

# PRE-TREATMENT OF TEXTILE WASTEWATER IN VAN PHUC HANDICRAFT VILLAGE BY COAGULATION PROCESS

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**Abstract.** Handicraft textile production of Van Phuc village in Vietnam has released polluted substances into Nhue River. This problem needs to be solved by proper methods to treat textile wastewater. Coagulation is considered to be a suitable process with the conditions of Van Phuc village. This paper concentrates on investigating the settling characteristics and the removal efficiency of pollutants in wastewater. Different parameters of the treatment process were examined including PAC concentration, coagulant aids concentration, pH, COD values of wastewater. In this regard, the treatment favors the utilization of PAC with A101. Moreover, settling characteristics of flocs were studied in a laboratory scale by settling column unit to apply for designing large scale settling tank.

*Keywords:* handicraft village, textile wastewater, coagulation

## 1. Introduction

Textile industries consume the large volume of water and chemicals for the processing of textiles. The chemical reagents used are very diverse in chemical composition, ranging from inorganic compounds to polymers and organic products [1]. The presence of very low concentrations of dyes in effluents is highly visible and undesirable [2].

Van Phuc village is one of the traditional handicraft villages of Viet Nam. It has been famous for special and unique silk, textile products for a very long time. Nowadays, the development of traditional textile production has improved the life of local people, as well as has newly changed the social and economical aspects of Van Phuc village. The production has consumed large considerable amounts of fresh water and discharged appreciable pollutions loads. Acid and direct dyes are widely used for handicraft production in Van Phuc textile village. Textile wastewater containing detergent, surface active agents, solvents, inorganic salts, bleaching agents, sodium organic and inorganic acids has become the major environmental pollution.

Recent survey monitored at Van Phuc village has reflected that the typical values such as COD, TSS, BOD<sub>5</sub> are higher than Vietnam standards [3]. In general, there have been many methods for treating textile wastewater. They include chemical, physical and biological methods [4]. The coagulant and coagulant aids make dissolved and colloid impurities destabilize and produce large floc aggregates, which can be separated from water in subsequent sedimentation, flotation and filtration stages. In

this study, PAC, a prepolymerised coagulant, has been selected. PAC is reported to be more effective at a comparatively lower dose than the other coagulant species present by the direct addition of a conventional coagulants [5]. It has many valuable properties such as stable preformed polymer, large active surface, efficiency at low temperature, high cationic charge capacity, and small remaining amount of  $Al^{3+}$  in water [6]. With a very small quantity, coagulant aids used to improve the efficiency of coagulation. By nature, they are organic polymer like polyacrylamide and its copolymer, which do not hydrolyze to form  $H^+$ . They were chemically divided into three main groups, which have different characteristics and applications: anionic polymers (A), nonionic polymers (N), cationic polymers (C).

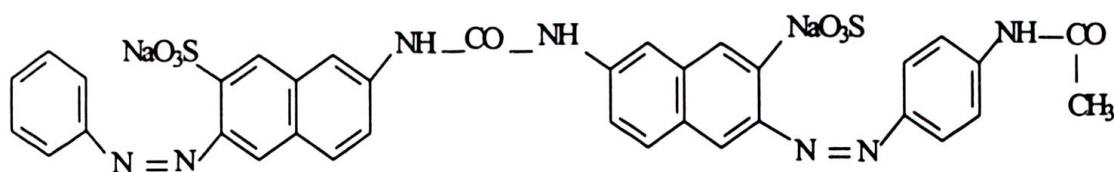
In this work the coagulation process was studied to remove direct scarlet 4BF, a dye often used in Van Phuc village. The results would be useful for designing a treatment system.

## 2. Materials and Methods

### Materials

The wastewater sample containing a dye - Direct Scarlet 4BF and other additives was taken from dyeing process at Van Phuc village. The wastewater has pH 7.5 and COD of 4495 mg/l. Some various COD concentrations researched in this regard were prepared by diluting the initial sample.

