# Determination the Composition of Afrotan Tannery Sludge's in Sudan

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***ABSTRACT*** - Afrotan tannery was established in 1983 in Albageer Industrial Area- Algazeera State - Sudan. It tans about 20000 skins per day and generates high amount of waste water. Beside the tannery, there are three units of waste water treatment. These treatment units precipitate high amounts of sludge in sedimentation tanks of these units. The tannery collects all this sludge, treats by adding Aluminum sulphate, lime and Poly electrolyte respectively, dewaters by pressing by centrifuge machine and fills it in land. The aim of this study is to determine and to investigate the parameters in sludge before treatment (slurry sludge) and after treatment (dewatered sludge). The analysis was carried out by using standards methods for the Examination of Water and Waste Water, Edition 20, (1998). The results showed that the values of BOD, COD, TVS, $NH_3$, $NH_4$, $NO_3$, $SO_3$, $SO_4$, Cl, Fe, Ca, Na, K, Al and Cr in slurry sludge (before treatment) were found to be 33600 mg/l, 56000 mg/l, 96.0%, 196 mg/kg, 238 mg/kg, nil, 0.25 %, 0.624%, 6747.8 mg/l, 16.18 mg/l, 18.421 mg/l, 8.864 mg/l, 10.609 mg/l, 0.00215 mg/l and 13.23 mg/l, respectively. The values of these parameters in treated and dewatered sludge (after treatment) were found to 40000 mg/l, 68000 mg/l, 81.7%, 252 mg/kg, 306 mg/kg, 28 mg/kg, 1.2 %, 1.44 %, 5100.8 mg/l, 4.911 mg/l, 21.328 mg/l, 9.041 mg/l, 8.146 mg/l, 0.00189 mg/l and 5.897 mg/l, respectively. The study recommended that it is important to prevent filling this sludge in the land to avoid soil contamination and also to conduct further studies to use this sludge in agriculture or others purposes.

***Keywords:*** *Sludge treatment unit, sludge parameters, slurry and dewatered sludge.*

***المستخلص***– انشئت مدبغة افروتان عام 1983 بمنطقة الباقير بولاية الجزيرة – السودان. المدبغة تدبغ 20000 جلد فى اليوم وتنتج كميات كبيرة من المياه العادمة. بجانب المدبغة توجد ثلاثة وحدات لمعالجة مياة المدبغة العادمة، هذه الوحدات ترسب كميات كبيرة من الحمأة فى اوعية الترسيب التابعة لها. المدبغة تجمع كل هذا الحمأة وتعالجه باضافة كبريتات الالومونيوم وكربونات الكالسيوم والبولى الكترولايت على التوالى وتزيل منه الماء بعصره فى ماكينة الطرد المركزى وتدفنة فى الارض. الغرض من الدراسة هو تحديد وقياس المكونات الموجودة بالحمأة المائع قبل المعالجة والحمأة المجفف بعد المعالجة. اجريت التحاليل بواسطة الطرق القياسية لاختبارات المياة والمياة العادمة النسخة العشرين لسنة 1998. اوضحت النتائج ان قيم الاوكسجين الحيوى المطلوب، الاوكسجين الكيميائى المطلوب، النشادر، الامونيا، النترات، الكبريتيد، الكبريتات، الحديد، الكالسيوم، الصوديوم، البوتاسيوم، الالومنيوم والكروم فى الحمأة المائع (قبل المعالجة) هى: 33600مج/لتر، 5600مج/لتر،96%، 196مج/كج، 238مج/كج، لايوجد، 0.25%، 0.624%، 6747.8 مج/لتر، 16.18 مج/لتر، 18.421 مج/لتر، 8.864 مج/لتر، 10.609 مج/لتر، 0.00215 مج/لتر، و 13.23 مج/لتر على التوالى. وان قيم هذه المكونات فى الحمأة المجففة بعد المعالجة هى: 4000 مج/لتر، 68000 مج/لتر،81.7%، 252 مج/كج، 306 مج/كج، 28 مج/كج، 1.2 %، 1.44 %،5100.8 مج/لتر، 4.911 مج/لتر، 21.328 مج/لتر، 9.041 مج/لتر، 8.864 مج/لتر، 0.00189 مج/لتر، 5.897 مج/لتر على التوالى. اوصت الدراسة بمنع دفن هذا الحمأة فى الارض لكى لا تتلوث التربة بالحمأة وبأجرا دراسات اخرى فى الحمأة للاستفادة منه فى الزراعة او اى اغراض اخرى.

