chlorination, ion exchange, and biological nitrification–denitrification. The efficiency of the process of air stripping, biological nitrification and denitrification are significantly impaired by low temperature in winter [2],[4]. The traditional method for removal of ammonium and organic pollutants from wastewater is biological treatment, but ion exchange offers a number of advantages including the ability to handle shock loadings and the ability to operate over a wider range of temperatures. Biological methods (nitrification) do not respond well to shock loads of ammonia, and unacceptable peaks in effluent ammonium concentrationmay result in such cases. The ion exchange method usually employs organic resins, which are very selective. However, they are very expensive. Ion exchange with natural zeolites is more competitive because of its low cost and relative simplicity of application and operation. Natural zeolites are the most important inorganic cation exchangers that exhibit high ion exchange capacity, selectivity and compatibility with the natural environment [5].

II. MATERIALS AND METHODS

2.1 Introduction

For the Removal of Ammonia Nitrogen from the wastewater, Ion Exchange Treatment can be used.Selective ion exchange is a process in which ions on the surface of a solid material are exchanged for ions in a solution in which the solid material is immersed. In wastewater applications, ammonia ions are “exchanged” for the cations on the solid material in the exchangecolumn. The ammonia ions remain in the exchange column and the cations from the column leave in the wastewater effluent.

2.2 Experimental Set up:

To study the ammonia removal by ion exchange method, a lab scale model has been set up at laboratory of Environmental Engineering Department, L.D. College of Engineering. Details regarding the Ion Exchange Packed bed column are given as follows.

Table – 2.1 Dimensions for Ion Exchange Packed bed column:

Total Column Height	0.54 m
Diameter	0.04 m
Resin Bed Height	0.40 m
Bed Volume	0.50 L

Figure 2.1 Experimental Set up

2.3 Ion Exchange Resin:

The cationic exchanger DOSHION CSA-9 Na is an available synthetic ion-exchanger resin which was used in this study. The resin was supplied by “DOSHION VEOLIA WATER SOLUTIONS PVT. Ltd”. The physicochemical properties are presented in Table 4.1.

Table – 4.2 Physicochemical properties of DOSHION CSA-9 Na

Properties	DOSHION CSA-9 Na^+
Type	strongly acid cation exchange resin
Matrix	cross-linked polystyrene, gel type
Functional group	sulphonic acid (-SO3-)
Ionic form (as supplied)	Sodium form
Total exchange capacity (meq/mL)	2.066
Maximum operating Temperature	120^{0} C (Na^+ form)
Operating pH range	0-14
Particle size (mm)	0.3-1.18
Moisture content (%)	44.0 - 48.0

2.4 Study Methodology:

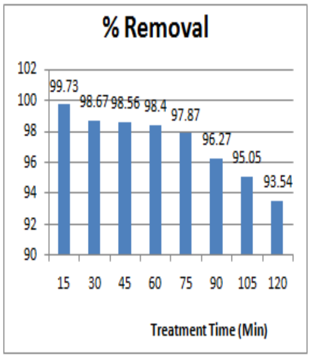
Experiment procedure - Continuous Process:

Continuous Process experiment is performed to study the ion exchange capacity of Resin, i.e. CSA9 Na.In this experiment, Flow rate of the influent is kept constant.At the time interval of every 15mins, effluent samples are taken for analyses till the Break through point (5% of influent ammonium nitrogen concentration in effluent) is reached. % Removal is also determined.

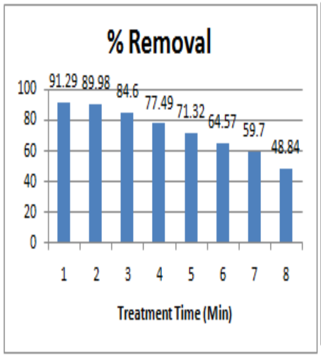
III. RESULTS AND DISCUSSION

3.1 Result

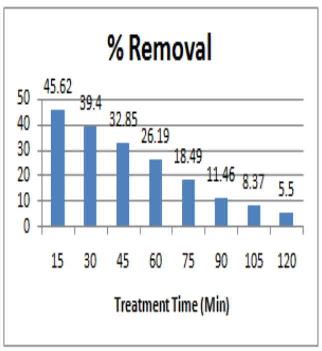
Initial concentration of ammonia nitrogen is 1052.8 mg/l.After ion exchange treatment, Ammonia Nitrogen removal values are given in the table 3, 4 and 5. Treatment timewas changed from 15, 30, 45,60,75,90,105 and 120 min. % removal of Ammonia nitrogen is shown in graphs.



Treatment Time (Min)	Final Concentration(mg/L)	% Removal
15	2.85	99.73
30	14.01	98.67
45	15.17	98.56
60	16.85	98.4
75	22.43	97.87
90	39.27	96.27
105	52.12	95.05
120	68.02	93.54



Treatment Time (Min)	Final Concentration(mg/L)	% Removal
15	91.7	91.29
30	105.5	89.98
45	162.14	84.6
60	236.99	77.49
75	301.95	71.32
90	373.01	64.57
105	424.28	59.7
120	538.62	48.84



Treatment Time (Min)	Final Concentration(mg/L)	% Removal
15	572.52	45.62
30	638	39.4
45	706.96	32.85
60	777.08	26.19
75	858.14	18.49
90	932.15	11.46
105	964.69	8.37
120	994.9	5.5

3.2 Discussion

In continuous column experiments, column is filled with resin up to 40 cm height. A wastewater is passed through column from top inlet at constant flow rate 0.33 ml/min. At the bottom of column treated effluent is collected at every 15 min time interval. Ammonia nitrogen removal efficiency is 99.73% at 15 min and after 1 hour removal efficiency is 98.4% obtained.

IV. CONCLUSION

The removal of ammonia Nitrogen from starch industry wastewater using synthetic resin named CSA9 Na, is successful on a laboratory scale with a selective ion-exchange process.

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