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# STARCH EFFICIENCY IN WATER TURBIDITY REMOVAL

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## ABSTRACT

*In this paper, the efficiency of starch as a coagulant aid factor is compared within two ranges of pH i.e. 7 and 8 in water turbidity removal. The experiments were performed in three turbidity ranges 100, 50, 20 NTU and the coagulant was ferric chloride. The volume of ferric chloride in all experiments were 10 mg $l^{-1}$ and starch in optimum concentration for turbidity of 100, 50, 20 NTU was 0.2 mg $l^{-1}$, 0.1 mg $l^{-1}$ and 0.04 mg $l^{-1}$ respectively. Using starch coagulant aid in turbidity 100, 50, 20 NTU can eliminate 92.4, 86.46, 83,8 % of turbidity in pH of 7, while in pH of 8 it can eliminate 85.44, 81.56, 78.9 % of the mentioned above turbidity, respectively. According to the achieved results, the optimum pH was 7.*

**Keywords**: Turbidity, Coagulant, Coagulant aid, Starch, Ferric Chloride.

## INTRODUCTION

Surface water has got different kinds of suspended materials which cause turbidity and color [6]. Many processes have been considered for particular contaminants [12]. Coagulation and flocculation are physicochemical processes which may be used for colloidal suspensions removal [13]. Usually, metallic salts such as alum, ferric sulphate, ferro sulphate, ferric chloride and organic polymers are among coagulant materials [3], [10].

In many of the developing countries are used natural poly electrolytes [5]. Moringaoleifera, starch, tannins, Chitosan are natural coagulant. [1], [4], [8]. Chitosan biopolymer is used in coagulation and flocculation processes [9], [11]. P. ovata extract as a coagulant aid is efficient in water turbidity removal [7]. One of the most important polysaccharides is starch [2].

This paper studies the application of starch as a coagulant aid accompany with coagulant ferric chloride in water turbidity removal. The experiments were performed in two pHs i.e. 7 and 8.

## MATERIALS AND METHODS

In this study, while preparing artificial water turbidity, the effect of adding coagulant aid in optimum pH to improve turbidity elimination was studied, and necessary comparisons were made practically.

Three different turbidity levels of high (100 NTU), medium (50 NTU) and low (20 NTU) were made synthetically by adding sufficient clay to the water samples.

The MERCK ferric chloride ($FeCl_3$, $6H_2O$) as coagulant and starch as coagulant aid were used. Sulphuric acid (1N) was used for pH adjustment. The experiments were performed in the water and wastewater lab of the faculty of environment, University of Tehran.

Experimental conditions of all experiments were as follow:

1) Experiments were performed in 25±2 °C, because the temperature is one of the most effective parameters on density, viscosity and amount of coagulants in keeping conditions.
2) The volume of samples containing different levels of turbidity was adjusted to 500 $cm^3$.
3) Chemical oxygen demand (COD) was determined by Spectrophotometer DR/2000HACH.
4) pH of the samples was measured by Metrohm 691 Model digital pH meter.
5) Turbidity was determined by HANNA turbidity meter.

All the experiments were performed by using jar experiment method. The jar set used in this study was PHIPPS &BIRD STIRRER 7790-402 Model.

At first, the samples of water whose turbidity and pH have been measured, were poured in special jar vessels, one time with the known amount of ferric chloride as coagulant together with the starch as coagulant aid in pH of 7 and another time ferric chloride with starch coagulant aid were added to the other samples of water in pH of 8 in comparison between ranges of pH. 10mg $l^{-1}$ concentration of ferric chloride was considered in jar test for all turbidity levels. Furthermore, 10mg $l^{-1}$ concentration of ferric chloride combined with 0.2 mg $l^{-1}$, 0.1 mg $l^{-1}$ and 0.04 mg $l^{-1}$ of starch was also tested in two practical pH levels of 7 and 8 to achieve the optimum combination.All experiments were tested in 100, 50, 20 NTU turbidity ranges.

The samples were shaken for a minute with 100 rpm, then 25 minutes with 30 rpm to make Floc. thenFlocs were allowed to settle for 30 minutes and after that jars were sampled for analyzing and measuring turbidity and pH. The residual turbidity was compared with initial turbidity. In addition, pH variations were examined. This method was repeated four times.

