ABSTRACT
Polymer industries generate significant amounts of effluent which has to be treated before being discharged into water stream. So far, very little attention has been paid towards polymer effluent treatment by physio-chemical process. In the present study, chemical coagulation-flocculation process was used to separate solids from industrial polymer effluent in order to make the effluent dischargeable with suitable characteristics. Aluminium Sulphate \([\text{Al}_2(\text{SO}_4)_3]\) and Anionic Polyacrylamide (Magnafloc155) were used as coagulant and flocculant respectively. Sulphuric Acid \((\text{H}_2\text{SO}_4)\) and Lime solution \([\text{Ca(OH)}_2]\) were used to adjust the pH values during the treatment process. A series of jar tests were conducted with different values of pH and dosing amounts of coagulant and flocculant. After each test, the supernatant layer of treated effluent was analysed for Chemical Oxygen Demand (COD), Suspended Solids (SS), colour and Turbidity. The process efficiency varied between 10 and 98% in COD removal, between 23 and 91% in suspended solids removal and between 37% and 99% reduction in turbidity. The optimal working pH value for coagulation was found to be 6 and that for flocculation was 8. The optimal doses of coagulant and flocculant were 7.5 mL per litre of effluent. These jar testing results have
been further proved by a successful pilot scale trial at the polymer plant with 1000 L effluent in
an Intermediate Bulk Container (IBC) using the same optimal values of the jar tests, which
indicates that the chemical coagulation and flocculation process is a feasible solution for the
treatment of effluent generated at polymer industry.

Keywords
Polymer effluent, water-based emulsion, effluent treatment, chemical treatment, coagulation and
flocculation.

1 Introduction
Polymer industry is the world’s fastest growing sector due to ever increasing demand of its
products. Polymer-based products have become an essential part of every day’s life. Due to their
unique mechanical and thermo-physical properties, they are replacing wood, metal and many
other products. The high demand for polymers has resulted in a large quantity of polymer
effluent that needs to be treated in order to protect the environment and aquatic life.

The industrial polymer effluent contains residual polymers in water or caustic solution and has
higher level of suspended solids and organic materials. This effluent is usually milky in colour
containing finely dispersed solids particles called collides which are stabilised by negative
electric charges on their surface, causing them to repel each other. The repulsion between these
particles prevents them from settling and keeps them in suspension. These particles cannot be
easily separated with conventional physical methods such as filtration or settling and therefore,
require the addition of chemicals to neutralise the charges on colloidal particles.
There are a number of processes available for water and wastewater treatment such as chemical coagulation-flocculation, electro-coagulation, electro-floatation, sedimentation precipitation, extraction, evaporation, membrane filtration, adsorption on activated carbon, ion-exchange, oxidation and advanced oxidation, incineration, bio-degradation and electrochemical treatment etc. However, complete treatment of wastewater usually require number of steps and it is often appropriate to combine more than one method of treatment and purification before the maximal efficiency/purity can be obtained, knowing that each method has its advantages and its disadvantages. [1-6].

Coagulation-flocculation is one of the most practised technologies extensively used on industrial scale wastewater treatment [7-12]. The removal mechanism of this process is mainly due to the charge neutralization of negatively charged colloids by cationic hydrolysis products which allows the Van der Waals force of attraction to encourage initial aggregation of colloidal particles to form microflocs [13]. The efficiency of coagulation-flocculation process depends on the coagulant type, dosage, pH value, temperature, ionic strength, nature and concentration of organic matter, total dissolved solids, size and distribution of colloidal particles in suspensions and several other factors [14, 15]. Coagulation-flocculation is an important unit operation in wastewater treatment of many industries such as pulp and paper, pharmaceutical, petrochemical, cosmetics, food, mineral processing, metal working and textile [16]. This technique has been successfully employed for the treatment of the effluents from tannery [17], yeast wastewater[18], textile [19, 20], petroleum refinery [8], dyebath and dye house [21], aquaculture [13], vinasse [22], municipal [23, 24], landfill leachates [25], pulping [26, 27], olive mill [28] and many other. These multitudes of applications on the examination of coagulation–flocculation for the
industrial effluents treatment aim mainly at the performance optimisation. Although chemical coagulation and flocculation may be a feasible solution for the treatment of effluent from polymer industry, few studies have been carried out to investigate the polymer effluent treatment using coagulation and flocculation processes. In fact, the studies on the polymer effluent treatment are also quite limited. Araya et al. investigated the anaerobic treatment of effluents from an industrial polymers synthesis plant and were able to reduce the COD value by 75% by using the anaerobic treatment process [29].

