

# Analysis of the Influence of Coagulant on Phosphorus in Landscape Water Environment

**Chunhong Su**

Beijing Vocational College of Agriculture, Beijing 102442, China.

Email: suchunh@sina.com

**Abstract.** This study selected three kinds of inorganic polymer coagulant: polyferric sulfate, polyaluminium chloride, polyaluminium ferric chloride, two inorganic low molecular coagulants: aluminum chloride and aluminum sulfate. The coagulation experiment of lake water without “water bloom” was carried out. The results were analyzed by multivariate linear regression and principal component regression analysis. It showed that the effects of the five coagulants on the phosphorus were the same when the landscape water was treated with different dosages of coagulants. The sequence was: total nitrogen (TN) > dosage > ammonia nitrogen > COD<sub>Cr</sub> > turbidity > PH. Among them: the highest effect of total nitrogen on phosphorus was aluminum chloride (71.73%). The most obvious effect of dosage on phosphorus was polyaluminium chloride (34.68%). The most significant effect of ammonia nitrogen on phosphorus was polyaluminum chloride (16.98%).

## 1. Introduction

The shortage of water resources is a major problem in China. Recycled water is widely used in landscape water environment, which solves the need of water shortage for urban water environment. It also was the best way to restore the natural restoration of water ecological cycle [1]. Phosphorus is a restrictive nutrient for algae growth in landscape water environment, playing an important role in the outbreak of "water bloom" and the growth process of phytoplankton, and is one of the main reasons for eutrophication in landscape water environment [2].

Controlling the concentration of phosphorus in landscape water environment, breaking the ratio of nitrogen and phosphorus between 10 and 20, preventing water bloom production, coagulant is the most direct, rapid and effective method. Taking the artificial lake of Beijing vocational college of agriculture and the lake of xiaoyue lake of yongding river -- the lake without water bloom as test water, the author analyzed the treatment effect of phosphorus in landscape water environment with different coagulants, studied the influence of various pollutants and different amounts of coagulant on phosphorus in water environment, and provided reference for landscape water environment management.

## 2. Materials and Methods

### 2.1. Test Materials

**2.1.1. Test Water.** Taking the artificial lake of Beijing Agricultural Vocational College and the lake of Yongding River without water blooms as test water.

**2.1.2. Coagulant Selection.** Based on the principle of wide application in the market, low cost and good effect, three industrial inorganic polymer coagulants are selected: polyferric sulfate,



polyaluminum chloride, polyaluminum ferric chloride, and two inorganic low molecular coagulants: Aluminum chloride, aluminum sulfate. Coagulation experiments were carried out according to different dosages and different water quality.

**2.1.3. Test Method.** The experiment was carried out with a beaker of a programmable six-step mixing and coagulation experiment device. The water was stirred and separated into six of the 1000 ml beaker, open the mixer switch, lowered stirrer, and graduated pipette will make good coagulant added to upper part of the dosing tube instrument in four stages: the first phase of speed (G) 300 RPM for 1 minute, the second stage is 132.2 RPM, working for 1 minute, the third stage G value is 28.8 RPM, working for 10 minutes, and stage 4 G value is RPM for 20 minutes. We took supernatant through sampling mouth, suveied and evaluated the water quality indicators.

