COMPARATIVE STUDY OF POLY INORGANIC COAGULANT IN WASTE WATER TREATMENT

F.M.Mohamed[1], K. A. Falous[2].

[1]Faculty of Marine resources, Al- Al-Asmaryia Islamic university , Libya
[2]Faculty of science, - Al-Asmaryia Islamic university , Libya
Corresponding author email : fathy732005@yahoo.com

ABSTRACT

Four novel of poly inorganic co-agulant were prepared such as poly aluminum chloride (PACl), poly ferric chloride (PFeCl), poly aluminum hydroxy silicate (PAHS) and poly aluminum ferric chloride (PAlFeCl) and characterized using FTIR, NFTIR and XRD. The samples were compared with conventional coagulant such as PAC` and Alum. Applications were carried out for the removal of some pollutants from ground and sewage waste water. It was found that the maximum percentages removal of $Fe^{+2}$ and $Mn^{+2}$ ions in ground water reached 99 and 92%,using PAC` and PAC respectively, the maximum percentages removal of COD, BOD and TSS in sewage waste water reached 88, 85, and 92%, using respectively PAlFeCl. The removal percentage of the same pollutants Fe^{+2}, Mn^{+2}, COD, BOD and TSS are 99, 83, 76, 70 and 91 % respectively when using conventional PAC, and in the case of Alum the removal percentage of Fe^{+2}, Mn^{+2},COD, BOD and TSS are 99, 83, 63, 62.5 and 90 %, respectively. Therefore, the co-polymer of iron and manganese co-agulants is considered as a better replacement technology for sewage waste water treatment due to low cost and good efficiency in this application, as well as it will solve the problem of water shortage and contribute as a non-conventional water resources.

Keywords: poly inorganic coagulants, conventional co- agulants, some pollutants removals.

1. INTRODUCTION

Wastewater treatment could become an important source of water and should be considered in any new water resource development policy. However proper attention must be paid to the associated issues with such reuse. The major issues include public health and environmental hazards as well as technical, institutional, socio-cultural and sustainability aspects (Fathy, 2009).

Aluminium and Ferric Salts are extremely versatile coagulants in the treatment of waste Water. Using Al and Fe based coagulants, water of widely differing chemical characteristics and biological quality can be successfully treated. Alum is the most widely used coagulant in the water treatment industry. In recent years, polymerized forms of Al and Fe have been used increasingly in water treatment due to advantages of these compounds over Alum. Poly Aluminium Chloride (PAC) is most common in this regard(F.M. Mohamed 2009).

Clean and safe drinking water is basic requirement for all. In the water treatment one of the main purposes of the initial treatment step is to remove suspended solids and colloidal impurities. By using PAC, coagulation/flocculation destabilizes and aggregates small, stable colloidal impurities into larger particle units called flocs, which are essentially removed in the subsequent solid-liquid separation stages of sedimentation (or flotation) and filtration, which is also the main way of removing pathogenic protozoan cysts. In raw water treatment, PAC coagulates very effectively in low as well as high turbidity water, which results into the rapid and better floc formation. PAC is used as a coagulant to remove suspended solids from raw water for the treatment for potable water(Fathy, 2009) (F.M. Mohamed 2009)..

The suspended solids are settled down rapidly and converted into thick flocs. In addition, it also helps in removal of some metal impurities (e.g. Fe, Mn) from water. PAC helps in reduction of Fluorides also. Water treated with PAC displays less reduction in pH. PAC is very effective coagulant in comparison to any other commonly used chemicals for the purpose of water purification(F.M. Mohamed 2009)

The simple chemistry behind the effectiveness is the polymeric nature of compound which has high ionic charge. Since the charge is very high, this would explain the superior properties of such chemical in comparison to other commonly used coagulants. Enormous saving in consumption of treatment chemicals makes it a preferred choice of customers. Other ancillary feature of using PAC is less sludge generation & ultimate reduction in labour cost of treatment. It also provides the treated water with less residual aluminum contents(F.M. Mohamed 2009).

Poly inorganic coagulants and conventional coagulants such as aluminum sulphate, aluminum chloride, ferrous sulphate …etc are widely used in water and waste water treatment. When poly inorganic coagulant is added to water, it produces a stable solution that has a negative surface charge. poly inorganic coagulant unite with the positively charged aluminum or with iron flocs, resulting in a larger and denser floc that settles faster and enhances enmeshment. Many researchers used adsorbent materials for removal of some pollutants (Abo-El-Enein S., et al., 2009, Abo-El-Enein S., et al., 2011, Jusoh, A,. et al., 2005, Kour, S., et al., 2008, Muter, R., et al.,2005, Namasivayam .,et al., 1995,Osipoowl.,et al., 1972, SenGupta Arup 2002, K.,(2002) Yu-li, Y., et al., 2006, Zacaria, R., et al., 2002, Ahmed F.,et al., 2015).