## INTRODUCTION

Tanning is a leader industry produces several kinds of wastes. Tanneries are typically characterized as pollution intensive industrial complexes which

generate widely varying, high-strength wastewaters. The surrounding environment of leather industry is a good environment for the growth of bacteria and fungi [1]. Tannery wastewaters are highly complex and are characterized by high contents of organic, inorganic and nitrogenous compounds, chromium, sulfides, suspended solids and dissolved solids. Characteristics of wastewater from different tanneries and various methods for treating these tannery wastes are very important [2]. The three main categories of tannery wastewater, each one having very distinctive characteristics, are:

- Effluents emanating from the beam-house – liming, deliming/bating, water from fleshing and splitting machines; they contain sulphides, their pH is high, but they are chrome-free.
- Effluents emanating from the tanyard (tanning and re-tanning, sammying) – high Cr content, acidic.
- Soaking and other general effluents, mainly from post-tanning operations (fat-liquoring, dyeing) – has low Cr content [3].

If wastewaters are to be treated in sewage works or to undergo traditional effluent treatment, the main problems that arise are due to the large volume of sludge that forms as the solids settle. Sludge often contains up to 97% water, giving rise to huge quantities of "light" sludge. Even viscous sludge has a water content of about 93% and can easily block sumps, sludge pumps and pipes. All this sludge has to be removed, transported, dewatered, dried and deposited, thus placing an inordinate strain on plant, equipment and resources. Even a thin layer of settled sludge can become a blanket that deprives sections of the river or lake bed of oxygen. As a result, aquatic life dies and decomposition sets in [4]. Tannery effluent treatment plants produce treated, "cleaned" effluent and sludge because inherently the primary aim of wastewater treatment is the removal of solids and some potentially hazardous substances from the wastewater. Furthermore, biologically degradable organic substances are converted into bacterial cells, and the latter are removed from the wastewater [5]. The amount of sludge generated is influenced directly by the requirements set for waste water effluents. The quality of the sludge produced depends on the chosen treatment [6]. Sludge is collected and treated in a sludge buffer tank. Dewatering is generally applied to reduce the volume of sludge for disposal. This is mostly done by mechanical equipment such as filter presses or centrifuges, sometimes followed by a drying process [7]. Mainly composition of waste water treatment sludge's are Water content, Organic matter, Inorganic matter, Organic carbon, Ammonium, Nitrogen (organic), Substance extractable with $CH_2Cl_2$, Phosphorous, Chromium (III), Aluminum, Iron, Calcium and Sulphur (total) [7].

**Study Area:**

Afrotan tannery was established in 1983. It tans about 20000 skins per day. The tannery consumes high amount of fresh water and generates high amount of waste water. Beside the tannery, there are three units of waste water treatment as follows

a) General waste water treatment unit: This waste water is resulted from soaking, deliming, bating, general cleaning and fleshing processes. The tannery precipitates the sludge from this waste water by adding aluminum sulphate and polyelectrolyte in the sedimentation tanks.
b) Liming recovery unit: This waste water is resulted from un hairing and liming processes. The tannery removes the sludge by physical methods.
c) Chrome recovery unit. This waste liquor is resulted from chromium tanning process.