The effectiveness of coagulation depends on the coagulating agent used, the dosage, the solution pH, the concentration and the nature of the organic compound present in the water [30]. The widely used coagulants are iron and alum salts. These coagulants promote particles agglomeration by reducing the electrostatic particle surface charges in the acidic pH region prominently where hydrolysed metal species are abundant [8]. The aluminium salts are commonly used coagulants for water and wastewater treatment [31]. One of the most widely used coagulant is Aluminium Sulphate (alum), due to its low cost, ease of use, handling, storage and mixing properties [32].

The flocculant adsorbs destabilised colloidal particles with loop and tails extending into the solution for bridging with other particles [33]. The long chain polymers attach at a relatively few sites on the particles, leaving long loops and tails which stretch out into the surrounding water. Flocculation is usually more effective with higher molecular weight polymers. Adding excessive amount of polymer results in entire particle surface becoming coated with polymer, such that no sites are available to ‘bridge’ with other particles [34]. The flocs structure may differ as a
function of physical-chemical conditions, as the flocs formed at the lower pH and dose are reported to be denser and less porous than those formed at higher pH and dose [35].

In the present study, an investigation on the treatment of effluent generated from an industrial-scale polymer plant was conducted by the chemical coagulation-flocculation. The polymer manufactured at the plant was water based, mainly consisting of Acrylic Acid, Methylacrylic Acid, Maleic Acid and their derivatives. A series of jar tests were conducted in order to determine the optimal dosage and pH for coagulation and flocculation. The experimental results were evaluated using major ecological parameters, like Chemical Oxygen Demand (COD), Suspended Solids (SS), colour and turbidity values.

2 Materials and methods

2.1 Materials

Aluminium Sulphate \([\text{Al}_2(\text{SO}_4)_3]\) and Magnafloc155 (Anionic polyacrylamide) were used as coagulant and flocculant respectively. Sulphuric acid \((\text{H}_2\text{SO}_4)\) and Lime solution \([\text{Ca(OH)}_2]\) were used for regulating the pH value of effluent during the treatment processes. The details of used materials are described in Table 1.
Table 1. Materials characteristics.

<table>
<thead>
<tr>
<th>Chemicals</th>
<th>Formula</th>
<th>Physical Form</th>
<th>Molecular Weight (g/mole)</th>
<th>Concentration (%)</th>
<th>Purpose</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sulphuric Acid</td>
<td>H₂SO₄</td>
<td>Liquid</td>
<td>98.01</td>
<td>77</td>
<td>pH adjustment</td>
</tr>
<tr>
<td>Aluminium Sulphate</td>
<td>Al₂(SO₄)₃</td>
<td>Powder</td>
<td>342.15</td>
<td>26</td>
<td>Coagulant</td>
</tr>
<tr>
<td>Lime</td>
<td>Ca(OH)₂</td>
<td>Powder</td>
<td>74.093</td>
<td>12</td>
<td>pH adjustment</td>
</tr>
<tr>
<td>Magnafloc155</td>
<td>-C₃H₅NO-</td>
<td>Powder</td>
<td>5x10⁶</td>
<td>0.16</td>
<td>Flocculant</td>
</tr>
</tbody>
</table>

2.2 Sampling

The effluent samples were collected from the polymer manufacturing plant at Scott Bader Company Limited situated in Northamptonshire, UK. The samples were collected from the outlet of the holding tank where the effluent is stored before it is sent to the effluent treatment plant.

The initial solid contents in the effluent samples collected were 1.0% on dry basis. Various characteristics of the effluent were determined according to the Standard Methods [36] and are summarised Table 2. The target values are defined for Scott Bader as the discharge consent limits by Anglian Water (regulated under the Water Industry Act 1991).

Table 2. Physico-chemical characteristics of the pre-treated effluent.

