ININVOLVING OF DEWATERING CAPACITY OF AEROBIC AND ANAEROBIC STABILIZED SLUDGES

by

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ABSTRACT

Sludge is one of the major problem in environmental engineering because its large water content. This study investigates the dewatering capacity of aerobic and anaerobic of stabilized sludges with chemical conditioning and co-conditioning methods by using different types of polymers. Dry solids content (DS, %), water content (WC, %), organic matter content (OM, %), pH, electrical conductivity (EC, µmhos/cm), capillary suction time (CST), specific resistance to filtration (SRF), and centrifugal settleability index parameters were analyzed for raw and conditioned sludge samples. Polymers have not significant bridging effect on stabilized sludge because its stabile structure. This research shows that stabilized sludge conditioning is not cost effective because of high polyelectrolyte need.

Keywords: Aerobic stabilized sludge, anaerobic stabilized sludge, conditioning, dewatering, centrifugal settleability index (CSI), specific resistance to filtration (SRF), capillary suction time (CST), polyelectrolyte.

ÖZ

Çamur yüksek su içeriği yüzünden Çevre Mühendisliğinin büyük problemlerinden biridir. Bu çalışma, değişik polimer tipleri ile şartlandırma ve ikili şartlandırma metotları kullanılarak aerobik ve anaerobik stabilize çamurların su verme kapasitesini incelemektedir. Ham ve şartlandırılmış çamurda kek katı maddesi (KM, %), askıda katı madde (%), kek organik maddesi (%), pH, elektrik iletkenliği (µmhos/cm), kapiler emme süresi (s), özgül direnç ve santrifüj ile çökelebilirlik parametreleri analiz edilmiştir. Stabilize çamurun stabil özelliğinden ötürü polimerlerin köprüleme özelliği ihmal edilebilir kalmıştır. Bu araştırma, stabilize çamurlarda şartlandırma işleminin yüksek polimer ihtiyacı dolayısı ile ekonomik olmadığını göstermektedir.

Anahtar kelimeler: Aerobic stabilize çamur, anaerobic stabilize çamur, şartlandırma, susuzlaştırma, santrifüjle çökelebilirlik indeksi, özgül filtrelenebilirlik direnci, kapiler emme süresi, polielektrolit.
1. Introduction

Sludge is one of the constituent removed in wastewater treatment plants and persists to be a major problem in various operations in wastewater treatment because its largest volume and, complexer processing and the diposal problem according to the other constituents removed by treatment. For this reason, dewatering capacity of aerobic and anaerobic stabilized sludges is investigated in this study.

Basic parameters in process design and operation is the characterization, dewaterability and volume of the sludge. The SRF is used to evaluate sludge dewaterability and CST to evaluate filterability. Using SRF and CST, versus dosage curves the optimal dose of a sludge conditioner can be estimated.

Sludge dewatering is preceded by conditioning operation to enhance water removal efficiency. In the conditioning operation, chemical coagulants or polymers are added to promote sludge particle aggregation for easier dewatering.

2. Sludge Conditioning

The conditioning of sludge involves pretreatment in order to facilitate water removal during thickening and/or dewatering operations. During the conditioning process small and amorphous gellike particles are transformed into larger end stronger aggregates. Separation of sludge components either by filtration, centrifugation can be enhanced by mixing additives to the sludge and/or by subjecting these solids to specific chem. and phys. processes.

Dentel, et al., (1998) indicated that in the classical representation of sludge, the particles in sludge have often been conceptualized as rigid and uniform spheres; and added that coagulation and flocculation in water treatment and conditioning in sludge treatment could be explained with this traditional approach.

Polymers are used for sludge conditioning to improve sludge dewaterability. "Sludge conditioned with a polymer generates less solid cake after sludge dewatering because of the lower dosage required as compared to the addition of fly ash and inorganic chemicals. The cost of the polymer accounts for almost half of the overall sludge dewatering and disposal
costs” (Chitikela & Dentel, 1998). “Effective sludge conditioning is thus important in sludge dewatering” (Lee et al., 2001, p.129).

Many factors affect sludge conditioning; these factors may broadly be categorized as physical, chemical, and biological.