This study concerns with the evaluation of polyinorganic coagulants and conventional co –agulants (Alum and PAC) in removal of pollutants from waste water.

2. MATERIALS AND METHODS

All chemicals used are of commercial grade except sodium hydroxide is an analytical grade product. Deionized water was used to make all solutions.

Four samples of poly inorganic co-agulants were prepared and characterized as conducted by(F.M. Mohamed 2009). The samples of novel poly inorganic coagulants, conventional PAC and Alum were used to remove some pollutants from ground water such as iron, manganese using representative samples obtained from a certain well. They were also applied for the removal of BOD, COD and TSS from sewage waste water to obtain the water quality for re-use in agricultural drip irrigation systems, where, the treatment depends on precipitation, coagulation and adsorption techniques by poly inorganic coagulants (PIC). Each sample was mixed with 5-10 ppm of PIC and agitated for 1 minute rapid mixing (300 rpm), followed by slow mixing for five minutes and (30 rpm) and 20 minutes standing time.

The concentrations of pollutants were measured in ore samples and in the filtrate using AAS and analyses as showed in (APHA, 2005)

3. RESULTS AND DISCUSSION

The data presented in Table (1) and represented in Figure (1) are summarized the variations of physicochemical properties of ground water before and after treatment using four samples of poly inorganic coagulants and conventional Alum and PAC`.

It was found that, the removals percentages of iron and manganese are 94, 20%, respectively, using PAC, the removals percentages of iron and manganese are 95, 20%, respectively, using PAlHS. the removals percentages of iron and manganese are 94, 19%, respectively, using PFeCl, the removals percentages of iron and manganese are 85, 6%, respectively, using PAlFeCl. the removals percentages of iron and manganese are 99, 19%, respectively, using PAC`. the removals percentages of iron and

manganese are 99, 17%, respectively, using Alum. Whereas The maximum removals of iron and manganese are 99 %, 19%, respectively, using PAC`. The data presented in Table (2) and represented in Figure (2) are summarized the variations of physicochemical properties of alkaline ground water before and after treatment using four samples of poly inorganic coagulants and conventional Aum and PAC. It was found that, the removals percentages of iron and manganese are 96, 97%, respectively, using PAC, the removals percentages of iron and manganese are 97, 77%, respectively, using PAlHS. the removals percentages of iron and manganese are 97, 92%, respectively, using PFeCl, the removals percentages of iron and manganese are 96, 92%, respectively, using PAlFeCl. the removals percentages of iron and manganese are 96, 83%, respectively, using PAC`. the removals percentages of iron and manganese are 99, 83%, respectively, using Alum. Whereas. The maximum removals of iron and manganese are 99 %, 97%, respectively, using PAlFeCl. The objective of such experiments of ground water to study the influence of alkaline media in iron and manganese removals while pH still within range, finally the residual carbonate appear in final solution. In all cases the residual aluminum was less than the permissible limits (0.2 mg/l). Concentration of sulphate and chloride ions increased using poly inorganic coagulants, conventional Alum and conventional PAC but still below permissible limits.

The data presented in Table (3) and represented in Figure (3) are summarized the variations of COD, BOD and TSS of sewage waste water before and after treatment using four samples of poly inorganic coagulants based on silica and conventional Alum and PAC. It was found that, the removals percentages of TSS, COD and BOD are 92, 72,78% respectively,

using PAC, the removals percentages of TSS, COD and BOD are 91, 77,78 % respectively, using PAlHS. the removals percentages of TSS, COD and BOD are 91, 82,85% respectively, using PFeCl, the removals percentages of TSS, COD and BOD are 91, 88, 85% respectively, using PAlFeCl. the removals percentages TSS, COD and BOD are 91, 76, 70 respectively, using PAC`. the removals percentages of TSS, COD and BOD are 90, 63, 62.5%, respectively, using Alum. Whereas. The maximum removals of TSS, COD and BOD are 91, 88, 85% respectively, using .PAlFeCl is the superior poly in-organic co-agulant copolymer may be attributed to the co-polymers of $Al^{3+}$and Fe^{3+} **(Yu-li et al., 2006)**.

As for the total dissolved solids it increased due to the formation new spiked ions. No variations of pH occurred and all the values after treatment are within permissible limits according to Egyptian law 44/2000.