PAC coagulant and A101, C502, N208 coagulant aids used in this study were of analytical grade, purchased from a Japanese Company Aronfloc.



**Direct Scarlet**

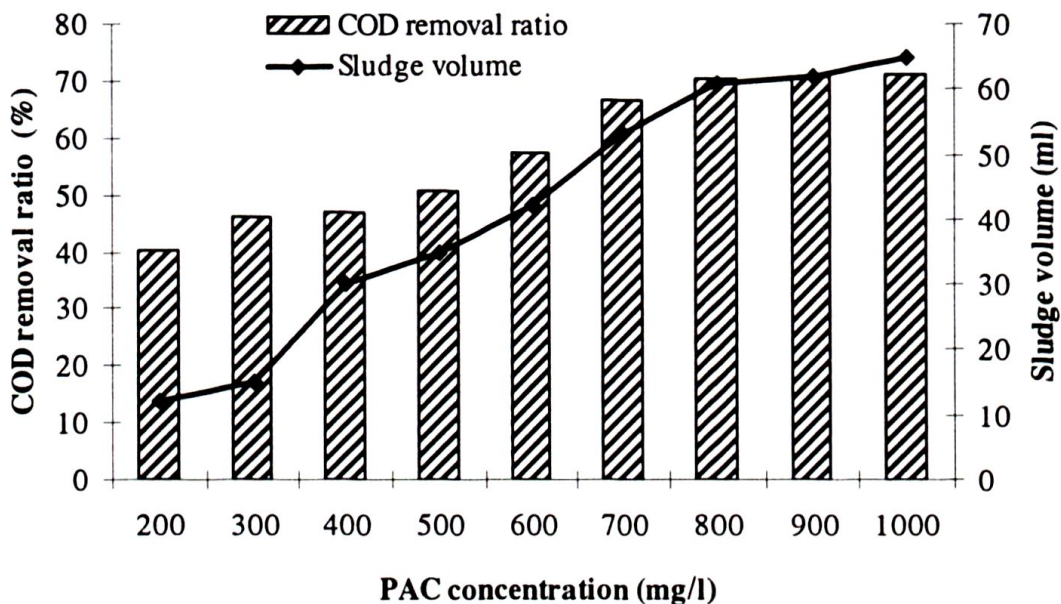
All the experiments were carried out in beakers of 250 ml with magnetic stirrer. PAC coagulant dosages were added to a beaker containing 100 ml of raw wastewater. Following coagulant addition, the solutions of 1M  $H_2SO_4$  and 1M NaOH were used to adjust pH to the desired values. The mixture was vigorously stirred with a magnetic stir bar at 120 rpm in 2 minutes. After 2 minute's stirring, dosage of coagulant aid was added. The slow mixing for 4 minutes at the speed of 30 rpm was followed. Then the suspension was transferred to a jar to settle for 15 minutes. As sedimentation process

has completed, supernatant was decanted to analyze COD according to the procedure method 5220 D described in Standard Methods [7]. Remained sludge volume was measured.

### 3. Results and Discussion

#### *Effect of PAC concentrations on the treatment process*

The pollution removal efficiency of the treatment process was evaluated by COD removal ratio. The volume of sludge created during coagulation process is an important parameter. The results obtained are presented in Fig 1.



