Journal of Engineering and Applied Sciences 4 (5-6): 310-317, 2009
ISSN: 1816-949X

Treatment of Urban Sewage Duration Coagulation Process with Use Natural Materials

[1]Vahid Yazdani, [2]Hoseyn Banejad and [3]Mansor Gholizade
[1]Department of Irrigation Engineering, Ferdosi University, Iran
[2]Department of Irrigation Engineering, Faculty of Agriculture, BU Ali Sina University, Iran
[3]Department of Irrigation Engineering, BU Ali Sina University, Iran

Abstract: In many arid areas of the world, the waste water of the cities is considered as one of the valuable and revivable sources of water. Sewage purification, in addition to environmental preservation, helps to recover the water for us to use it again. Considering the shortage of water and the cost of water sources recovery and purification, we can use the waste water that remains after the purification of cities sewage and industrial sewage for different uses. This kind of reusing the waste water depends on the quality and the quantity of sewage, grade of purification, cost of purification and the environmental rules and standards. In this study, the researchers tried to measure the efficiency of a mixture of the Plantago Major powder, Alyssum SP, Plantago Psyllium and Zizi Phora Clinopodioides in comparison with aluminium sulfate efficiency in the course of purification. In carrying out the experiments, the city sewage with the average level of impurity have been used. The coalescence experiments have been done by the Jar machine and the sewage quality parameters have been measured by the methods described in the Standard Method book. Surveys have shown that in the optimum density of the four seeds the percentage of removing turbidity, total solidity, Calcium solidity, Magnesium solidity, the total Coliform and Ashrshya are equal to 99.5, 65, 61, 90, 95 and 94, respectively. Regarding the results, we came to the conclusion that the mixture of 30 mg L^{-1} of the four seeds powder with 20 mg L^{-1} of Alum is more efficient than other kinds of attendance. One of the most important advantages of using the four seeds powder in comparison with Alum is the reduction of sedimentation time from 30-10 min. Considering the results of surveys, we can mention that the sludge volume resulted from the four seeds powder is less than the sludge volume resulted from the Aluminium Sulfate and also dehydration of sludge resulted from the Aluminium Sulfate is more difficult and more time consuming than dhydration of the sludge resulted from the four seeds powder.

Key words: Sewage purification, plantago major, alyssum SP, plantago psyllium, zizi phora clinopodioides, aluminium sulfate

INTRODUCTION

Using the coalescence materials in water purification in order to remove the turbidities has a long history and it dates back to the usage of Alum by Egyptians in 2000 BC. After centuries in 1767, this substance has been used by ordinary people of England in making the muddy waters clear. The credit of doing coalescence process by the usage of Iron Per Chloride was granted to the New Orleans Company in 1884 for the first time and in the next year, they reported the results of their first researches on Alum as a coalescent in the Rutgers University. The result of the developments was that the coalescence was being known as a preprocess that completed the filtration operation. Most of the people, who live in the rural areas of the developing countries (especially Asia and Africa) are forced to use sources of surface waters and sewages, which are often very turbid and bacterial infected to supply their needed water (for drinking or farming). These rural people have found through the centuries that some plants can purify the turbid and polluted waters. These autochthonous plants are not only able to coalesce and settle the impurities of water, but also are of a great aid in order to avoid wasting money on importing current coalescent chemicals in water purification industry, like Aluminium Sulfate (Alum) from the economic point of view.

Different coalescent and co-coalescent materials are being used during the process of coalescence. Coalescent materials include materials that are used to make the

Corresponding Author: Vahid Yazdani, Department of Irrigation Engineering, Ferdosi University, Iran

ingredients impermanent and then stick them together, whereas the purpose of adding these materials is to increase the density of attached ingredients and help them to settle more quickly. During the recent years, lots of researches have been carried out about the coalescence process and different coalescent materials have been studied. Today, Aluminium Sulfate and Fricke Chloride are one of the most current coalescents that are being used in water purification in order to remove turbidity. Poly Aluminium Chloride (AL_2 (OH) nCL 6-n) is also a pre-polymerized coalescent that is being used vastly in recent years as it has become one of the most current coalescents in water purification in countries such as America, Canada, China, Italy, France and England (Montgomery, 1995; Nonod and Brault, 1991).

