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THE ROLE OF SODIUM ION IN PHOSPHORUS REMOVAL WHEN ALUM IS USED AS A COAGULANT

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Abstract: Jar examination was applied to treat dairy water by using alum as a coagulant. Synthetic samples similar to actual wastewater were prepared from real dairy products to achieve the work. All tests of characteristics have been performed according to American Public Health Association (APHA), American Water Works Association (AWWA), and Water Environment Federation (WEF). The apparatus used in this study is the Jar test model JLT 6 Leaching test VELP Scientifica, with all kits and tools that could complete the work. The results showed the ability of aluminum sulfate to remove phosphorous from dairy wastewater by up to 95%. This resulted in an optimum aluminum dose equal to 0.5 mg / l at 20 ° C, and a gradient speed of 1076.915 seconds. -1. These results correspond to the role of the sodium ion in removing contaminants as a catalyst; the sodium ion concentration that contributed to this activity was 60 mg per liter, representing 23.07% of the initial concentration. The main goal of this article, it's how can exploit the factors and circumstances adjacent to reducing pollutants without increasing aluminum dosages.

Keywords: *Dairy wastewater; gradient velocity; alum, phosphorus; sodium*

1. Introduction

The importance of dairy products for life on the surface of the earth cannot be ignored, because dairy also has a fundamental role in life and they represent the backbone of the economy in some countries. Therefore, they are very important for two main reasons: the first is their relationship to food and the second is their relationship to water. Recent scientific reports have documented that the world's milk production is about 600 million tons per year [1-4].

Phosphorus is a component of nutrients that forms the main identity of dairy wastewater. The discharged wastewater of dairy factories will give sources for algae blooming and other plants. On the other hand, phosphorus has a way of going through the chain of food into different creatures [5-8].

Aesthetic problems [9, 10]: The effluent affects the aesthetic value of the receiving water and this could be explained "And the aesthetic effect of phosphorus extends to the increase of the algal revolution and the hydrophytic plant bodies, which cover the water surface with a vegetative membrane that may be green or bluish- green, and this distorts the aesthetic of the water" on the other hand alkaline pH causes damage to aquatic life it's excessive BOD consumed the dissolved oxygen concentration of the aquatic system. This text could be explained in short "This effect may cause a change in the pH, which in turn will damage the biomass by affecting the entire

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physiological system of the organism. On the other hand, it may lead to high demand for oxygen by the water mass, and this, in turn, will lead to the depletion of dissolved oxygen in the water body and over time will lead to the anaerobic state in the aqueous system”. These reasons make it necessary to decontaminate in various forms and may be physical, chemical, and biological processes. It is important that these methods are economical and practical without placing an economic burden on the state. [11-14].

Phosphorus in wastewater hires one of three shapes:

- Organic compounds,
- Orthophosphates and
- Polyphosphates.

Orthophosphate is resolvable and may be regular as a phosphoric, or phosphate ion. These shapes are regarding solution pH. Polyphosphates which is the highest barbed procedure of phosphorus. It could have adjusted the forms to phosphate by hydrolysis or biological activity [15-18].

Since the Romanian century, alum has been used as a coagulant in the treatment of water, and then in the treatment of wastewater [19-23The coagulation mechanism by using this compound has been studied for many years [24-26Generally suspended particles have negative charges, so it is normal to add an opposite sign on the liquid to make a disturbance of these materials and then enlarging the size then settle. [27-29], denoted dissimilar causes which play a role in the mechanism of treatment. As noted in Figure 1, the pH plays an essential role in forming the shape of the aluminum hydroxides [22].

