

# Effect of pH and time on the treatment by coagulation from slaughterhouse of the city of Rabat

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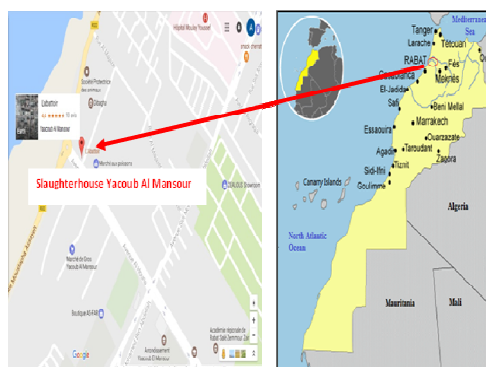
**Abstract.** Water is an essential element in the agri-food industry. The resulting wastewater is often returned to the natural environment without prior treatment; which can be an important source of environmental pollution. Among these food processing industries, there are slaughterhouses that are classified as dangerous, unhealthy and inconvenient, so the treatment of their discharges is necessary before their spill. This article presents the results of the waste water treatment study of the Rabat slaughterhouse by coagulation-flocculation using ferric chloride and the effect of pH and retention time on the elimination of turbidity, Chemical oxygen demand (COD) and organic matter (OM). The results show that pH and retention time plays a major role in the elimination efficiency of these parameters. Thus, with a pH = 5.83, a significant reduction in COD and turbidity are observed after 90 min and 120 min of decantation.

## 1 Introduction

In recent years, the red meat slaughtering industry has expanded enormously around the world. All the conditions are there to allow this industry to continue its development. Nevertheless, this industry is among the most polluting because of the large quantities of wastewater discharged. The effluent from these slaughterhouses is characteristic and requires appropriate treatment (separation of solid wastes and fats, specific treatments). Among the many proposed physico-chemical methods [1,2-4,5], coagulation-flocculation-sedimentation remains a relatively simple technique [6-8,9], mainly applied to the removal of heavy metals and organic compounds [10,11,12], and widely used for the treatment of water that contains high organic matter [8]. Numerous factors can influence the effectiveness of such a treatment: type of coagulant, pH, temperature, mixing velocity, retention time [13]. A laboratory study was conducted to determine the performance of the treatment according to different parameters: Coagulant type, pH, retention time, COD, turbidity, conductivity and OM content were performed. Several tests have been carried out using various coagulants such as ferric sulfate  $Fe_2(SO_4)_3$ , ferric chloride ( $FeCl_3$ ), aluminum sulfate ( $Al_2$

( $SO_4$ )<sub>3</sub>). The choice of ferric chloride coagulant has been dictated by its effectiveness in reducing turbidity and organic matter in wastewater, in addition to its validation by previous studies, iron salts appear to be more effective than aluminum [1, 2]. This article reproduces the results of a coagulation-flocculation treatment followed by decantation on a different pH series. The performance tests of this treatment as a function of the ferric chloride content showed that the optimization was at a concentration of 0.6 g of  $FeCl_3/L$ .

## 2 Materials and methods



## 2.1 Study site

The town of Rabat has a municipal slaughterhouse located in Yacoub Al Mansour. Inaugurated in 1956, it covers an area of 1800 m<sup>2</sup>, it is part of the traditional municipal slaughterhouses, and it is located in one of the most popular districts of the capital “Figure 1”.

**Fig.1.** Geographical location of the Rabat slaughterhouse

## 2.2 Sample

The wastewater from the slaughterhouse studied was taken from the rejected slaughterhouse at Yacoub Al Mansour in Rabat, following the precautions of sampling [14].