**Figure 1. Effect of PAC dosages on the treatment process**

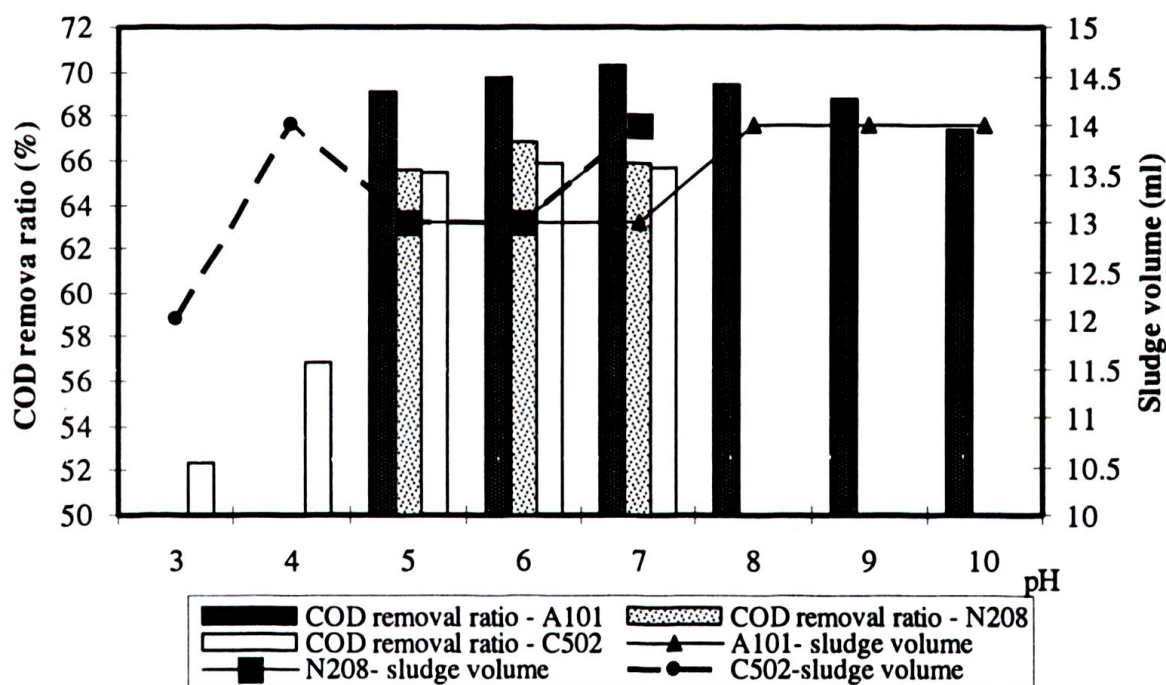
As can be seen, COD removal ratio increases with the increasing PAC dosages, which ranges from 200 to 1000 mg/l. Considerable efficiency of approximately 70 % was obtained at concentration of 700 mg/l. However, there has been a large volume of sludge remained after sedimentation, especially at dose more than 700 mg/l of PAC.