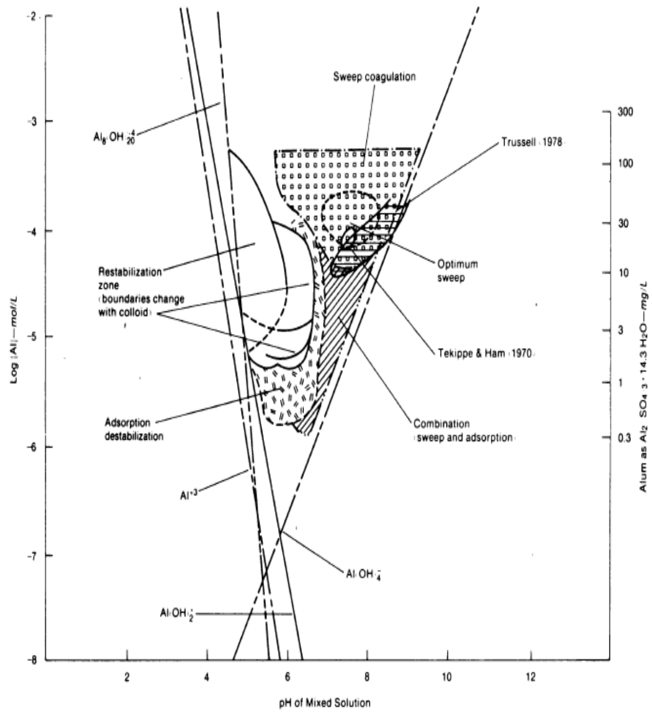

Figure 1. Design and operation diagram for alum coagulation (Amirtharajah and Mills 1982)

The role of the dairy industry in the life and the consumption of large water then discharging the large quantity of wastewater into water bodies, has been the motivation to look for all opportunities to reach the optimum treatment. It has been important to find out the assistant elements that could be supporting the removal of pollutants. Some of these elements come under parameters and determinants. On the other hand, other factors such as positive ions like salts included in the liquid could have the ability to make the removal of pollutants by sharing with the coagulants. This article considers the two concepts to reduce the concentrations of pollutants, specifically phosphorus.

2. Dairy Wastewater Characteristics

Generally, dairy wastewater is free of toxic materials to the environment and water bodies as listed in EPA’s standards. Though; the characteristic of this wastewater is the predominance of dissolved organic matter due to its sources found in wastewater which are whey, lactose, fat, and minerals also present in this water [30-34].

The dairy wastewater involves milk solids, soaps, disinfectants, milk wastes, and cleaning water. It is also deemed by high intensities of nutrients and organic and inorganic contents. Instance, salting proceedings across cheese making may product in high salinity amounts. The acids, alkali in different compositions could be included with microbiological load, pathogenic viruses, and bacteria [35-37]. Treatment of dairy effluents appears to be a Necessity. Many papers tried different and various processes and treatments were conducted and came out with different acceptable results [38-40].

3. Revision of Sodium-Ion

Sodium is one of the important elements of the human body for its direct relationship to blood pressure, so when it is reduced or increased there will be a disturbance of blood pressure due to the oscillation of the pressure state during the gastric membrane of the blood vessels and arteries. Therefore, its shortage or increase leads to such problems. In general, the diet needs less than 500 mg per day [41-43].

$Sodium^{1+}$ is a monoatomic mono cat ion gotten after sodium. It has a rank as a human metabolite and a cofactor. It is an alkali metal cation, essential sodium, a monovalent mineral cation, and a monoatomic mono cation [44-46].

Sodium is absorbed from the small intestine (fasting), and a small amount of it is absorbed from the stomach. On the other hand, NaCl and KCl are excreted in a small amount of gastric juice [47].

It is the main extracellular descending, which enters nerve and muscle cells in working condition, and is then pumped out of the cell by a sodium pump [48, 49].

Amounts

It's an estimated 40-60 mole. 60-70% of them are quickly interchangeable

If it is less than:

125 mmol / l causes mental confusion

120 mmol / l cause shock

Its plasma concentration: 135-147 mmol/L

Its concentration in CSF is 135-145 mmol/L

Intracellular sodium is 1-2% of total sodium.