3. Material and Method

In the experimental studies, chemical conditioning were applied to aerobic stabilized sludge samples taken from Manisa Organized Industrial District and to anaerobic stabilized sludge samples taken from Pakmaya/Kemalpaşa Inc. for investigation of dewatering performance. Raw sludge samples were collected seven times and kept at 4°C during the experiments. pH, electrical conductivity (EC), dry solid content (DS), organic matter (OM), total suspended solid (TSS), capillary suction time (CST), centrifugal settleability index (CSI), sludge volume index (SVI) and supernatant turbidity were analyzed for raw sludge samples. The physico-chemical characteristics of raw sludge samples are reported in Table 3.1.

Table 3.1 The physico-chemical characteristics of raw sludge samples

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Units</th>
<th>I</th>
<th>II</th>
<th>III</th>
<th>IV</th>
<th>V</th>
<th>VI</th>
<th>VII</th>
<th>VIII</th>
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</thead>
<tbody>
<tr>
<td>pH</td>
<td>-</td>
<td>7,95</td>
<td>7,89</td>
<td>8,01</td>
<td>8,00</td>
<td>7,98</td>
<td>7,72</td>
<td>6,68</td>
<td>7,41</td>
</tr>
<tr>
<td>EC</td>
<td>µmho/cm</td>
<td>13000</td>
<td>11900</td>
<td>11500</td>
<td>13500</td>
<td>16800</td>
<td>15000</td>
<td>350</td>
<td>210</td>
</tr>
<tr>
<td>DS</td>
<td>%</td>
<td>3</td>
<td>1,23</td>
<td>2,82</td>
<td>1,53</td>
<td>3,24</td>
<td>1,58</td>
<td>0,49</td>
<td></td>
</tr>
<tr>
<td></td>
<td>mg/L</td>
<td>3000</td>
<td>-</td>
<td>1230</td>
<td>2820</td>
<td>1530</td>
<td>3240</td>
<td>1580</td>
<td>492</td>
</tr>
<tr>
<td>OM</td>
<td>%</td>
<td>37,22</td>
<td>-</td>
<td>41,06</td>
<td>41,01</td>
<td>39,66</td>
<td>41,02</td>
<td>58,92</td>
<td>26,20</td>
</tr>
<tr>
<td></td>
<td>mg/L</td>
<td>3722</td>
<td>-</td>
<td>4106</td>
<td>4101</td>
<td>3966</td>
<td>4102</td>
<td>5892</td>
<td>2620</td>
</tr>
<tr>
<td>TSS</td>
<td>mg/L</td>
<td>-</td>
<td>-</td>
<td>19000</td>
<td>10666</td>
<td>5000</td>
<td>50900</td>
<td>10000</td>
<td>4300</td>
</tr>
<tr>
<td>CST</td>
<td>Second</td>
<td>617,6</td>
<td>1022</td>
<td>184,3</td>
<td>717,4</td>
<td>344,5</td>
<td>820,4</td>
<td>76</td>
<td>12,5</td>
</tr>
<tr>
<td>CSI</td>
<td>%</td>
<td>-</td>
<td>-</td>
<td>92,1</td>
<td>96,24</td>
<td>89,6</td>
<td>99,8</td>
<td>99,7</td>
<td>96,04</td>
</tr>
<tr>
<td>SVI</td>
<td>mL/g</td>
<td>750</td>
<td>89</td>
<td>210</td>
<td>900</td>
<td>190</td>
<td>960</td>
<td>925</td>
<td>140</td>
</tr>
<tr>
<td>Turbidity</td>
<td>JTU</td>
<td>12300</td>
<td>5000</td>
<td>5000</td>
<td>13000</td>
<td>6000</td>
<td>22000</td>
<td>5000</td>
<td>4500</td>
</tr>
</tbody>
</table>
Materials used as conditioning agents in chemical conditioning trials were; commercially available three types of cationic polyelectrolyte (KWD 3500, 5980 SB and SNF 5980), Alum \(\text{Al}_2\text{(SO}_4\text{)}_{3.18} \text{H}_2\text{O}\), non-ionic polyelectrolyte (KWD 20LT and anionic polyelectrolyte (KWD A 0055). The polyelectrolyte solutions were prepared as 0.1% stock solution, and alum solution was prepared as 10% stock solution using distilled water. Dosages of polyelectrolytes were varied between 5 to 450 mg/L, and the dosage of alum varied 100 to 1000 mg/L.

Dry solids content (DS, %), water content (WC,%), organic matter content (OM,%), pH, electrical conductivity (EC, \(\mu\text{mhos/cm}\)), capillary suction time (CST), specific resistance to filtration (SRF), and centrifugal settleability index parameters were analyzed for raw and conditioned sludge samples in laboratory studies. DS, WC, OM, pH, EC, CST and SRF were measured according to procedures given in Standard Methods (APHA, 1995).