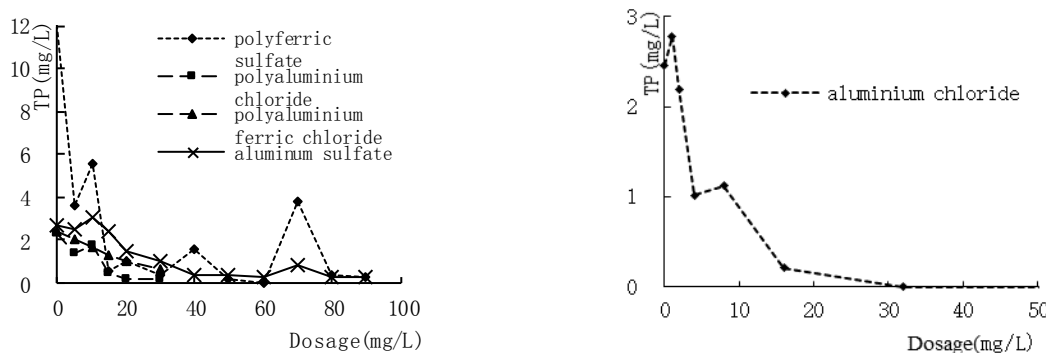
## 2.2. The Research Methods

The method of multivariate linear regression and principal component regression analysis in DPS data processing system is adopted [3]. Its basic principle is to deal with collinear relations of various influencing factors by the situation of high correlation (complex collinear) between independent variables. The effects of main test items and different coagulants on phosphorus in reclaimed water environment were studied.

## 3. Results and Discussions

### 3.1. Analysis of Phosphorus Removal Effect of Coagulant

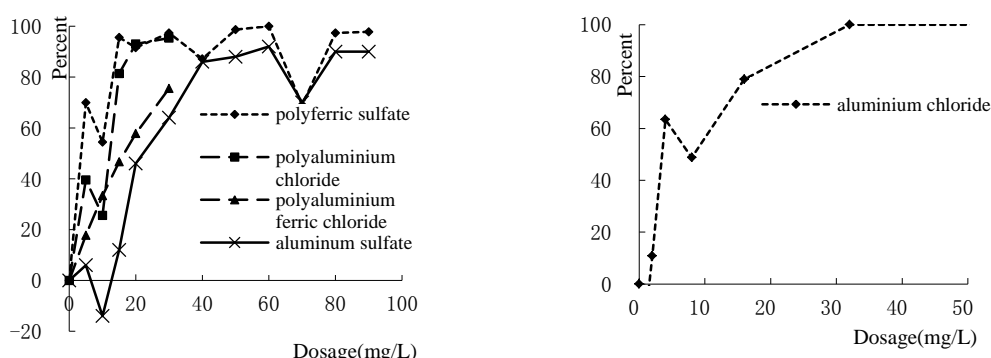
Using polyferric sulfate, polyaluminium chloride and polyaluminium ferric chloride, aluminium sulphate, press 5, 10, 15, 20, 30, 40, 50, 60, 70, 80, 90 (mg/L) concentration of coagulant dosage, aluminium chloride respectively by 1, 2, 4, 8, 16, 32, 64 (mg/L) concentration of coagulant dosage, coagulation test results as shown in figure 1[4].



**Figure 1.** Phosphorus removal effect of different dosage

The above experimental results show that the amount of phosphorus in water gradually decreases with the increase of dosage of polyaluminium chloride and polyaluminium ferric chloride. Polymeric ferric sulfate, aluminum sulfate and aluminum chloride decrease the amount of phosphorus in water with the increase of dosage.

In order to further study the experimental results of the five reagents, the phosphorus removal percentage was analyzed, as shown in figure 2.



**Figure 2.** Percentage of total phosphorus affected by different dosage

The above figure shows that aluminum chloride has the best effect of removing phosphorus with the same dosage among the five reagents, and the removal rate of phosphorus in water reaches 100 % when the dosage is 32mg/L. The second best effect is polyferric sulfate. When the dosage is 15 mg/L, the removal rate of phosphorus is 95.58%, while when the dosage is 30 mg/L, the removal rate of phosphorus reaches 97.35%. Thirdly, polyaluminium chloride, when the dosage is 15 mg/L, the removal rate of phosphorus is 81.40%, while when the dosage is 30 mg/L, the removal rate of phosphorus is 95.35%. Moreover, the polyaluminium ferric chloride, when the dosage is 15 mg/L, the removal rate of phosphorus is 46.67%, while when the dosage is 30 mg/L, the removal rate of phosphorus is 75.56%. The worst effect was aluminum sulfate, the removal rate of phosphorus was 12.0 % when the dosage was 15 mg/L, and 64.00 % when the dosage was 30 mg/L. At the same time, with the addition of aluminum ferric chloride, the phosphorus removal effect of the other four coagulants fluctuated with the increase of dosage. When the dosage of aluminum sulfate was 10 mg/L, the phosphorus removal rate was -14.0 %.