The sodium ion diameter is 0.095 nm, while A free aluminum atom has a radius of 143 pm [51-53]. The covalent radius is also named the atomic radius (when a covalent bond is formed), and the non-metallic radius in the case of non-metallic elements, the metallic radius in the case of metallic elements [54, 55]. Technically, the atomic radius is half the balance distance between two adjacent atoms (which are linked together by a covalent bond or are located close to each other in the form of a crystal net of any element. What is striking is that although the ionic radius of aluminum is small compared to sodium, it has the susceptibility to sedimentation of pollutants across a range of mechanisms [56, 57]. These mechanisms are concentrated in a range of names, including the mechanism of scavenging or catching, and possibly adsorption, electrical attraction, and even chemicals. The three shipments he owns help him to do these mechanisms very strongly compared to sodium, but sodium has a great potential for the formation of gelatin-like gels [58, 59].

4. Materials and Methods

4.1. Materials

- Various materials and apparatuses have been used in this article which are:
- Aluminium sulfates, which are known as Alum and have the chemical formula $Al_2(SO_4)_3$.18 were poured into 1 litter. The solution will have a concentration of 1%.

This figure comes from adding 10 gm. to 1 litter of distilled water. To keep the characteristics of the solution unchanged, it has been remade every week.

- Graduated pipettes have been used to suck and pour liquid, dose each beaker with the anticipated amount of metal salt, rising concentration from left to right,
- Then been operated stirrer to simulate plant process,
- Limit best dose level by testing supernatant,
- Jar test model JLT 6 Leaching test VELP has been used in this article. The brand Scientifica, with all apparatuses and tools has been used to complete work.

It has been prepared mock models at lab rendering to international features with size of one litre. The Jar-Test technique has been applied on these samples to achieve the results. As shown in table 1.

Table 1. The reaction process of treatment

Material (Solution)	Equation	Amount	Unit
Alum 2.285 ml	Alum 2.285 ML------ Al^{3+} =0.8 g/L ------- Al^{3+} =2.25 mg/l	Al^{3+} =2.25	mg/L
Alum 2.857 ml	Alum 2.857 ML ----- Al^{3+} =1.00 g/L ------- Al^{3+} =1.55 mg/l	Al^{3+} =1.55	mg/L
Alum 3.428 ml	Alum 3.428 ML ----- Al^{3+} = 1.2 g/L ------- Al^{3+} =1.45 mg/l	Al^{3+} =1.45	mg/L
Alum 4.285 ml	Alum 4.285 ML ----- Al^{3+} = 1.5 g/L ------- Al^{3+} =1.7 mg/l	Al^{3+} =1.7	mg/L

4.2. Tools and Chemicals:

The tools and apparatuses handled in this work are Turbid meters, Scale, COD Device, Spectrophotometer, Dryer Oven, glasses and pipettes, cones, carafes, sieve papers, and other tools. Chemical Kits to measure COD, Total Phosphates (TP), EC, pH meter, Total Nitrate meter, HCL acid and other chemicals like NaOH, and other chemicals, NaCl salt and salts.

4.3. Procedure of Work

These article has been achieved through the usage of synthetic samples which has been prepared by running kaolin clay as a source of initial turbidity which was 113 NTU. The synthetic samples have's several sorts of salts which afford the similar individuality as raw samples. The greatest significant fact is to reach the finest extent of coagulant by means of the Jar Test Technique. The laboratory works has been achieved by using various devices.
It has been used different tools:
4.3.1 1000 ml graduated cylinder,
4-3.2 Graduated pipettes,
4.3.3 Operated stirrer to simul
ate the plant process.
4.3.4 different apparatuses to determining the best dosage.

5. Results and Discussion

The outcomes denoted after finishing tests has been tabulated in Table [2] below.

