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Sustainable Non Conventional Water Resources Using Developed Steel By-Product as a Novel Poly Inorganic Co-agulant

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Summary The present study is highlight to overcome the fresh water shortage by reuse of steel factories by-product from a certain workshops reforming residues in waste water treatment as a non conventional water resources. A novel poly ferric chloride (PFeCl), and comparied with commercial poly aluminum chloride (PAC) and Alum in removal of some pollutants of ground, sewage, and industrial waste water using PFeCl. It was found that; the maximum percentages removal of Fe^{+2} and Mn^{+2} ions in ground water reached 97 and 84%, respectively. The maximum percentages removal of COD, BOD and TSS in sewage waste water reached 82, 77, and 91%, respectively. The maximum percentages removal of Pb^{+2} , and As^{+3} ions in industrial waste water reached 100 and 98%, respectively, The removal percentages of the same pollutants Pb^{+2}, As(III), Fe^{+2}, Mn^{+2}, COD, BOD and TSS are 100, 74, 98, 96, 72, 68 and 90 % respectively when using conventional PAC, where as in the case of Alum; the removal percentages of Pb^{+2}, As(III), Fe^{+2}, Mn^{+2}, COD, BOD and TSS are100,94, 97, 94, 63, 62.5 and 89 %, respectively. Therefore, PFeCl was considered as a good coagulant for ground, sewage, and industrial waste waters treatment due to low cost and good efficiency in this application, as well as it will solve the problem of water shortage and to sustain a non-conventional water resources.

Introduction

The increasing demands for reuse domestic water or industrial waste water after treatment, due to adequate renewable and non renewable water resources, so wastewater treatment could become an important source of water and should be considered one method to sustain of non conventional water resource development.(1)The presence of heavy metals like iron, manganese, lead and arsenic and some anions such as nitrate and fluoride in aquatic systems is a very earnest problem and related to the prevalence of some diseases, toxicity and tendency to accumulating in the environment. The industrial wastewaters are considered to be the main source of heavy metal impurities. Iron and aluminum co-precipitation/adsorption are a well-accepted processes for removal of heavy metals from wastewater [2-5]. Currently, COD and BOD are treated by biological and physicochemical methods. Fluidized beds, coagulation [6-8].

Poly inorganic coagulants and conventional coagulants such as aluminum Many researchers used adsorbent materials for removal of some pollutants [9-14]. Iron based coagulants are suggestive as superior for organic precursor removal, demonstrating that natural organic materials (NOM) removal is a function of regional water chemistry. And more effective than aluminum based coagulants for the removal of COD, and heavy metals [15, 16]. This study concerns with the preparation of PFeCl based on steel by product and compare with conventional coagulants (Alum and PAC) in removal of some pollutants from waste water

Materials and Methods

The precursor of poly ferric chloride was steel; which is a by-product of a certain steel workshops residues, treatment with concentrated hydrochloric acid, then neutralization with sodium carbonate to prepare poly ferric chloride [17], as well as, comparing the last product efficiency with 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, and finally treatment of spiked heavy metals such as lead, fluoride and Arsenic to re-use the waste in agricultural drip irrigation systems, where, the treatment depends on precipitation, coagulation and adsorption techniques by inorganic coagulants. Each sample was mixed with 10-50 ppm of reagent and agitated for 1 minute by rapid mixing (300 rpm), followed by slow mixing for five minutes, (30 rpm) and 20 minutes standing time.

The concentrations of pollutants were measured before and after treatment according to standards methods as shown (APHA, 2005) [18].

Results and Discussion

The data presented in Table (1) and Figure (1) are summarizes the variationd of physicochemical properties of ground water before and after treatment using poly ferric chloride(PFeCl), conventional Alum and PAC. It was found that, the removal percentages of iron and manganese are 94.2, 19%, respectively, using PFeCl, the removal percentages of Fe^{+2} and Mn^{+2} ions in ground water reached 99 and 19%, respectively, using PAC, the removal 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.

Table (1): Variations of some physicochemical parameters of ground water samples by influence of different inorganic coagulants

Coagulant / **Parameters**	**Before treatment**	**After treatment**			**Permissible Limits**
		PFeCl	**PAC**	**Alum**	
TDS mg/L	552	637	590	596	< 1000
pH	7.40	7.10	7.4	7.2	6.5-8.5
Cl^- mg/L	62	147	180	67	< 250
SO_4^{--} mg/L	59	70	74	143	< 250
Fe^{++} mg/L	1.946	0.112	0.07	0.08	< 0.3
Mn^{++} mg/L	2.1	1.7	1.7	1.75	< 0.4
Al^{+3} mg/L	0.114	0.068	0.12	0.13	< 0.2

Figure (1): Variations of some physicochemical parameters of ground water samples by influence of different inorganic coagulants

Table (2) and and Figure (2) summarize the variations of physicochemical properties of alkaline ground water before and after treatment using PFeCl, conventional Alum and PAC. It was found that, the removal percentage of iron and manganese are 97,and 85%, respectively, using PFeCl, the removal percentage of iron and manganese are 99,and 96%, respectively, using PAC, the removal percentage of iron and manganese are 98,and 95%, respectively, using Alum, Where as the maximum removal percentage of iron and manganese are 99,and 96%, respectively, using PAC. The objective of such experiments of ground water to study the influence of alkaline media on iron and manganese removals while pH still within range, finally the residual carbonate appears 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.