Using too much coalescent together with lime in advanced coalescence process causes the production of clods and sediments, which produces too much sludge. Since, the dehydration of this sludge is very difficult, using these coalescents would not be advantageous. As a result, natural coalescents are being used more and more these days. According to the discussion, we can mention the researches of these scholars as follows:

Muyibi and Okufu (1995) have used the powder of Maringa seeds for coalescence and purification of turbid waters. They concluded that the more turbid the water the more Maringa reacts, as its reaction was evaluated 50% in waters with low to medium level of turbidity (23-90 NTU), whereas the efficiency of reducing turbidity in high levels of turbidity (600 NTU) is 98.5%. Ndabigengesere and Narasah (1998) have used two kinds of attendances including the powder of Maringa seeds, one with husk and the other without husk, in comparison with Alum for water purification in Canada. They came to the conclusion that the sludge volume produced by Alum is much more than the sludge produced by Maringa (almost five times as much) and in this case, the sludge volume produced by powder of seeds without husk is less than the sludge volume produced by powder of seeds with husk. Alum operation in reducing Carbonate Calcium and sulfate of sample water is better than the powder of Maringa seeds, Maringa seeds operation in reducing phosphate, oxygen needed for chemicals, Nitrate and Magnesium of sample water is better than Alum and also the operation of Alum and the powder of Maringa seeds in the reduction of Calcium of the sample water is almost equal.

Using each of the natural substances of Starch, Tragacanth, Zymogen and Fenugreek seed separately and with density of 1 and 5 mg L^{-1} as an aid for coalescence with Alum in optimum density of Alum results in the removing of turbidity to >94% (Bina *et al*., 2001). Mahvi *et al*. (2002) have surveyed the operation of natural yarns in removing Cadim from the industrial sewage waters and came to the conclusion that the ability of absorbents in absorbing Cadim with the density of 5 mg L^{-1} and the absorbent dosage of 0.5 g is 59.3% for wheat straw, 70.1% for rice straw, 79.3% for walnut husk and 97.1% for tea scum and also the metallic ion absorbed depends on the primary density of that ion.

Barkhordar and Qiyasiddin (2004) have observed the ability of Sargom alga in absorbing Chrome, Nickel and Copper from the industrial sewage. The results showed that the absorbing system with a low moving flow is always able to remove the heavy metals, to the degree that is allowed to be poured in the environment, in thin sewage, but the outgoing remained metal in heavy sewage and high moving flow will be great. Also, the quality of 1 g of dry Sargom alga in absorbing the above said metals is about 15.5 m mol. They also stated that the usage of Sargom alga for removing the metals is more economic than the ordinary methods of liming or ion exchanging. Mostajeran *et al*. (2006) have evaluated the reduction of industrial sewage pollution by green alga and green-blue alga. They have used the sewages of Naz Oil Company, Sugar Company and Isfahan slaughterhouse and the results revealed the high efficiency of the attendances in BOD5 and Chemical Oxygen Demand (COD) reduction. The said attendances in the optimum density were able to reduce BOD5 for 90% and COD for 80%.

Hitendra *et al*. (2007) have used Maringa seeds for sewage purification. They have used 50 and 100 mg of Maringa seeds powder alone and with the mixture of 10 mg of Alum. COD degree was measured after coalescence, settlement and filtration steps and the result showed that the mixture of 10 mg of Alum with 100 mg of Maringa seeds powder was the best in removing COD, (64% of COD have been removed). Katayon *et al*. (2005) have observed Alum and Maringa seeds operation in the reduction of water turbidity.

They came to the conclusion that 6 mg L^{-1} of Alum can reduce turbidity from 201-9.6 NTU. In this case, the reduction efficiency is 96.5% and Zeta potential increases from −16 to +5.8 mv. Total 80 mg L^{-1} of Maringa seeds powder is able to reduce the turbidity from (201-13.9 NTU) and in this situation the reduction efficiency equals to 93% and Zeta potential increases from -21 to 2.1 mv. Liew *et al*. (2006) have evaluated Alum operation in comparison with Maringa seeds for surface water purification in laboratory scale. The results showed that Maringa seeds, Alum and a mixture of the two cause in the reduction of turbidity and the final turbidity measured was 7.2, 4.2 and 3.2 (NTU), respectively.

Yazdani *et al*. (2008) have used Plantago Major, Quince and Manna seeds powder in the process of purification. They declared that in the optimum density of the substances the extent of removing turbidity is >80% in all cases. Also, the highest percent of reducing solidity in 10 mg L^{-1} of Manna was 98%. Using the substances in water purification results in the reduction of 20% of EC and 30% of TDS, averagely.