TABLE (1): VARIATIONS OF SOME PHYSICOCHEMICAL PARAMETERS OF GROUND WATER SAMPLES BY INFLUENCE OF DIFFERENT INORGANIC CO AGULANTS

Coagulant / Parameters	Before treatment	After treatment						Permissible Limits
		PAC	PAHS	PFeCl	PAlFeCl	PAC`	Alum	
TDS mg/l	552	615	562	637	630	590	596	< 1000
pH	7.40	7.54	7.18	7.10	7.40	7.4	7.2	6.5-8.5
Cl^{-} mg/l	62	120	57	147	120	180	67	< 250
SO_4^{--} mg/l	59	61	148	70	70	74	143	< 250
Fe^{++} mg/l	1.946	0.11	0.086	0.112	0.289	0.07	0.08	< o.3
Mn^{++} mg/l	2.1	1.68	1.65	1.7	1.98	1.7	1.75	< 0.4
Al^{+3} mg/l	0.114	0.16	0.136	0.068	0.192	0.12	0.13	< 0.2

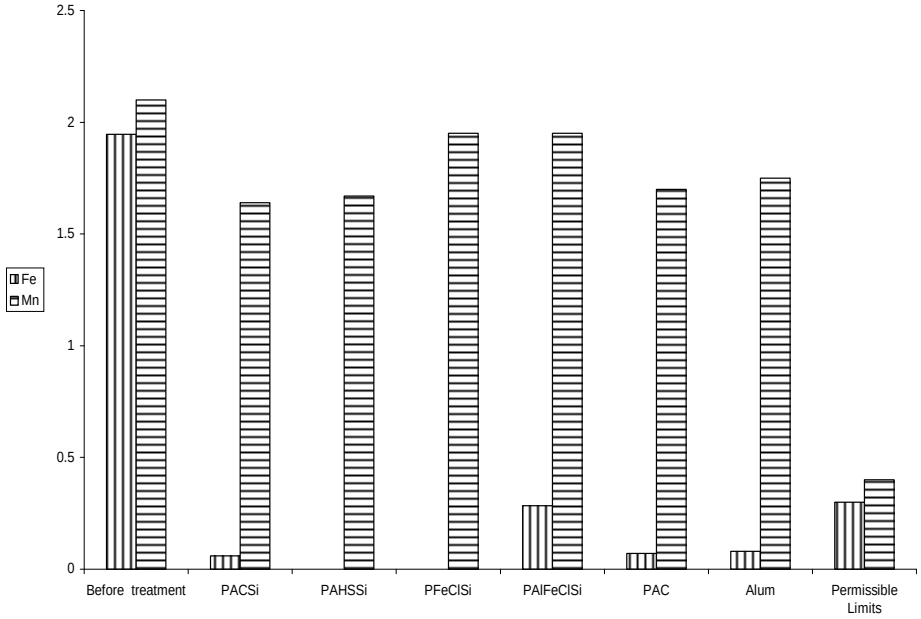

Fig.1 Variations of some physicochemical parameters of ground water samples by influence of different inorganic co agulants

TABLE (2): VARIATIONS OF SOME PHYSICOCHEMICAL PARAMETERS OF ALKALINE GROUND WATER SAMPLES BY INFLUENCE OF DIFFERENT INORGANIC CO AGULANTS

Coagulant / Parameters	Before treatment	After treatment						Permissible Limits
		PAC	PAHS	PFeCl	PAlFeCl	**PAC`**	Alum	
TDS mg/l	590	706	724	810	714	600	633	< 1000
pH	7.37	8.29	7.93	7.94	8.12	7.7	8.0	6.5-8.5
Cl^{-} mg/l	47	110	48	151	107	70	45	< 250
SO_4^{--} mg/l	48	60	151	63	64	45	47	< 250
CO_3^{--} mg/l	0	30	20	35	45	30	25	----
Fe^{++} mg/l	2.5	0.1	0.08	0.09	0.1	0.04	0.07	<0.3
Mn^{++} mg/l	1.5	0.038	0.345	0.235	0.125	0.26	0.28	< 0.4
Al^{+3} mg/l	0.1	0.12	0.13	0.022	0.145	0.13	0.16	< 0.2