### 3.2. Analysis of Factors Affecting Phosphorus Removal by Coagulant

Because of different coagulation reagents and their input amount, the effect of phosphorus treatment in water environment is different. So we used linear regression and principal component regression analysis with the results of three kinds of polymeric coagulants and two kinds of molecular coagulant test results, to seek different coagulants, the PH, ammonia nitrogen, CODCr, total nitrogen and the amount of pharmaceutical inputs with the change of phosphorus and analysis of its remarkable.

Five kind of coagulant with different coagulant dosage, PH, ammonia nitrogen, CODCr, total nitrogen and phosphorus by principal component regression linear regression analysis, the significance test is made to the regression model, the model factor regression coefficient significance test results: the regression model of F values were greater than  $F_{0.05}$ , correlation coefficient  $R > R_{0.05}$ , model fitting is good.

The six main influencing factors of drug dosage, PH, turbidity, ammonia nitrogen, CODCr and total nitrogen were calculated respectively. The characteristic values and percentages of the factors affecting total phosphorus in the five coagulants are shown in Table 1.

**Table 1.** Characteristic values and percentages of the effect of input factors on total phosphorus

Coagulant	Influencing factors	Characteristic values	Percent %	Cumulative percentage %
polyferric sulfate	TN(mg/L)	4.27	71.09	71.09
	Dosage(mg/L)	0.93	15.50	86.60
	Ammonia Nitrogen(mg/L)	0.56	9.35	95.95
	CODcr(mg/L)	0.16	2.74	98.70
	Turbidity(FNU)	0.06	0.95	99.65
	PH	0.02	0.35	100.00
polyaluminium chloride	TN(mg/L)	2.62	43.59	43.59
	Dosage(mg/L)	2.08	34.68	78.27
	Ammonia Nitrogen(mg/L)	1.02	16.98	95.25
	CODcr(mg/L)	0.21	3.55	98.79
	Turbidity(FNU)	0.06	1.08	99.87
	PH	0.01	0.13	100.00
polyaluminium ferric chloride	TN(mg/L)	3.96	66.03	66.03
	Dosage(mg/L)	1.75	29.22	95.25
	Ammonia Nitrogen(mg/L)	0.21	3.55	98.80
	CODcr(mg/L)	0.06	1.08	99.88
	Turbidity(FNU)	0.01	0.12	100.00
	PH	0.00	0.00	100.00
aluminum chloride	TN(mg/L)	4.30	71.73	71.73
	Dosage(mg/L)	0.92	15.37	87.10
	Ammonia Nitrogen(mg/L)	0.60	9.92	97.03
	CODcr(mg/L)	0.16	2.66	99.69
	Turbidity(FNU)	0.02	0.31	100.00
	PH	0.00	0.00	100.00
aluminum sulfate	TN(mg/L)	3.00	50.04	50.04
	Dosage(mg/L)	1.21	20.09	70.13
	Ammonia Nitrogen(mg/L)	0.90	14.96	85.09
	CODcr(mg/L)	0.52	8.62	93.72
	Turbidity(FNU)	0.31	5.17	98.89
	PH	0.07	1.11	100.00

According to the above table, the order of influence factors on total phosphorus in each coagulant is the same, and the order is: total nitrogen (TN) > dosage > ammonia nitrogen > CODcr > turbidity > PH.