Economically, in addition to the fact that the water that has transferred into sewage is automatically unusable, it causes the surface and underground water resources to be polluted. Therefore water, as a limited vital resource, with its drastic shortage in the world is in danger. Regarding the hygienic risks and economical considerations paying attention to the production, collection and improvement of sewage is a necessary and inevitable affair. Besides, considering the cost of importing chemicals needed for sewage purification it is required to do some researches about the ability of natural substances in sewage purification. Thus, the researchers have tried to take into consideration the operation of Aluminum Sulfate in comparison with the four seeds powder in coalescence process and finally specify the best density for a coalescent in this research. It is to be mentioned that the main goal of this research is to find out the optimum density of these substances in reducing the measured instances hence, carrying out more experiments about densities more than the optimum is unjustifiable from the economical and technical point of view.

MATERIALS AND METHODS

Providing and preparing the powder for experiment: The powder prepared for the experiment was a mixture of Plantago Major, Alyssum SP, Plantago Psyllium and Zizi Phora Clinopodioides.

It is said that the powder under experiment is called the four seeds powder from now on to avoid lengthy statements. In preparing the powder, the seeds were put in the oven with the heat of 45°C to make sure that they are totally dry. Then the seeds were pulverized into a powder with the size of about 600 μm. Afterwards the required amount of the powder was dissolved in 20 m L of distilled water and was shaken for 3 min 5 h before the Jar test to make the necessary mucilage. After passing the mucilage through the filtration paper with the hatch diagonal of 0.45 μm, we got an equal blend without any suspending substance that was used as a coalescent. It is needed to make a new blend for each time of purification and also this blend should be kept in a cool place with at most 20°C of temperature to avoid changes in pH and viscosity.

Sewage sample: Raw sewage sample was collected daily (in the time of Jar test) from the river behind the agricultural department of Bu Ali Sina University. It should be mentioned here that all the raw sewage samples were collected in autumn and also on the basis of the primary tests on raw sewage, it was found that the sewage in use was in the range of medium city sewages from the pollution degree viewpoint. Some of the rudimentary features of sewage are shown in Table 1.

Purification: This research was done on the basis of laboratory scales and with the use of Jar test machine in the laboratory of water and sewage quality of agricultural department of Bu ali Sina University. Mixing operation caused an increase of contact between the substances that were become impermanent.

As a result, some clods were created that were able to be settled or strained. The mixing operation was done mechanically with Jar test machine and with the ability to choose the variant periods. After preparing the samples in the Jar test machine under the fast mixing operation with 120 turns min^{-1} for 2 min and the slow mixing operation with speeds of 60, 40 and 20 for 8, 8 and 5 min, respectively they were at last put at rest position for 10-30 min to be settled (Kawamura, 1991).

In the end solidity (total Calcium and Magnesium), turbidity, intestinal Coliform, total Coliform, acidity, total suspended substances and electrical conduction were measured in the samples and the efficiency of each of the said coalescents in removing the mentioned parameters was drawn by nomination regression and related charts by using Excel software. It should be mentioned here that the methods of measuring quality parameters were totally on the basis of formulas explained in the Standard Method book.

Table 1: Some of particular sewage

EC (mmoh cm^{-1})	TDS (mg L^{-1})	pH	T (c)	Turbidity (NTU)	Total coliforms	*E. coli*
8	5200	8.3	12	450	16000	6000

REULTS AND DISCUSSION

Turbidity reduction: The percentage of turbidity reduction by Alum is shown in Fig. 1. Considering Fig. 1, increasing Alum density causes an increase in the percentage of turbidity reduction. In the best condition, the efficiency of turbidity reduction was 99.5% that was seen in the 20 mg L^{-1} of Alum. It should be noted that a change in the efficiency of turbidity reduction in densities >20 mg L^{-1} of Alum in 95% state did not have any senses. Therefore, carrying out experiments on densities >30 mg L^{-1} of Alum is not justifiable from the economical and technical point of view.

In the following, the effect of the mixture of four seeds powder with Alum in turbidity reduction was needed to be surveyed. On this basis, the efficiency of turbidity reduction by using this mixture is shown in the Fig. 2. As shown in Fig. 2, the mixture of Alum with four seeds powder makes the reduction of turbidities more effective. It should be mentioned that mixing 20 and 30 mg L^{-1} of Alum with different densities of four seeds powder did not make any drastic change in the efficiency of turbidity reduction. Surveys have shown that the most amount of turbidity reduction was taken place by using the mixture of 30 mg L^{-1} of Alum along with 30 mg L^{-1} of four seeds powder, which in this condition the percentage of turbidity reduction was 99.9%.