<table>
<thead>
<tr>
<th>Parameters</th>
<th>Units</th>
<th>Initial Values</th>
<th>Target Values</th>
</tr>
</thead>
<tbody>
<tr>
<td>Temperature</td>
<td>°C</td>
<td>45</td>
<td>&lt;40</td>
</tr>
<tr>
<td>PH</td>
<td>–</td>
<td>13</td>
<td>6–10</td>
</tr>
<tr>
<td>COD</td>
<td>mg/L</td>
<td>&gt;20,000</td>
<td>&lt;6000</td>
</tr>
<tr>
<td>SS</td>
<td>mg/L</td>
<td>3500</td>
<td>&lt;1000</td>
</tr>
<tr>
<td>Turbidity</td>
<td>NTU</td>
<td>750</td>
<td>&lt;20</td>
</tr>
</tbody>
</table>
2.3 Jar tests

The jar test has been the standard technique used to optimise the addition of coagulants and flocculants used in the water and wastewater treatment industry from more than half a century. The scope of this practice is to evaluate the treatment to reduce the suspended, colloidal and non-settable matter from the effluent by chemical coagulation-flocculation. The same standard was utilized to evaluate the variables normally encountered in the coagulation-flocculation process [13].

Considering the number of possible jar tests and total effluent volume of 15 L available for all these tests, it was decided to use 200 mL sample for each jar test. The resulting optimal pH and dose of chemicals was then applied to 500 mL and 1000 mL of the remaining sample and the same results were observed as those for 200 mL. The equipment used was a laboratory flocculator model JLT-4 VELP by Scientifica, Italy equipped with four parallel beakers. A volume of 200 mL of the polymer effluent was placed in each beaker. The desired pH for coagulation was adjusted using Sulphuric Acid (H$_2$SO$_4$) and for flocculation using Lime solution [(Ca(OH)$_2$]. Inorganic coagulant Aluminium Sulphate [Al$_2$(SO$_4$)$_3$] and anionic polyacrylamide flocculant (Magnafloc155) were used in different combinations.

For coagulation, vigorous mixing at 200 rpm was used for 5 minutes whereas for flocculation, slow mixing at 40 rpm was used for 5 minutes followed by settling time of 30 minutes. Two series of jar tests were conducted according to the standard test methods [37]. In the first series, the dose of coagulant and flocculant was varied from 0.5 to 2.5 mL. In the second series, the pH
for coagulation was varied from 4 to 8 and for flocculation 6 to 10. The final pH, COD, SS, colour and turbidity of the supernatant were then measured.

2.4 Analysis

The methods and equipment used for determining the pH, COD, SS, TS and Turbidity are shown in Table 3. All analyses were performed according to the Standard Methods [36].

Table 3. Analytical methods and equipment used in the study.

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Method</th>
<th>Apparatus</th>
<th>Range</th>
<th>Brand/Model</th>
<th>Reference</th>
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<tbody>
<tr>
<td>pH</td>
<td>Electrometry</td>
<td>pH Meter</td>
<td>0–14</td>
<td>HANNA Instruments HI2212</td>
<td>Standard Methods [36]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>APHA 4500-H</td>
</tr>
<tr>
<td>COD</td>
<td>Spectroscopy</td>
<td>Photometer</td>
<td>20–20,000 mg/L</td>
<td>PALINTEST 8000</td>
<td>Standard Methods [36]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>APHA 5520-B</td>
</tr>
<tr>
<td>Turbidity</td>
<td>Nephelometry</td>
<td>Turbid meter</td>
<td>0.01–1100 NTU</td>
<td>HANNA Instruments TB200</td>
<td>Standard Methods [36]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>APHA 2130</td>
</tr>
<tr>
<td>Total Solids</td>
<td>Evaporation</td>
<td>Moisture Analyser</td>
<td>0–36 %</td>
<td>OHAUS MB35</td>
<td>Standard Methods [36]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>APHA 2540</td>
</tr>
</tbody>
</table>

3 Results and Discussion

3.1 The coagulation-flocculation process

The coagulation-flocculation process was completed in four steps. In the first step, the pH of effluent was adjusted to 6 as the optimum pH for Aluminium Sulphate is between the range of 5.8 to 6.5 [38]. The second step was the addition of coagulant (Aluminium Sulphate) to destabilise the colloidal particle of emulsion. In the third step, pH was adjusted to 8 using lime as Magnafloc155 tends to work best in the pH range of 6 to 10 [39] which was also suggested by the manufacturer, Goldcrest Chemicals Limited, UK. In the final step, flocculant (Magnafloc155)
was added to bridge the destabilised colloidal particles together to develop larger flocs. The same
procedure was repeated for the second series of the experiments in which the concentration of
the coagulant and flocculant were kept constant but pH values for coagulation and flocculation
were changed. The effects of coagulant-flocculant concentration and pH were analysed on the
removal of COD, suspended solids, colour and turbidity.