## 2.3 Characterization of Releases

The Slaughterhouse wastewater from Rabat has been characterized by different physicochemical parameters (T °C, pH, Conductivity, Suspended matter, Biochemical Oxygen Demand, Chemical Oxygen Demand). The pH and temperature were determined by a Lutron pH meter equipped with a temperature probe. The electrical conductivity was measured by a WTW LF90 type conductivity meter, while the turbidity was measured by a HACH 21009 turbidimeter. The SM (Suspended Materials) is determined by filtering on a filter. COD is determined by acid oxidation by excess potassium dichromate at the temperature of 148 ° C of the oxidizable materials under the test conditions in the presence of silver sulphate as catalyst and sulphate of mercury [15] and BOD<sub>5</sub> is determined by the respiratory method using a WTW OXITOP DBO-meter, according to the technique described by DIN [16].

The organic matter content is determined by evaporation of the samples in porcelain capsules weighed first and then in an oven at 105 °C. and then weighed again and then after conditioning these capsules in the oven at 550 ° C. This is cooled and weighed again.

The flocculation-coagulation tests were carried out according to the Jar-Test protocol (JLT6 Leaching VELD Scientifica), which comprises 6 agitators, is equipped with 6 beakers which simultaneously and simultaneously agitate the waste water of the slaughterhouse and the coagulant. The coagulant used is ferric chloride (FeCl<sub>3</sub>, 6H<sub>2</sub>O) as a conventional coagulant at a concentration of 0.6 g FeCl<sub>3</sub> / l. In the four beakers, the same volume of slaughterhouse water (752 ml), the same volume of FeCl<sub>3</sub> (48 ml) and different pH values (3.90, 5.83, 6.28 and 9, 28), the pH is adjusted by addition of sulfuric acid H<sub>2</sub>SO<sub>4</sub> and sodium hydroxide NaOH. These beakers are subjected to rapid stirring of 120 rpm for 30 seconds. The speed is then reduced to 40 rpm for a period of 20 minutes (In order to promote the encounter and aggregation of the colloids but without destroying the already formed flocs). Subsequently, the mixture was subjected to a decantation of 15 min, 30 min, 45 min, 60

min and 90 min to monitor the pH effect as a function of the retention time. The performance of the treatment is expressed using the following equation: removal efficiency (%) =  $((C_0 - C_f) / C_0) \times 100$  where C<sub>0</sub> and C<sub>f</sub> the initial and final concentrations of each of the parameters (COD, Turbidity, pH) [17].

## 3 Results and Discussion

### 3.1 Characteristics of Slaughterhouse Wastewater

The characteristics of the wastewater sample from Slaughterhouse are summarized in the following table.

**Table 1.** Physico-chemical characteristics of wastewater from the Rabat slaughterhouse [18].

| Parameters                                | Value | Direct Releases Standards |
|---|-------|---------------------------|
| T°C                                       | 19,06 | 30                        |
| pH  | 7,3   | 6,5-8,51                  |
| Turbidity (NTU)                           | 853   | -                         |
| E.C (µs/cm)                               | 1711  | 2700                      |
| BOD <sub>5</sub> (mg d'O <sub>2</sub> /l) | 640   | 100                       |
| COD (mg d'O <sub>2</sub> /l)              | 1386  | 500                       |
| Suspended matter (mg/l)                   | 835   | 50                        |

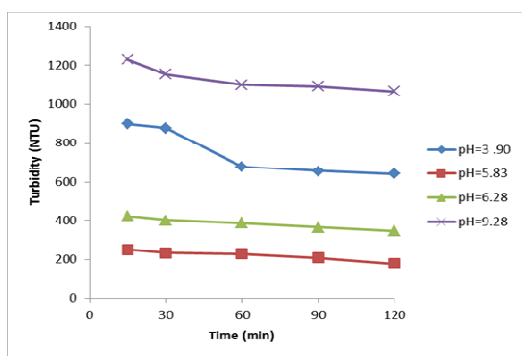


**Photo 1:** Treatment of slaughterhouse water by coagulation as a function of pH and retention time

### 3.2 Effect of pH

The “Figure 2” shows the variation of the turbidity as a function of the settling time, for the various analyzes as a function of the pH. It is important to note a very significant reduction in turbidity at pH 5.83. It goes from 853 NTU to 180 NTU after 120 min of decantation. This could be related to the chemical nature of the organic compounds. Indeed, the organic compounds tested seem to be better eliminated in a pH range between 5 and 6. And means that the Fe (OH)<sub>3</sub> formation zone. In view of the simultaneous presence of several hydrolysed Fe (OH)<sub>3</sub> iron species And Fe (OH)<sub>2</sub> (soluble and insoluble) at these pHs, the reactions involved are probably