## RESULTS AND DISCUSSION

In this paper, the role of starch in elimination of water turbidity was studied using coagulation and flocculation processes. Starch coagulant aid was used to reduce ferric chloride consumption and optimum value and pH were determined.

The final turbidity versus pH values for three different cases of starch i.e. 10 mg $l^{-1}$ $FeCl_3$& 0.2 mg $l^{-1}$, 10 mg $l^{-1}$ $FeCl_3$& 0.1 mg $l^{-1}$ and 10 mg $l^{-1}$ $FeCl_3$& 0.04 mg $l^{-1}$ within the samples containing primary turbidity of 100, 50 and 20NTU and pH values equal to 7 and 8 are presented in tables 1 and 2. The results indicate that the turbidity elimination is ideal in pH=7**.**

## CONCLUSION

The achieved results of turbidity removal in different turbidity levels of 100, 50 and 20 NTU caused by different concentrations of starch as coagulant aids besides ferric chloride as the main coagulant are compared in this study. Additionally, the effect of pH on turbidity removal is also considered in each case. According to the tables 1 and 2 which indicate the high turbidity water sample, the turbidity removal in the case of 10 mg $l^{-1}$ of $FeCl_3$ and 0.2 mg $l^{-1}$ of starch is estimated to be 92.4% and 85.44% in pH values of 7 and 8, respectively. At the same time, for medium turbidity where 10 mg $l^{-1}$ of $FeCl_3$ and 0.1 mg $l^{-1}$ of starch are used, the removal efficiency is reported to be 86.46% and 81.56% in two adjusted pH values. In low turbidity of 20 NTU using 10 mg $l^{-1}$ of $FeCl_3$ and 0.04 mg $l^{-1}$ of starch in pH=7, the removal efficiency rate was 83.8% . At the same condition in pH=8, this rate was 78.9%.

According to the achieved results, application of the starch plays an important role in turbidity elimination with reducing ferric chloride consumption as well as producing sludge significantly. Generally, the starch coagulant aids seem to be more efficient in pH value of 7 rather than 8. COD measurement results, in all experiment were Nil and it shows that using starch does not have any residual in treated water.

The influence of starch on coagulation process increased with the starch injection enhancement. However, if the

Starch injection exceeds its optimum value, its effect will decrease. Increase in the efficiency of water turbidity removal observed in low pH values should be determined under conditions of the water treatment plants.

**Table1. Comparison of final turbidities in different turbidity levels of 100, 50 and 20 NTU at initial pH 7 caused by different concentrations of starch as coagulant aid besides ferric chloride as the main coagulant.**

| Materials | Initial Turbidity (NTU) | Final Turbidity (NTU) | Removal percentage % | Initial pH |
|---|---|---|---|---|
| $FeCl_3$ 10 mg $l^{-1}$& Starch 0.2 mg $l^{-1}$ | 100 | 7.60 | 92.4 | 7 |
| $FeCl_3$ 10 mg $l^{-1}$& Starch 0.1 mg $l^{-1}$ | 50 | 6.77 | 86.46 | 7 |
| $FeCl_3$ 10 mg $l^{-1}$& Starch 0.04 mg $l^{-1}$ | 20 | 3.24 | 83.8 | 7 |

**Table2.Comparison of final turbidities in different turbidity levels of 100, 50 and 20 NTU at initial pH 8 caused by different concentrations of starch as coagulant aid besides ferric chloride as the main coagulant.**

| Materials | Initial Turbidity (NTU) | Final Turbidity (NTU) | Removal percentage % | Initial pH |
|---|---|---|---|---|
| $FeCl_3$ 10 mg $l^{-1}$& Starch 0.2 $mgl^{-1}$ | 100 | 14.56 | 85.44 | 8 |
| $FeCl_3$ 10 mg $l^{-1}$& Starch 0.1 $mgl^{-1}$ | 50 | 9.22 | 81.56 | 8 |
| $FeCl_3$ 10 mg $l^{-1}$& Starch 0.04 $mgl^{-1}$ | 20 | 4.22 | 78.9 | 8 |

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