The above table shows that the total nitrogen (TN) affects phosphorus in the range of 71.73 ~ 43.59 (%), the dosage of 34.68 ~ 14.96 (%), ammonia nitrogen accounted for 3.55 ~ 16.98 (%), CODcr accounted for 1.08 ~ 8.62 (%), turbid The degree is 0.12 to 5.17 (%), and the PH value is 0.00 to 1.11 (%). It can be seen that the influence value of each impact factor on phosphorus is different under the different percentage. Among them, aluminum chloride has the highest effect on phosphorus, accounting for 71.73%, followed by polyferric sulfate, accounting for 71.09%. The weakest effect is polyaluminium chloride, accounting for 43.59%.

The most obvious effect of the dosage on phosphorus is Polyaluminium chloride, accounting for 34.68%, followed by polyaluminum ferric chloride, accounting for 29.22%, the most important is aluminum sulfate, accounting for 14.96%; the most significant effect of ammonia nitrogen on phosphorus is polyaluminium chloride, accounting for 16.98%, after that is a polyferric sulfate, accounting for 14.96%. The weakest effect is polyaluminium ferric chloride, accounting for 3.55%. The results showed that the turbidity and pH had the weakest effect on phosphorus. In order to serve the production better. The turbidity and pH of the coagulant were less than 10% were eliminated, and the principal component regression was combined. Linear regression simplified analysis, significant regression test of regression coefficient of each model factor: F in regression model was greater than

$F_{0.05}$ , significant level  $P < 0.0001$ ; correlation coefficient  $R > R_{0.05}$ , model fit was still good. According to the calculation results, the order of influence on phosphorus in each coagulant is the same, and the order is still: total nitrogen (TN) > dosage > ammonia nitrogen > COD<sub>Cr</sub>.

#### 4. Conclusion

It can be seen that the removal effect of these five coagulants on phosphorus is: aluminum chloride > polyferric sulfate > polyferric chloride > polyferric aluminum chloride > aluminum sulfate.

The amount of phosphorus in water delinques with the increase of dosage of polyaluminum chloride and ferric chloride. The amount of phosphorus in water decreases with the increase of dosage of polyferric sulfate, aluminum sulfate and aluminum chloride, but when the dosage of aluminum sulfate is 10mg/L, the amount of phosphorus in water decreases. Compared with raw water, the amount of phosphorus increased by 14.0%.

After five kinds of coagulant use different dosage to treat the water quality of landscape environment, The main pollution indexes in the water environment have the same order of total phosphorus, and the sequence is: Total nitrogen (TN) and dosage of ammonia nitrogen > COD<sub>Cr</sub> > turbidity > PH.

The highest impact of total nitrogen on phosphorus was aluminum chloride, accounting for 71.73 %, followed by polyferric sulfate, accounting for 71.09 %, and the weakest impact was polyaluminium chloride, accounting for 43.59 %.

The most obvious effect of the dosage on phosphorus is Polyaluminium chloride, accounting for 34.68%, followed by polyaluminum ferric chloride, accounting for 29.22%, the most important is aluminum sulfate, accounting for 14.96%; the most significant effect of ammonia nitrogen on phosphorus is polyaluminium chloride, accounting for 16.98%, followed by it is a polyferric sulfate, accounting for 14.96%. The weakest effect is polyaluminium ferric chloride, accounting for 3.55%.

#### 5. References

- [1] LI Xin, HU Hongying, YANG Jia, BAI Yu. Method to establish the nitrogen and phosphorus standard of reclaimed water reused in landscape. *J. Ecology and Environmental Sciences* 2009, **18**(6):2404-2408.
- [2] ZHANG Bo, LI Yong-feng, JIANG Xia, WANG Shu-hang, HU Jia-chen. Influences of environmental governance project on spatial distribution of phosphorus in Lihu Lake. *J. China Environmental Science*, 2013, **33**(07):1271-1279.
- [3] Tang, Q.-Y. and Zhang, C.-X. *DPS Data Processing System*. M. Science Press. 2007.
- [4] GAO Xiu-qing, SU Chun-hong, JIAO You-quan, WU Xiaosu. Effects of Five Kinds of Coagulants in Controlling Water Environment Deterioration. *J. China Water & Wastewater*, 2016, **07**:89-91.