#### *Effect of coagulant aids on the treatment process*

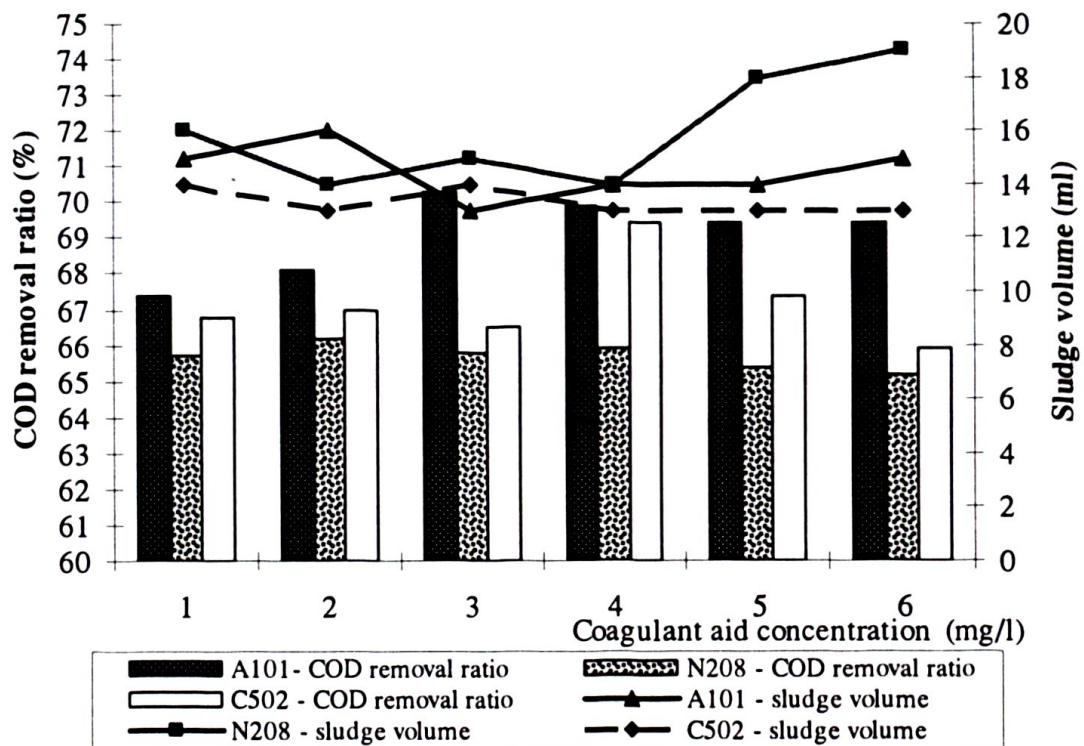
Further experiments in which PAC was combined with coagulant aids were carried out to solve the above disadvantage, and to enhance the coagulation process. Three utilized coagulant aids were A101, N208, C502. The treatment efficiency depended not only on dosages of each coagulant aids, but also on pH of medium. The results are shown in Fig 2 and Fig 3.

As shown in Fig 2, at concentration of 3.5 mg/l of each coagulant aids, the pH optimum for three coagulant aids was a little different, but the range of pH from 6 to 8 was useful for all.

As illustrated in Fig 3, it was found that the optimal dosages of A101, N208, C502 were 3 mg/l, 2 mg/l, and 4 mg/l respectively. Very little coagulant aids dosages might not create significant "bridges" approaching particles to form larger masses that can settle out. Thus, this resulted in relative high ratio of sludge and porous and loose sludge lay. However, very high coagulant aids dosages breed the thin film of sludge on the surface of mixtures. The result mainly indicates that the addition of coagulant aids led to the decreasing in sludge volume by twice or three times in comparison with the using PAC alone, and bulky flocs were produced with high settling velocity in a short time. This related with operational cost in practice. Utilization of coagulant aids could reduce sludge volume, but could not enhance much COD removal ratio.



**Figure 2. Effect of pH on the treatment process**



**Figure 3. Effect of coagulant aids on the treatment process**

It was observed that the treatment efficiency is highest when using PAC with A101. Moreover, A101 is cheaper than C502 and N208. Therefore, in this regard PAC in combination with A101 is the right selection for the treatment of textile effluent at Van Phuc handicraft village.

#### *Effect of the various pretreated COD values on the treatment process*

The amount of dye used in handicraft reactor depends on requirements of products. To guarantee the treated water quality at various dyeing batches and washing process, the experiments were carried out at some typical pretreated COD values of 4497, 3012, 1526, 469 mg/l. The results are shown in table 1.

**Table1. Treatment efficiency at various pretreated COD values**

COD <sub>0</sub> (mg/l)	PAC Conc. (mg/l)	A101 Conc. (mg/l)	COD <sub>1</sub> (mg/l)	COD removal (%)
4497	4000	4.0	1733	61.46
3012	3000	4.0	1114	63.01
1526	1600	3.5	513	66.38
469	500	3.0	155	69.95

*COD<sub>0</sub>: COD of raw wastewater; COD<sub>1</sub>: COD of coagulated wastewater.*

It is clear that the PAC concentration needed is proportional to COD of wastewater.