Whereas, researchers such as Katayon *et al.* (2005) and Liew *et al.* (2006) have come to the turbidity reduction of about 95% by using natural substances in their experiments. The results show a reduction in the time consumed for settlement 20 min, when using this mixture in purification process in comparison with using only Alum. The settlement time reduced from 30-10 min. This reduction in time is the result of producing more permanent and heavy clods. This reduction in settlement time was also proved to be the result of producing more permanent and heavy clods by Muyibi and Okufu (1995).

It was found that the sludge volume produced by Alum is more than the sludge volume produced by four seeds powder. Besides, dehydrating the sludge produced by four seeds powder was easier. Ndabigengesere and Narasah (1998) have also reported Alum to produce more sludge and harder to be dehydrated.

Removing solidity: The higher percentage of removing solidity (total, Magnesium and Calcium) was seen in densities of 20, 10 and 20 mg L^{-1} of Alum, which were 32, 75 and 28.1, respectively. The lower degree of solidity reduction was related to Calcium solidity, which was seen in the density of 30 mg L^{-1} of Alum, which increased

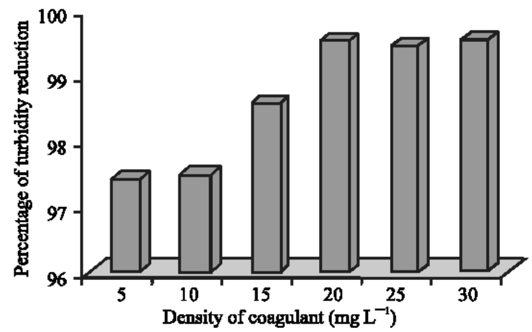

Fig. 1: Percentage of turbidity reduction by Alum

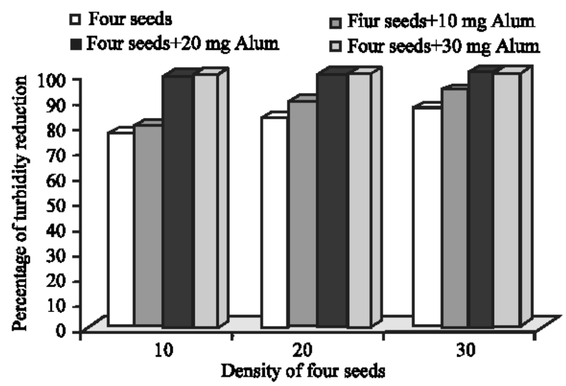

Fig. 2: Efficiency of turbidity reduction by using mixture of four seeds powder with Alum

12.5%. As shown in Fig. 3, an increase in the amount of Alum causes a decrease in the efficiency of removing solidity (Fig. 3). Ndabigengesere and Narasah (1998) have also mentioned the low efficiency of Alum in its higher densities in relation to removing solidity.

Considering Fig. 3, an increase in the density of four seeds powder causes an increase in its percentage of removing solidity. It should be noted that the efficiency of four seeds powder with 30 mg L^{-1} of density was higher in removing the total solidity than in other conditions. In this density, the efficiency of removing solidity was 65%.

Also higher percentage of removing Calcium solidity was caused by 30 mg L^{-1} of four seeds powderm, which was equal to 61%. In contrast low densities of four seeds powder did not have any effect on reducing Magnesium solidity. The higher percentage of removing Magnesium solidity was 90% in 30 mg L^{-1} of four seeds powder. It is clear that the density of 30 mg L^{-1} of four seeds powder have the best degree of efficiency in reducing solidity.

Removing coliform: For providing a clearer picture of the efficiency of these substances in sewage purification, in