Table (2): Variations of some physicochemical parameters of alkaline ground water samples by influence of different inorganic co agulants

Coagulant / Parameters	**Before**	After treatment			Permissible Limits
		PFeCl	PAC	Alum	
TDS mg/L	590	810	600	633	< 1000
pH	7.37	7.94	7.7	8.0	6.5-8.5
Cl^- mg/L	47	151	70	45	< 250
SO_4^{--} mg/L	48	63	45	47	< 250
CO_3^{--} mg/L	0	35	30	25	----
Fe^{++} mg/L	2.5	0.09	0.04	0.07	<0.3
Mn^{++} mg/L	1.5	0.235	0.06	0.08	< 0.4
Al^{+3} mg/L	0.1	0.022	0.13	0.16	< 0.2

Figure (2): Variations of some physicochemical parameters of alkaline ground water samples by influence of different inorganic coagulants

Table (3) and Figure (3) summarize the variations of COD, BOD and TSS of a certain sewage waste water before and after treatment using alum and PAC. It was found that, the removal percentage of TSS, COD and BOD are 91,82, and 77%, respectively, using PFeCl. The removal percentage of TSS, COD and BOD are 91, 82 and , 77%, respectively, using PAC. The removal percentages of TSS, COD and BOD are 90, 63, and 62.5%, respectively. The maximum removals of

TSS, COD and BOD are 91, 82, and 77% respectively, using PFeCl, PFeCl is the superior poly in-organic coagulant due to high density of iron which produce a compact and dense sludge. Previous study revealed that removal percentages of COD and TSS reached 38 and 69% using alum where. As, 60 and 48% using ferric chloride respectively[19]. It reached 72 and 67% whereas reached 76 and 81% using PAC and Ferric chloride respectively [20].

Table (3): Variations of some parameters of sewage waste water samples by influence of different inorganic coagulants

coagulant Parameters	Before treatment	After treatment			Permissible Limits
		PFeCl	**PAC**	**Alum**	
TDS mg/L	1500	1980	1600	1605	<2000
TSS mg/L	550	49	48	55	< 40
pH	7.4	7.33	7.2	7.7	6.0-9.0
COD mg/L	300	54.7	73	110	< 80
BOD mg/L	200	46.0	60	75	< 40

Figure (3): Variations of some parameters of sewage waste water samples by influence of different inorganic coagulants

The data presented in Table (4) and Figure (4) summarize the variations of Pb^{+2}, As(III) and F^{-1} of spiked industrial waste water before and after treatment using PFeCl, Alum and PAC. It was found that, the removal percentages of Pb^{+2}, As^{+3} and F^{-1} are 100, 98,and 67% respectively, using PFeCl. The removal percentage of Pb^{+2}, As^{+3} and F^{-1} are 100, 74, and 95%, respectively, using PAC. the removal percentage of Pb^{+2}, As(III) and F^{-1} are 100, 95, and 85%, respectively, where as the maximum removals of Pb^{+2}, As^{+3} and F^{-1} are 100, 98, and 85% respectively, using PFeCl in Pb^{+2}, As(III) cases and using PAC in F^{-1} case, in all cases the effluent industrial water after treatment obey the Egyptian Regulations.

Table (4): The effect of co-agulants on industrial waste water (iww)

coagulant Parameters	Before treatment	After treatment			Permissible Limits
		PFeCl	PAC	Alum	
pH	3.5	8.36	8.87	7.19	6.0-9.0
Pb^{2+} mg/l	50.0	0.15	0.017	0.011	< 1

As (III) mg/l	1.221	0.032	0.321	0.064	0.05
F^{-1} mg/l	1	0.33	0.06	0.15	0.8

Fig. (4): The effect of co-agulants on industrial waste water (IWW)

Conclusion

The maximum removals percentages of Fe^{+2} and Mn^{+2} ions from a certain ground water reached 99 and 96%, respectively, using PAC with alkaline ground water. The maximum removal percentages of COD, BOD and TSS in sewage waste water reached 91, 82, and 77% using PFeCl. The maximum removals of Pb^{+2}, As (III) and F^{-1} are 100, 98, 85% respectively, using PFeCl in Pb^{+2}, As (III) cases and using PAC in F^{-1} case. The usage of inorganic polymers is suggestive as replacement technology of chemical oxidation for iron and manganese in ground water, as well as lead, antimony and fluoride in industrial waste water in one side and biological treatment of sewage waste water from another side. Poly ferric chloride (PFeCl) is suggestive as favorable coagulants in different treatment technology than conventional coagulants. And also considered as a better replacement technology for ground, sewage, industrial waste water treatments due to low cost and good efficiency in this application, as well as it will solve the problem of water shortage and to sustains a non-conventional water resources.

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