Table 2. The reaction process of treatment

Material (Solution)	Equation	Amount	Unit
Alum 2.285 ml	Alum 2.285 ml------ Al^{3+} =0.8 gm./l ------- Al^{3+} =2.25 mg/l	Al^{3+} =2.25	mg/l
Alum 2.857 ml	Alum 2.857 ml ----- Al^{3+} =1.00 gm./l ------- Al^{3+} =1.55 mg/l	Al^{3+} =1.55	mg/l
Alum 3.428 ml	Alum 3.428 ml ----- Al^{3+} = 1.2 gm./l ------- Al^{3+} =1.45 mg/l	Al^{3+} =1.45	mg/l

Alum 4.285 ml	Alum 4.285 ml ----- Al^{3+} = 1.5 gm./l ------- Al^{3+} =1.7 mg/l	Al^{3+} =1.7 mg/l

The process of treatment based on these foundations, has been functioned on 2 liters of samples. Grounded on these tests the amounts above should be split by 2. on the other hand, the values must be divided by two to obtain realistic results in Figure (2) below. After dividing the results by two, the results will lead to be more logical and close to the real situation due to the use of two-liter flasks per beaker. This usage was the result of giving more space to the chemical process and treatment. In addition, the mixing efficiency and the role of the slope in the speed will be greater and the flocculation will be less affected by all the surrounding factors [61-63].

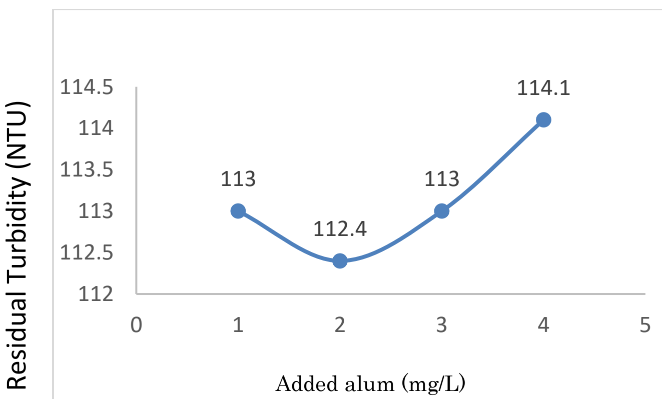

Figure 2. Relationship between added alum (mg/L) and residual turbidity (NTU).

- The main determinants have been adopted from references [64, 65].
- Rapid mixing duration is 3 min.
- The gradient velocity for rapid mixing are (122.79 sec-1, 205.7 sec-1) for 10 °C and 30 °C respectively, which mean temperatures of lab and samples.
- Peak worth was developed from the retreat value at a gentle mingling and blending speed (31.5, 38.4 sec-1 respectively), While the optimal sintering period was found 30 min.

G value has been used as an abbreviation for scaling the intensity of stir. This value has been adopted via Camp and Stein (1943), is extensively wrought in proposing rapid mixing and flocculation procedures [24]. This value is explained by equation (1). The last equation was applied in this topic then presented in Figure (3).

$$G = \sqrt{W}/\mu \qquad (1)$$

Which W= Dissipation function,

μ = absolute viscosity Kg/m.sec.

$$G = \sqrt{P/\mu} \qquad (2)$$

Where is P = Power per unit volume

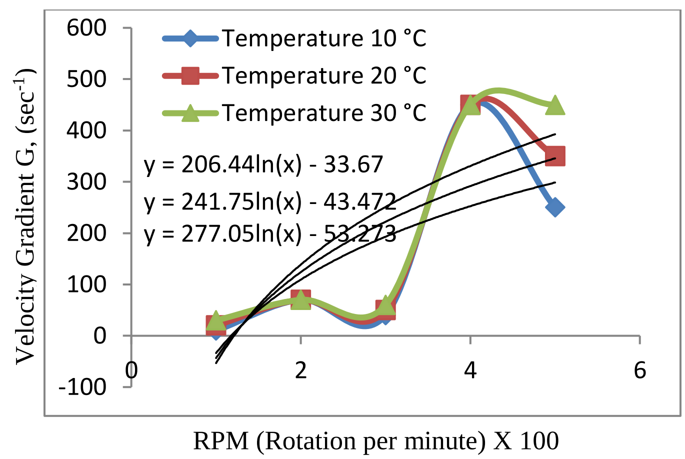

Figure 3. Relationship between the rotation of the paddle per minute and velocity gradient at different temperatures.