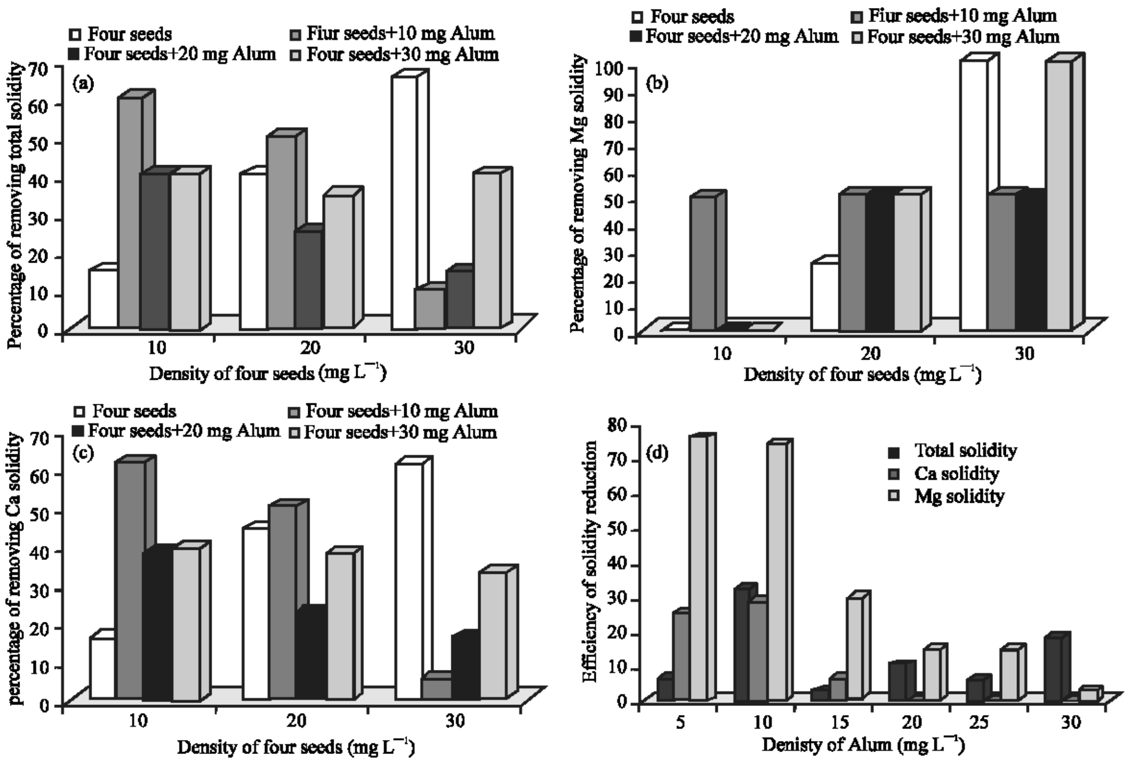

Fig. 3: (a-d) Efficiency of solidity reduction

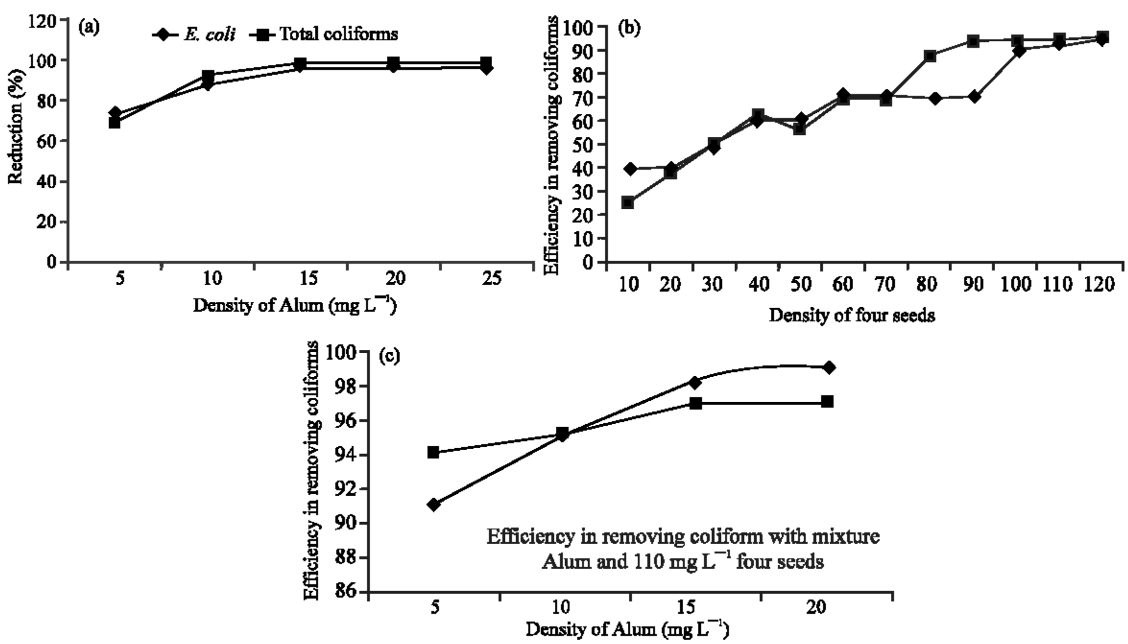

Fig. 4: (a-c) Efficiency of coliforms reduction

a sterilized way, we needed to survey their efficiency in removing Coliforms. On this basis, the reduction percentage of removing Coliforms by different densities of Alum and the four seeds powder is shown in Fig. 4. Surveys revealed that the highest percentage of removing occurs in 110 mg L^{-1} or more density of the four seeds