3.2 Effects of coagulant and flocculant doses on the removals of COD, suspended solids, colour and turbidity

The effects of coagulant and flocculant doses on the removals of COD, SS and turbidity were
investigated at constant pH values of 6 for coagulation and 8 for flocculation with varying doses
of the reagents. pH is a measure of the acidity or alkalinity of water and is one of the stable
measurements. pH is a simple parameter but is extremely important, since most of the chemical
reactions in aquatic environment are controlled by any change in its value. Anything either
highly acidic or alkaline would kill marine life. Aquatic organisms are sensitive to pH changes
and biological treatment requires pH control or monitoring. The toxicity of heavy metals also
gets enhanced at particular pH. Thus, pH is having primary importance in deciding the quality of
wastewater effluent. Waters with pH value of about 10 are exceptional and may reflect
contamination by strong base such as NaOH and Ca(OH)₂ [40]. The range of desirable pH of
wastewater prescribed for discharge purpose by Anglian water was 6.0 to 10.0. The pH value of
effluent samples collected was observed as 13.0, well above from the permissible limit.

Chemical Oxygen Demand value is useful in specifying toxic condition and presence of
biologically resistant substances. It is an important, rapidly measured parameter for industrial
wastewater studies and control of waste treatments. The COD value is a measure of the relative
oxygen-depletion effect of a waste contaminant and has been widely adopted as a measure of pollution effect [41].

The COD value in collected effluent was observed to be greater than 20,000 mg/L whereas the discharge consent limit allowed by Anglian Water authorities is only 6000 mg/L. The effects of the coagulant and flocculant doses on the removal of COD are shown in Fig. 1.

![COD removal with different coagulant and flocculant doses](image)

**Fig. 1.** COD removal with different coagulant and flocculant doses.

It can clearly be seen that the COD removal increased with the increase in coagulant and flocculant doses until the maximum values were obtained. When the doses of coagulant and
floculant were 0.5 mL (in 200 mL sample), the removal of COD was about 10% but it increased to 51% which is still not sufficient for the required standard (<6000 mg/L) when both doses increased to 1.0 mL; however, when the coagulant dose was increased from 1.0 to 1.5 mL combined with the addition of 1.5mL of flocculant, a significant improvement in COD removal efficiency was achieved with the COD removal of 91% with the corresponding COD value (1800 mg/L) much smaller than the required standard value. At the coagulant dosage of 1.5 mL and flocculant dose of 2.0 mL, the COD removal was at the highest level, 98%. With a further increase in the coagulant dose up to 2.5 mL, no further significant COD reduction was observed.

Both the scientific literature and international water quality guidelines relating to SS are dominated by the implicit assumption that the concentration-response model applies to SS effects on aquatic biota (i.e. increase in SS = increase in effect on aquatic biota) [42]. Indeed, numerous authors have reported that the magnitude of the effects of SS on aquatic organisms generally increases with SS concentrations. However, other factors such as the duration of exposure, particle-size distribution and chemical composition of the SS, and the presence of other contaminants on the solids also appear to have an important control over the effect of SS on aquatic biota. Suspended solids can harbour opportunistic pathogens and speed up the growth of bacteria. They are associated with environmentally-induced disease problems, and have been reported to cause sub-lethal effects such as fin rot and direct gill damage [43]. The effects of the coagulant and flocculant doses on the removal of SS are shown in Fig. 2.
It can clearly be seen that SS removal increased with the increases in coagulant and flocculant doses until the maximum removal values were obtained, similar to what have been shown in Fig. 1. For example, when the initial doses of coagulant and flocculant were 0.5 mL, the removal efficiency of SS was about 23% but it increased to 40% when both doses increased to 1.0 mL, which is still not sufficient for the required standard value (<1000 mg/L). When both the coagulant doses were increased to 1.5 mL, the SS removal efficiency was significantly high at 82% with the SS value (674 mg/L) being well below the required standard value. At the coagulant dosage of 2.5 mL and flocculant dose of 2.0 mL, the SS removal was at its highest level of 86%.
No significant SS reduction was observed for further increases in the coagulant and flocculant doses beyond 1.5 mL.