#### *Determining the settling characteristics of the particles*

The experiments using PAC with and without A101 were studied. The results were illustrated in fig. 4. By drawing the tangent lines, the experimental and theoretical settling velocity and time were determined. The settling velocity is 10 cm/min, and the settling time is 3 minutes using PAC with A101; 1 cm/min and 30 minutes using PAC without A101. It is evident that using A101 improved sedimentation process of suspension.

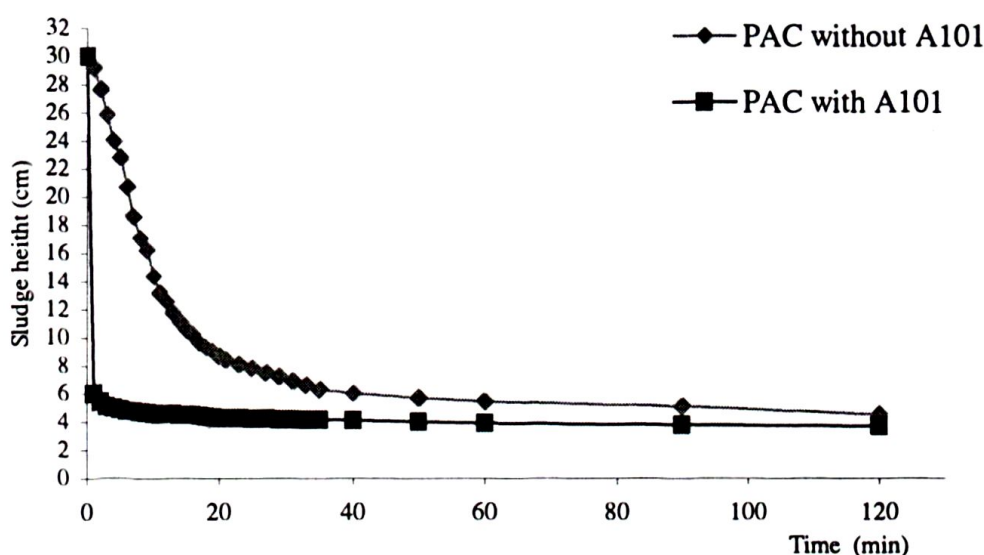


Figure 4. Settling characteristics

## 4. Conclusions

The experimental results found out that using optimal concentration of PAC, combined with A101, C502, N208 the COD removal efficiency was up to 70% and the sludge volume remained was only 13–14 %. The pH range from 6 to 8 was optimal for coagulation process using PAC and additive polymers. PAC coagulant in combination with A101 gave the best results for the treatment. The obtained data were applied to design the settling tanks for the textile wastewater treatment plant at Van Phuc village.

## Acknowledgments

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## NGHIÊN CỨU TIỀN XỬ LÝ NƯỚC THẢI DỆT NHUỘM LÀNG NGHỀ VẠN PHÚC BẰNG PHƯƠNG PHÁP KEO TỤ

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Hoạt động sản xuất của làng nghề Vạn Phúc đang thải ra các chất ô nhiễm nước sông Nhuệ. Để giải quyết vấn đề này cần nghiên cứu tìm ra những phương pháp hoá học thích hợp. Keo tụ có thể là một giải pháp phù hợp với điều kiện của làng nghề Vạn Phúc. Trong công trình nghiên cứu này chúng tôi tập trung tìm hiểu các đặc tính của quá trình sa lắng và hiệu quả loại bỏ các hợp chất ô nhiễm trong nước thải. Các thông số công nghệ được khảo sát bao gồm nồng độ PAC, nồng độ các chất trợ keo tụ, pH, COD của nước thải. Trong các nhóm trợ keo tụ được nghiên cứu, sử dụng A101 kết hợp với PAC cho hiệu quả cao nhất. Tốc độ sa lắng của huyền phù cũng đã được xác định để phục vụ tính toán thiết kế thiết bị lắng.

Từ khoá: làng nghề, nước thải dệt nhuộm, keo tụ.