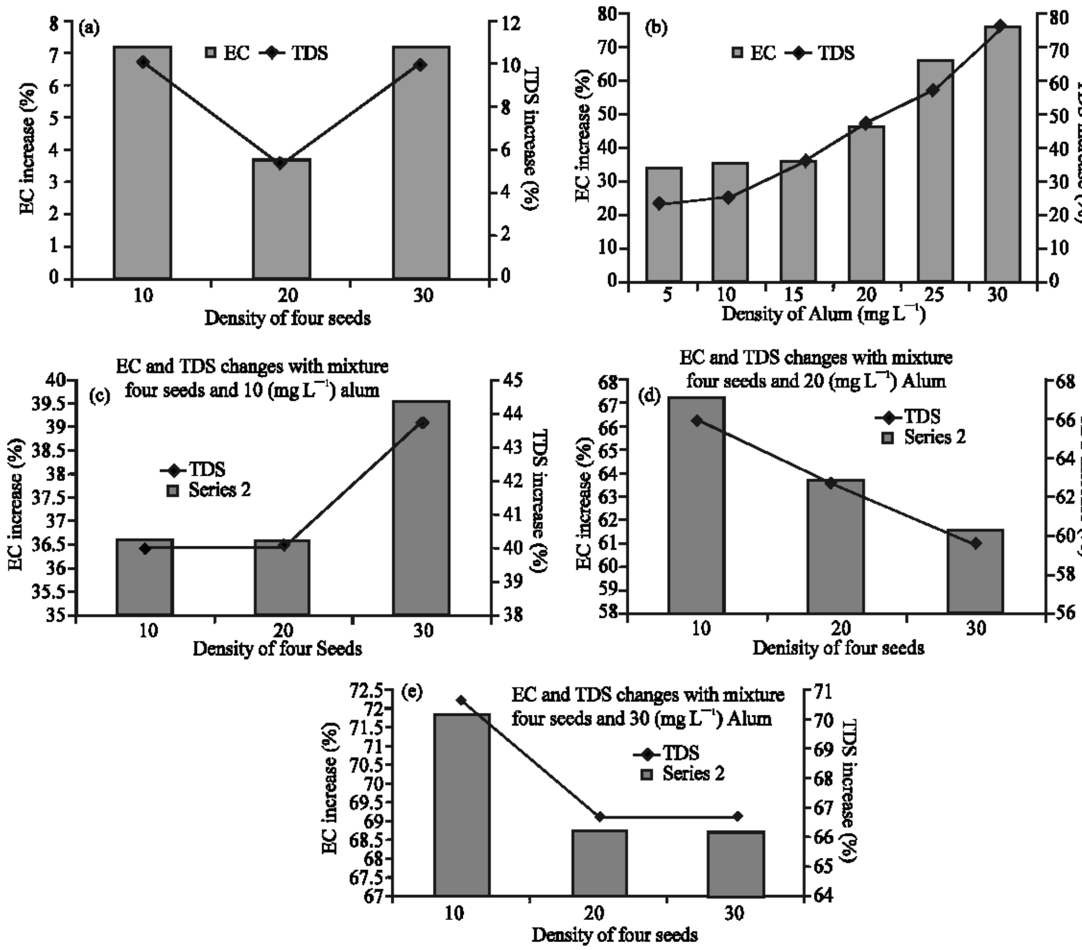

Fig. 5: (a-e) Percentage of EC and TDS increase

powder. With this level of density, the reduction percentage of total Ashrshya and total Coliforms was equal to 93.7 and 92%, respectively. In contrast with highest Alum density, the reduction percentage of total Ashrshya and total Coliforms was equal to 98 and 95%, respectively. It should be mentioned that with densities >110 mg L^{-1} changes in Coliforms reduction efficiency in 95% level was unjustifiable. Therefore, mixture of Alum and the four seeds powder has also a high efficiency in removing Ashrshya. It is to be noted that removing Coliforms has a direct relation with turbidity reduction and an increase in turbidity reduction percentage causes the Coliforms removing happens more easily. As shown in Fig. 4, when the Alum density increases in the time of mixing with the four seeds powder, the Coliforms reduction efficiency increases at first and then decreases.

This property is relevant to the intervening effect of the four seeds powder in high density of Alum, as some amount of the four seeds powder remains sustained and almost causes a reduction in efficiency. From other results of Fig. 4, it can be mentioned that the purification operation on removing Ashrshya is more effective than other Coliforms.