It has been demonstrated the relationship between the concentration of residual phosphorus and added alum. This drawing showed the ability of alum to build different chemical compounds with phosphorus, depended on results gathered from laboratory work. These explanations are showed at figure (4).

$$Al^{3+} + H_nPO_4^{3-n} = AlPO_4(S) + n\,H^+ \quad (3)$$

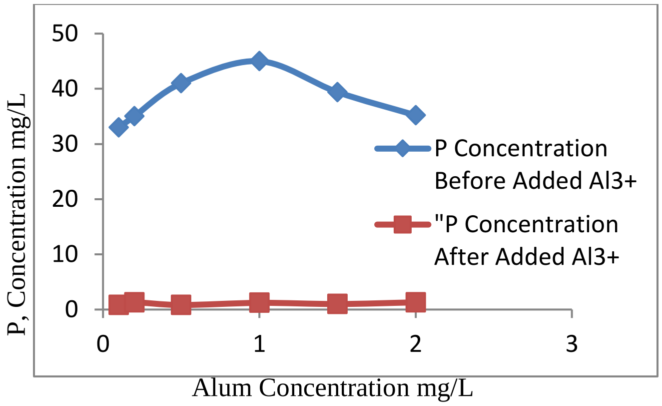

Figure 4. The Relationship between concentrated aluminum and concentrated phosphorus

There are limits to the effectiveness of aluminum sulfate known as alum.

Concentrations on the treatment mechanism were studied see Figure (5). Sodium salt was added to the wastewater in dairy products to remove contaminants. This process was performed to monitor the role of sodium in the treatment mechanism in the presence of aluminum ion and how to remove contaminants. Here what is meant is the removal of phosphorous which is indirectly implicit in the existing diuretics and the sources of pollution in the model. This process should be according to the study of treatment theory without the risk of adding any salt to treatment and without regard to the consequences. Because the results will lead to an increase in the salinity of the treated water and this will lead to an increase in the discharge of these salts to the water bodies and then the environment. The purpose is to control the treatment with thrombus such as alum, thus obtaining better wastewater treatment.

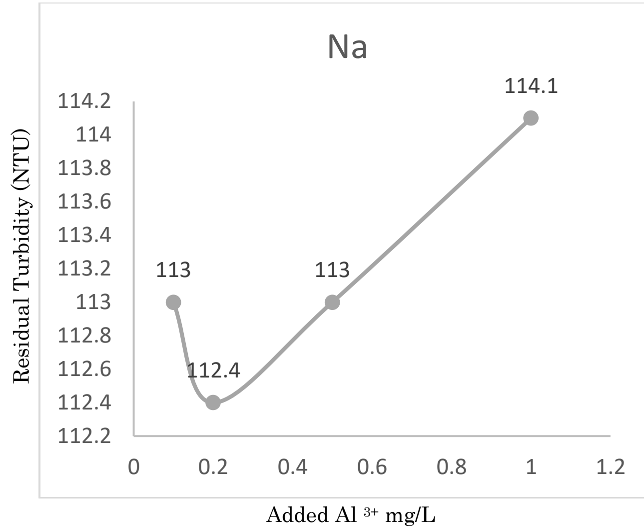

Figure 5. Show's the relation between Alum, sodium, turbidity removal by alum

This drawing can be said to be that sodium ion plays a role as a help in the removal of pollutants, which is evident through the form of a number (5). This is where the sweeping mechanism will be applied, and of course, this happens after the formation of aluminum hydroxide. Here the role of the sodium and because it carries one shipment would be similar to the role of sand in construction of concrete mix, which plays the role of a link between cell components for mounting the wall of a brick building. Notes of this form also the arms of this composition (hydroxides of aluminum gelatin), and how they received support by attracting sodium ions and then increase the effectiveness in greater deposition of contaminants to different mechanisms as shown in Figure (6).