4. Conclusion

The aim of this study was to investigate the dewaterability of aerobic and anaerobic stabilized sludges. For this purpose, aerobic stabilized sludge samples were taken from Manisa Organized Industrial District Wastewater Treatment Plant and anaerobic stabilized sludge samples were taken from Pakmaya Wastewater Treatment Plant/Kemalpaşa and these samples were used for experimental studies. After characterization studies, raw sludge samples were conditioned using different types of polymers and aluminum hydroxide. In conditioning experiments, three types of cationic polyelectrolyte (KWD 3500, 5980 SB and SNF 5980), non-ionic polyelectrolyte (KWD-20 LT) and anionic polyelectrolyte (KWD A-0055) and aluminum 18 hydroxide were applied (to sludge samples at different dosages (together or separately). To determine the optimum dose range of each type of conditioners applications, specific resistance to filtration (Buchner Funnel Test) and capillary suction time test were applied to the raw and conditioned sludge samples.

Chemical conditioning using cationic polyelectrolyte played an important role on the dewaterability of aerobic and/or anaerobic stabilized sludges; however non-ionic and anionic polyelectrolyte have not any effect on dewatering capacity. Filibeli A., & Kaynak, G. E. (2005) stated in their study that cationic polyelectrolytes have an important effect on sludge dewaterability which shows that the experimental result is reaching an agreement with it.
Typical results from conditioning experiments by using cationic polyelectrolyte can be seen in table 4.1 and experimental results can be observed in figures 4.1 to 4.4.

Table 4.1 Typical results from conditioning experiments by using cationic polyelectrolyte

<table>
<thead>
<tr>
<th></th>
<th>Optimum Dose (mg/L)</th>
<th>Minimum r Value</th>
<th>Minimum CST (s)</th>
<th>Maximum Dry Solid (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Aerobic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KWD 3500</td>
<td>240</td>
<td>1,31E+13</td>
<td>7,8</td>
<td>20,64</td>
</tr>
<tr>
<td>SNF 5980</td>
<td>45</td>
<td>2,10E+14</td>
<td>7,7</td>
<td>19,12</td>
</tr>
<tr>
<td>5980 SB</td>
<td>350</td>
<td>6,17E+13</td>
<td>7,7</td>
<td>18,53</td>
</tr>
<tr>
<td><strong>Anaerobic</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>KWD 3500</td>
<td>250</td>
<td>1,26E+13</td>
<td>12,3</td>
<td>13,4</td>
</tr>
<tr>
<td>SNF 5980</td>
<td>200</td>
<td>6,29E+12</td>
<td>17,2</td>
<td>16,08</td>
</tr>
<tr>
<td>5980 SB</td>
<td>270</td>
<td>2,82E+13</td>
<td>12,9</td>
<td>18,22</td>
</tr>
</tbody>
</table>

4.1 Buchner Funnel test results applied to aerobic sludge samples
4.2 Capillary Suction Time test results applied to aerobic sludge samples

![Capillary Suction Time Test Results](image)

4.3 Buchner Funnel test results applied to anaerobic sludge samples

![Buchner Funnel Test Results](image)
In conditioning experiments it was observed that co-conditioned sludge samples with cationic polyelectrolyte and alum dewatering capacity is not as effective as separately conditioned sludge samples. Lai, J.Y. & Liu, J.C. stated in their study that co-conditioning of mixed (alum sludge and waste activated sludge mixture) sludge was very effective due to alum sludge’s skeleton builder behavior. (Lai, J.Y. & Liu, J.C, 2004).

In conditioning experiments, it was observed that aluminum sulphate 18 hydrate has any effect on aerobic and/or anaerobic stabilized sludge dewatering when used as preconditioning agent. It is more beneficial to use polymers for these types of sludge. “Polymers also have an important conditioning advantage called ‘bridging effect’.” (Dentel, S.K. & Dursun, D., 2005).

Regarding to the optimal dosages, it may be beneficial to carry out a cost analysis in addition to investigation of sludge dewatering properties.

Since KWD-20 LT, non-ionic and KWD A-0055 anionic polyelectrolyte have any significant effect on aerobic and anaerobic stabilized sludge, they cannot be used as conditioner on this type of sludges.
Since aluminum sulphate 18 hydrate have no significantly positive effect on these type of stabilized sludges when used alone without any polyelectrolyte addition, it’s use as conditioner on these type of sludge is not recommended.

**References**