EC and TDS changes: Electrical conduction is one of the important indicators of qualifying the water quality. Electrical conduction is used in qualifying the surface waters quality, purified waters in refineries and water and sewage storages. This method can be used in making sure of the analysis results of the ion environments. In some cases, the absolute amount of conduction is important and in other cases its relative changes is considered. Because, the four seeds powder is an herbaceous substance did not have a drastic effect on increasing EC and TDS, in contrast because Alum is a chemical substance causes EC and TDS to increase, this is a negative property of chemicals in water and sewage purification. As shown in Fig. 5 using Alum causes an increase in electrical conduction and the rest of salts. This increase has a direct relation with turbidity reduction percentage. Therefore, high densities of the four seeds powder causes EC and TDS to be increased.

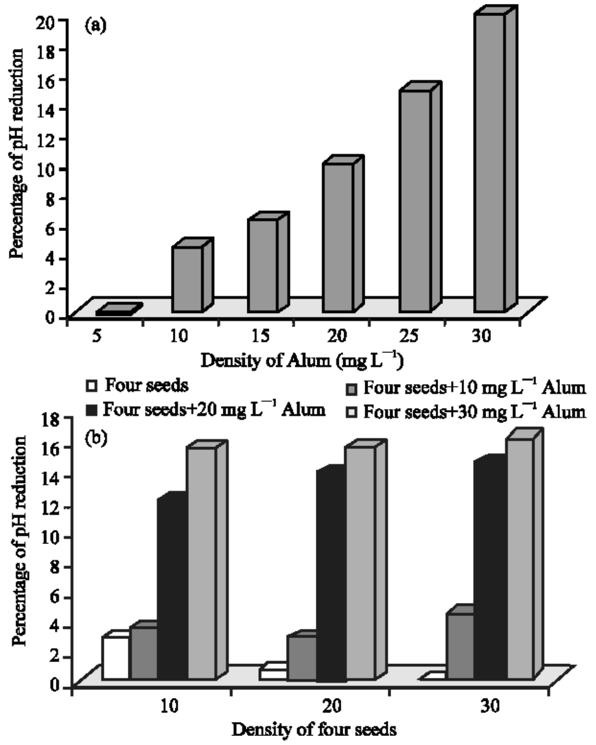

Fig. 6: (a and b) Changing pH in different densities of coagulants

This property is because high amounts of the four seeds powder do not settle and remain sustained. You should pay attention to the fact that adding the four seeds powder to Alum causes the negative effect of Alum in increasing EC and TDS to be reduced.

pH changes: In standard conditions, natural waters' pH is from 7-8.5 and in these waters Bicarbonate remains solved in water. Drastic changes of pH decreases the accessible amount of carbon, this takes place because of Carbonic gas emitting in acid environment or Carbonate settling in alkali environment.

In addition to affecting the Carbon system of water, drastic changes of pH can change the solving ability of Carbon Dioxide and hydrosphere capacity for absorbing water (Yazdani and Banejad, 2009). With regard to the above discussions measuring the effect of purification process on water acidity is of importance. Hence, for presenting a clear picture of acidity changes, the process of changing pH in different densities of coalescents is shown in Fig. 6.

As shown in Fig. 6, increasing Alum density causes an increase in pH reduction, this reduction in pH causes the water to get acidized, therefore, in most of the refineries lime is added to the water to compensate for the pH reduction. It should be mentioned that dehydrating the produced sludge is very difficult and time consuming; hence, liming is not advantageous from the economical point of view. Results show that Alum property in reducing pH is adjusted, when mixing with the four seeds powder.

Table 2: Some of purified sewage characteristic

Parameters/coagulant	Alum	Four seeds	Alum+ four seeds
pH	8.03	8.64	8.7
P (Mg L^{-1})	0.33	0.013	0.35
NO_3 (Mg L^{-1})	0.89	0.52	0.21
E-coli (MPN/100 mL)	900	120	100
Total coliforms (MPN/100 mL)	1500	300	220
Turbidity (NTU)	5	14	8
Ca (Mg L^{-1})	0.32	0.12	0.28
Mg (Mg L^{-1})	0.58	0.5	0.054

Investigating purified sewage from the environmental standards viewpoint: Regarding the water shortage crisis and the cost of water sources improvement and their purification in the world, the sewage remained from the cities and industrial sewage purification can be used for different uses of cities and other areas. The type of reusing depends on the quantity and quality of raw sewage, the needed purification degree, the cost of purification and environmental regulations and standards. Biological pollution is one of the most important concerns in using sewage wastes for watering. Generally, in most of the given standards, after the secondary purification process, using antiseptics is a complementary process that only on this condition the sewage waste can be used for watering the nutritions and parks. It is clear that the high density degree of substances such as Nitrogen and Phosphor is very useful and required for plants growth.