numerous. PH may be an important parameter in that it promotes the reaction of the functional groups of ferric chloride and of the organic matter in question. At acid pH (5 and 6), the cationic species of Iron are preponderant. The possible reactions would be the formation of complexes, soluble or insoluble according to the structure of the compound and the nature of the organic functions present. Admittedly at these pHs the organic matter is in its dissolved form which also increases the adsorption surface of the coagulant.

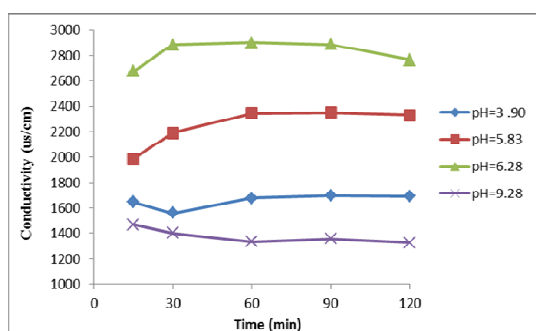


**Fig. 2.** Evolution of the turbidity according to the pH as a function of retention time

### 3.3 Effect of pH on conductivity

When FeCl<sub>3</sub> is added, it is noted that the conductivity shows high values between 5.83 and 6.28, which can be interpreted by the formation of a complex of Fe (OH)<sub>3</sub> from Fe (III) And also by the destabilization of the colloidal particles.

A decrease in conductivity from pH 9.28 to 1323 μs / cm at 120 min due to the formation of Fe (OH)<sub>3</sub> In view of the simultaneous presence of several hydrolyzed Fe (OH)<sub>3</sub> and Fe (OH)<sub>2</sub> (soluble and insoluble) at these pH values “Figure 3”.



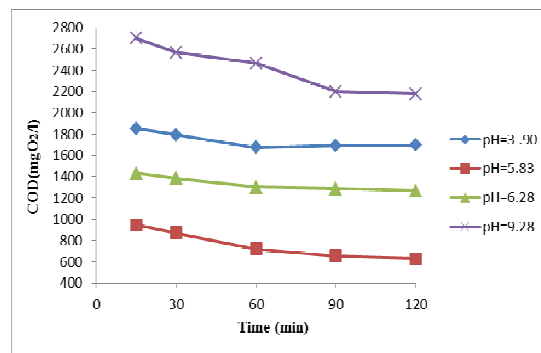
**Fig. 3.** Evolution of conductivity according to pH as a function of retention time

### 3.4 Effect of pH on COD removal

The best COD reduction yields were observed at pH 5.83 with a significant reduction from 1386 mg/l to 632 mg/l after 120 min of settling in a yield of 54.40%, this reduction can be interpreted by the removal of the organic matter under the effect of ferric chloride.

For the pH 9.28 can be interpreted by the presence of the fulvic acids (FA) which are derived from the decomposition of the organic plant matter “Figure 4”.

PH can be an important parameter insofar as it conditions the dissociation of organic compounds. In general, the organic compounds appear to be better eliminated in a pH range between 5 and 6. Similarly, the coagulation of the organic matter is much more effective at acidic pH than near neutral pH.



**Fig.4.** Evolution of the COD according to the pH as a function of retention time

## Conclusion

Slaughterhouses are places where the consumption of water is very important because of the multiple uses that are made of it. Wastewater from these industries is not without impact on the environment. The results of this study confirm the choice of ferric chloride for the coagulation-flocculation of slaughterhouse wastewater. This method allows, after adjustment of the pH to a value of 5.83 to obtain the first 15 minutes of decantation, important elimination efficiency greater than 78.89% of the turbidity and 54.40% of the COD. These results show that the pH and the retention time have an effect on the elimination efficiency of these parameters.

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