Turbidity diffuses sunlight and slows photosynthesis. Plants begin to die, reducing the amount of dissolved oxygen and increasing the acidity (decaying organic material produces carbonic acid, which lowers the pH level), both of these effects harm aquatic life. Turbidity as sedimentation can also affect ecosystem functions [44, 45]. Fig. 3 shows the removal of turbidity with different coagulant and flocculant doses at constant pH values of 6 and 8 for coagulation and flocculation respectively.

Fig. 3. Turbidity removal with different coagulant and flocculant doses.
Similar to the COD and SS removals, the turbidity removal increased with the increase in coagulant and flocculant doses until the maximum values were obtained. With the doses of coagulant and flocculant at 0.5 mL, the removal efficiency of turbidity was about 37%. When both doses increased from 0.5 to 1.0 mL, the removal of turbidity increased to 69% but still not up to the required standard value (<20 NTU). When both the coagulant dose and the flocculant dose were 1.5 mL, the total turbidity removal reached 98% with the turbidity value (18 NTU) being well below the required standard value. At the coagulant dosage of 2.5 mL and flocculant dose of 1.5 mL, turbidity removal was at its highest level of 99%.

This series of tests showed that it was possible to achieve the maximum removal efficiency of 98% for COD, 86% for SS and 99% for turbidity. When both the coagulant and the flocculant doses were increased from 1.0 mL to 1.5 mL remarkable improvements in removal efficiencies were observed. Visual inspection also showed that with the increase in coagulant and flocculant dosage, the supernatant became clearer as shown in Fig. 1. On the other hand, the targeted values of COD, SS and turbidity were well within the range of 91%, 82% and 98% removals respectively which are quite close to the best values. Therefore it can be concluded that the coagulant dose of 1.5 mL and flocculant dose of 1.5 mL are optimal doses for the targeted values of the all three parameters.

### 3.3 Effects of pH on the removal of COD, suspended solids, colour and turbidity

The effects of pH values on the removals of COD, SS and turbidity were investigated at a constant dose of 1.5 mL (in 200 mL sample) of coagulant and 1.5 mL (in 200 mL sample) of flocculant whereas the pH values for both steps were varied. The removal percentage of COD with varying pH values for coagulation and flocculation is shown in Fig. 4.
Divergent from the series one tests where the pH value for coagulation and flocculation were fixed at 6 and 8 respectively, the pH values for the series two tests were changed from 4 to 8 for coagulation and from 6 to 10 for flocculation. Fig. 6 shows that the percentage of COD removal increases up to the maximum level of 98% then starts to decrease with an increase in the pH value for either coagulation or flocculation. At an initial pH value of 4 for coagulation and 6 for flocculation the removal percentage of COD was 40% while changing pH value to 5 for coagulation and 6 for flocculation led to the COD removal percentage of 69%, which is still not sufficient for the required standard value (<1000 mg/L). Further increases in pH value to 6 for coagulation and 8 for flocculation resulted in the COD removal to the highest level of 91%.

Fig. 4. COD removal with varying pH values for coagulation and flocculation.
Further increases in the pH value for coagulation to 8 and for flocculation to 10 resulted in a decrease in the COD removal efficiency (down to 36%).

![Graph showing SS removal with varying pH values for coagulation and flocculation.]

Fig. 5. SS removal with varying pH values for coagulation and flocculation.

Fig. 5 shows the variation of the removal percentage of SS with the pH values for coagulation and flocculation. It is clear that when the pH values for coagulation were changed from 4 to 8 and for flocculation from 6 to 10, the percentage of SS removal increases up to a certain level then starts decreasing. At the pH value of 4 for coagulation and 6 for flocculation the removal percentage of SS was 52%. Changing the pH value from 4 to 5 for coagulation and from 6 to 7 for flocculation, the removal percentage of SS increased to 79% which is still not sufficient to achieve the standard value (<1000 mg/L). A further increase in the pH value to 6 for coagulation
and to 8 for flocculation resulted in the maximum SS removal efficiency of 90% SS. Any further increase in the pH values for coagulation and flocculation lead to a reduction in SS removal. The effects of pH values on the removal of turbidity are shown in Fig. 6.