To give you a clear picture of the purified sewage waste quality, the measured amounts after purification operation is shown in Table 2. It should be mentioned that these amounts were gained in the best condition and the highest efficiency state.

Investigating the conformity of the purified sewage waste quality with the environmental protection standards we came to the conclusion that the sewage waste purified by Alum is absorbed to the shafts or abandoned in surface waters more than the standards used in agriculture or evacuation from the digestive Coliforms and all the other types of Coliforms measures viewpoint. The measured degrees in sewages purified by other attendances were less than the standard level and therefore there is no problem in using it in the three uses already mentioned. But it should be noted that because the EC in purified sewage is high, this sewage cannot be used for rain watering because it causes the leaves to be burnt.

CONCLUSION

The operation of 30 mg L^{-1} of the four seeds powder mixed with 20 mg L^{-1} of Alum is better than other kinds of attendances. One of the most important advantages of using the four seeds powder compared with Alum is a reduction in time needed for settlement (from 30-10 min). This advantage saves both time and energy. The reduction in time is because of the fact that the four seeds powder produces more heavy and stable clods in comparison with Alum. Surveys revealed that the sludge volume produced by the four seeds powder was less than the sludge volume produced by Alum and also dehydrating the sludge produced by Alum was more difficult and time consuming than dehydrating the sludge produced by the four seeds powder. It has to be mentioned that having the optimum density of the substances, the produced purified sewage preserving the environmental standards can be used to be poured into the surface waters or shafts and for watering. Therefore, this sewage can be used for any type of watering except for the rain watering because it causes the leaves to be burnt (the electrical conduction level is very high). With regard to the significant advantages of the four seeds powder usage and its satisfactory operation in purification it is suggested to be used in sewage purification.

REFERENCES

Barkhordar, B. and M. Qiyasiddin, 2004. Surveying the sargom alga capacity in absorbing Chrome, Nickel and Copper. Environ. Sci. Technol., 21: 11-18.

Bina, B., M. Shahmansori and A. Chinaee, 2001. Usage of nautral coagulant material for coagulant aid in water treatment process. J. Res. Med. Sci., 6: 113-119.

Hitendra, B.G., K. Folkard and S. Chaudhari, 2007. Innovative physico-chemical treatment of sewage incorporating *Moringa oleifra* seed coagulant. J. Hazardous Mater., 142: 477-482.

Katayon, S., M.J.M.M. Noor, M. Asma, L.A. Abdulghani and A.M. Thamer *et al*., 2005. Effects of storage conditions of *Moringa oleifera* seeds on its performance in coagulation. Biores. Technol., 97: 1455-1460.

Kawamura, S., 1991. Effectiveness of natural polyelectrolytes in water treatment. J. Am. Water Works Assoc., 83: 88-91.

Liew, A.G., M.J.M.M. Noor, S.A. Muyibi, A.M.S. Fugara, T.A. Muhammed and S.E. Lyuke, 2006. Surface water clarification using *Moringa oleifera* seeds. Int. J. Environ. Stud., 63: 211-219.

Mahvi, A.H., B. Bina and A. Saedi, 2002. Surveying natural brushes in removing *Cadim* from the industrial sewage. Water Sewage Sci. J., 43: 2-6.

Montgomery, J.M., 1995. Water Tretmrnt Principals and Desing. John Wiley and Sons, New York, pp: 28.

Mostajeran, A., Y.A. Sima and G. Emtiyazi, 2006. Reducing industrial sewage pollution by green alga and green-blue alga. Water Sewage Sci. J., 57: 37-46.

Muyibi, S.A. and C.A. Okufu, 1995. Coagulation of low turbidity surface water with *Moringa oleifera* seeds. Int. J. Environ. Stud., 48: 263-273.

Ndabigengesere, A. and K.S. Narasah, 1998. Quality of water treated by coagulation using *Moringa oleifera* seeds. Water Res., 32: 781-791.

Nonod, J. and J.L. Brault, 1991. Water Treatment Hand Book. 6th Edn., Degremont Co., France, pp: 3.

Yazdani, V. and H. Banejad, 2009. Evaluating the possibility of using surface waters in agriculture and industry (Saveh case study). Proceedings of the 2nd National Congress of Drought Effects and its Management Methods, May 30-31, Isfahan.

Yazdani, V., H. Banejad, M. Gholizade and A.R. Rahmani, 2008. Physical-chemical creativity in water purification. Proceedings of the 3rd Territorial Congress of Agricultural and Natural Resources Research Findings, Western Iran Universities, Kurdistan.