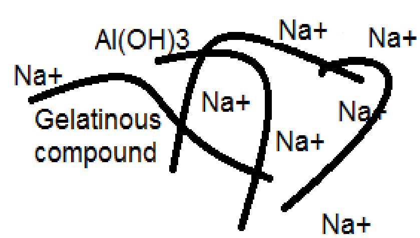

Figure 6. The movement and interaction of aluminum ion with gelatin aluminum hydroxide in the removal of contaminants

The best removal of phosphorus will be 95.7%~96% when added 1.45 mg/L of the aluminum ion as alum as shown in Figure (5). In same time he optimum value of alum is 0.5 mg/L., and this led to 0.2 mg/L Al3+.

The following is a note from Figure (7) below, indicating a decrease in the sodium ratio, with an increase in the percentage of phosphorous removal and an increase in the deposition of aluminum compounds. The concentrations were read through examinations, as shown in the x-axis. At the same time, it has been observed that the remaining aluminum concentration decreases and this confirms the readings of Figure (5) above, which gives the impression of the scavenging mechanism with aluminum hydroxides supported by sodium ions that carry one positive charge.

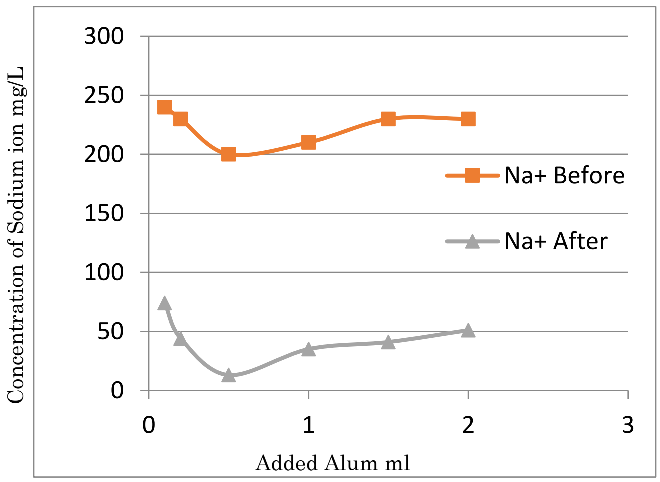

Figure 7. The Relationship between concentrated aluminum and Sodium ion before and after treatment

6. Conclusions

- Play Sodium-ion as an assistant item in removal phosphate, due to its mono charge which gives supporting Aluminum floc in removal phosphorus.
- The ability of the aluminum ion to remove phosphorous by 95%, and create the aluminum phosphorous Floc and these gelatinous properties that can drop. Here, the sodium ion had a role in this activity, and the participation rate was the removal percentage, which is 23.08% of the original sodium concentration.
- The concentration of phosphorus will be 0.5 mg/L in 20 ° C when the gradient velocity is equal to 1076.915 seconds -1.Here, the concentration of sodium ions contributing to this activity was 60 mg per liter, which is the concentration that represents 23.07% of the initial concentration.
- The aluminum phosphate compound also had an important role in removing phosphates through the scavenging mechanism. Here, sodium had an auxiliary role by building this tease by connecting it as sand particles in the cement mixture. Therefore, it is noted that the sodium concentration was the lowest concentration when optimum removal of phosphate by aluminum.
- The greatest temperature to realize the finest action and elimination of phosphorus and the best participation of sodium ion is 20 degrees Celsius, and therefore the best gradual velocity will be achieved.

7. Summary of the purpose of conducting the research

In this study, the role of sodium ion in removing phosphorous from milk waste water was studied. The main goal was the possibility of controlling some parameters for completing the treatment process using alum as a coagulant, and from here this control over the parameters will reduce the amount of alum used to achieve the best treatment. To achieve this goal, some parameters have been re controlled as well as managed some parameters to reduce the amount of alum needed to make treatment.

Declaration of Conflict of Interests

The authors declare that there is no conflict of interest.

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