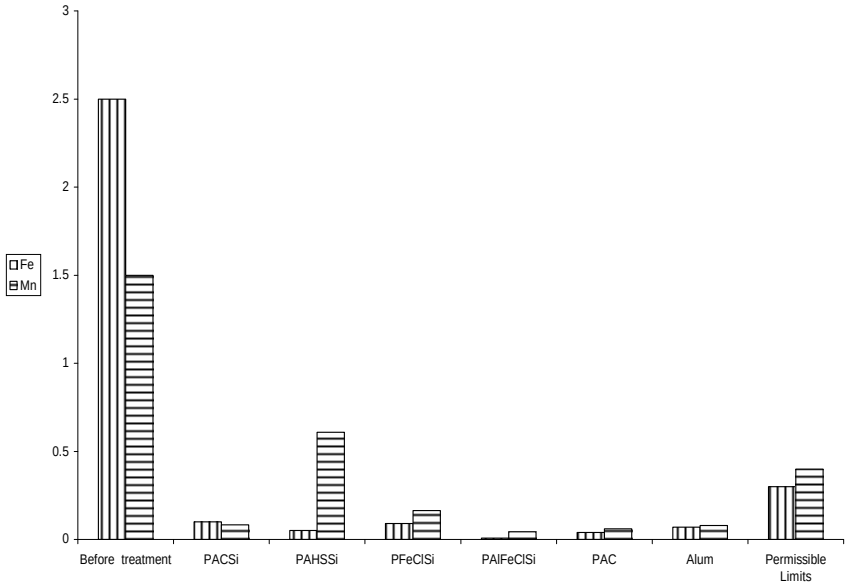

Fig .2 Variations of some physicochemical parameters of alkalineground water samples by influence of different inorganic co agulants

TABLE (3): VARIATIONS OF SOME PARAMETERS OF SEWAGE WASTE WATER SAMPLES BY INFLUENCEOF DIFFERENT INORGANIC CO AGULANTS

coagulant / Parameters	Before treatment	After treatment						Permissible Limits
		PAC	PAHS	PFeCl	PAlFeCl	PAC`	Alum	
TDS mg/l	1500	1943	1850	1980	1700	1600	1605	<2000
TSS mg/l	550	45	48	49	50	48	55	< 40
pH	7.4	7.39	7.32	7.33	7.7	7.2	7.7	6.0-9.0
COD mg/l	300	85.1	70.0	54.7	35.0	73	110	< 80
BOD mg/l	200	44.7	44.0	46.0	30.0	60	75	< 40

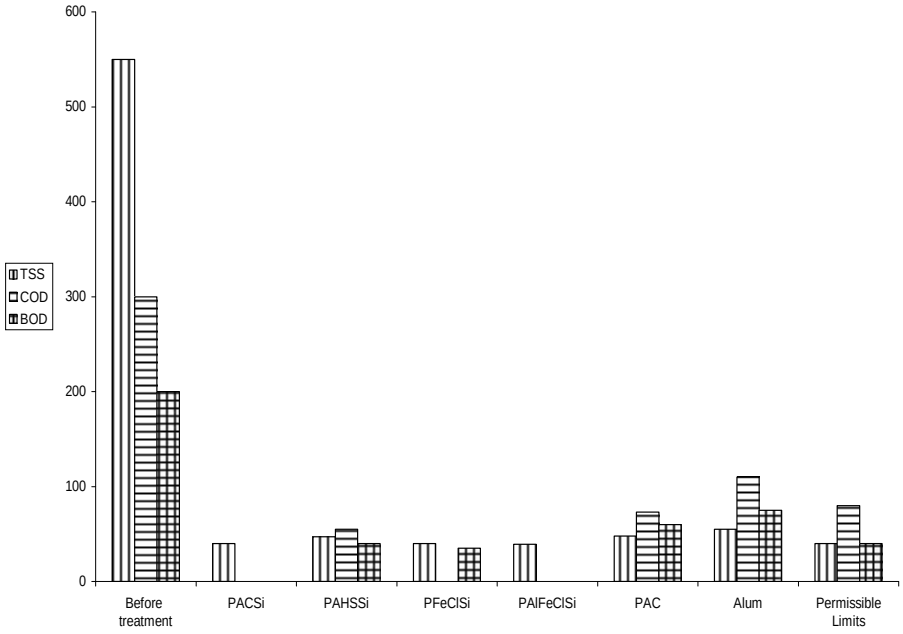

Fig.3 Variations of some parameters of sewage waste water samples by influenceof different inorganic co agulants

5. CONCLUSIONS

All coagulants under investigation were gave the removal percentages of iron below permissible limits in the case neutral or alkaline ground water. All coagulants under investigation were gave the removal percentages of manganese above permissible limits, in the case neutral ground water. All coagulants under investigation were gave the removal percentages of manganese below permissible limits in the case alkaline ground water. Iron removed easily if the ground water neutral or basic, Manganese required increasing of pH solution. The maximum removals percentages of Fe^{+2} and Mn^{+2} ions in ground water reached 99 and 97%, using PAC` or Alum and

PAC, respectively and also with alkaline ground water. The maximum removals percentages of COD, BOD and TSS in sewage waste water reached 85, 88, and 91%, respectively, using PAlFeCl. The usage of inorganic polymers is suggestive as replacement technology of chemical oxidation of iron and manganese in one side and biological treatment of sewage waste water from another side. Poly aluminum ferric chloride silicate (PAlFeCl) is suggestive as favorable co-agulants in different treatment technology than conventional co- agulants. The developed copolymer of iron and aluminum co-agulants are considered as a better replacement technology sewage waste water treatment due to low cost and good efficiency in this application.

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