![Fig. 6. Turbidity removal with varying pH values for coagulation and flocculation.](image_url)

In contrast to the trends of COD and SS removals shown in Figs. 5-6, the pH value of flocculation has a much smaller influence on the removal of turbidity. In addition, within the ranges of the investigated pH values (4 to 8 for coagulation and 6 to 10 for flocculation), the percentage of turbidity removal remained above 80% although it peaked to 98% at the pH value of 6 for coagulation and 8 for flocculation.
The second series test results showed that the maximum removal efficiencies of 91% for COD, 90% for SS and 98% for turbidity could be achieved with the pH value of 6 for coagulation and 8 for flocculation. Under these conditions, the required target values for COD, SS and Turbidity were all successfully achieved. Therefore, it can be concluded that the pH value of 6 for coagulation and pH value of 8 for flocculation are the optimal pH values for targeted parameters.

Examples of jar tests, which yielded good results, are shown in Fig. 7.

![Fig. 7. Effluent samples during treatment: (A) acid addition, (B) coagulant addition, (C) lime addition, and (D) flocculant addition.](image)

These jar tests were then followed by a successful pilot scale trial at the polymer plant with 1000 litres of effluent in an Intermediate Bulk Container (IBC) using the same optimal pH and dosage values. 1000 litres of the effluent was transferred into and open top Intermediate bulk container (IBC) with an air driven agitator fitted on it and spinning at 30 rpm. The total solids in this effluent were 1.1% (dry basis). The pH of the effluent was adjusted to 6 by adding 77% sulphuric acid. 7.5 litres of coagulant (26% aluminium sulphate) solution was added into IBC.
The pH was re-adjusted to 8 by manually adding 12% lime solution. Then 7.5 litres of flocculant (0.16% Magnafloc) was added and the agitator speed was slowed down to 15 rpm. The agitator was stopped 5 minutes after adding flocculant and the flocs were allowed to settle. After 10 minutes of sedimentation, the sludge was settled at bottom taking about 15% volume of IBC. Supernatant water was collected for analysis and the results showed its pH 7.9, Suspended Solids 280 mg/L, COD 350 mg/L, Turbidity 20 NTU. These values were quite similar with those of jar tests.

The results of the present study are also better than those of few studies on the treatment of polymer effluent [29] found in the literature. Ayara et al. [29] investigated the feasibility of the anaerobic treatment of an industrial polymer synthesis plant effluent having the initial COD value of about 2000 mg/L. Their process was able to reduce the COD value by 75%, which is much smaller 91% achieved with the present work.

4 Conclusions

The chemical coagulation-flocculation process for the treatment of effluent from a polymer industrial plant showed a great potential to reduce the COD, SS, colour and turbidity. The process effectively removed COD, SS and turbidity up to 98%, 91% and 99% respectively. However, the jar tests found that the treatment process was highly sensitive to the pH values and the coagulant and flocculant doses used for the effluent treatment. The targeted values of the main parameters (COD<6000 mg/L, SS<1000 mg/L and turbidity < 20 NTU) were achieved by the coagulant and flocculant doses of 7.5mL/L (1.5 mL per 200 mL of effluent) each at the pH value of 6 and 8 respectively. Thus 7.5 mL/L doses of coagulant and flocculant at pH values of 6 and 8 were found to be optimal conditions for the effluent treatment. Under the optimal
conditions, the final values of COD, SS and turbidity were 1750 mg/L, 354 mg/L and 18 NTU respectively, meeting their respective standard values. The jar test results were also confirmed by a successful pilot scale trial at the polymer plant with 1000 L effluent in an Intermediate Bulk Container (IBC) using the same optimal values. So far, there are only a few studies having investigated the treatment of polymer effluent and therefore more investigations are required. The chemical coagulation and flocculation process has been shown to be a feasible solution for the treatment of effluent from polymer industry.
References