The recovery of chromium sulphate by precipitates it by adding magnesium oxide and sodium carbonate in the bottom of the neutralization tank. The liquor from the top of this tank which contains un precipitated chromium (supernatant) is sent to general waste water treatment unit and the chromium is precipitated in bottom of sedimentation tanks with sludge. The acidified of precipitated chromium by adding sulphuric acid in acidification tank [8]. The above treatment units precipitate high amount of sludge in sedimentation tanks. Afrotan Tannery collects this sludge, treats by adding Aluminum sulphate, lime and Poly electrolyte, dewaters by pressing by centrifuge machine and fills it in land.

The objective of this study is to determine and to investigate the parameters in sludge before treatment (slurry sludge) and after treatment (dewatered sludge).

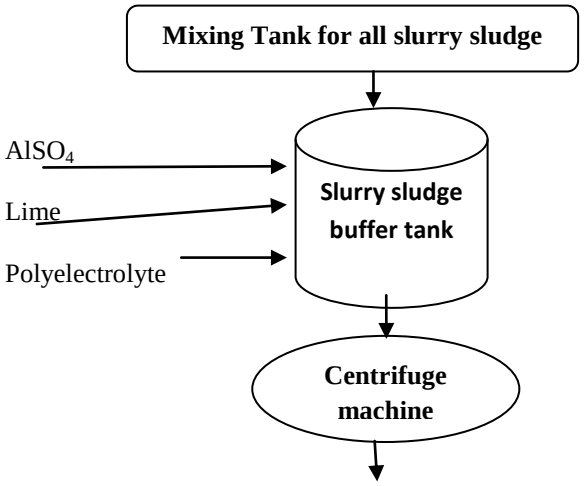


**Figure 1: Flow diagram of sludge dewatered unit:**

## MATERIALS AND METHODS

This study was carried out in Afrotan Tannery sludge. 500 ml of slurry sludge (before treatment) and 300 g of dewatered sludge (after treatment) were collected from Afrotan Tannery. Analysis was carried out in Constructional & Environmental Labs Center according to reference of Standards Methods for the Examination of Water and Waste Water, Edition 20, (1998). The COD measured by using Dichromate reflex method:

Procedure: Place 50 ml of sample in 500 ml refluxing flask. Add 1 g of sulfuric acid, several boiling chips, and 5 ml sulfuric acid. Add sulphuric acid slowly, with mixing to dissolve the mercuric sulphate. Cool while mixing. Add 25 ml 0.25N $K_2Cr_2O_7$ solution and again mix. Attach the flask to the condenser and start the cooling water, add the remaining 20 ml conc sulfuric acid slowly, with continuous swirling. Mix the reflex mixture thoroughly, before heat is applied. Reflex the mixture for about 2 hrs and after cooling titrate it against standard ammonium sulphate (0.1N) with feroin as indicator to the correct end point, note the titer value. Then make calculations.

The BOD measured by using BOD5 analysis method. The chloride measured by Ergonometric method:

Procedure: Take 5 ml of the sample to 50 ml round bottomed flask, add 3 drops of potassium chromate indicator and titrate with standard silver nitrate titrate to brown yellowish end point. Then make calculations.

The TVS measured by heating to 650 C. The ammonia measured Acidimetric method with distillation step:

Procedure: Take 100 ml sample in a distillation flask and dilute with 100 ml distilled water. Add 25 ml borate buffer and adjust pH to 9.5 with 6 N NaOH using pH meter. Transfer the distillation flask to the distillation apparatus, and start the distillation at a rate of 6 to 10 ml/min with the tip of the delivery tube submerged. Collect the distillate in a 500 ml erlenmeyer flask containing 25 ml indicating boric acid. Collect 200 ml distillate. Titrate ammonia in the distillate with standard 0.02N $H_2SO_4$ titrate until the indicator a pale lavender. Then make calculations. The sulphate measured by using Turbid metric Method. Cr, Ca, Na, K, $NH_4$, Fe and Al were measured by Shimadzu Atomic Absorption Spectroscopy (AA – 6300 (P/N 206 - 51800)) Shimadzu – Tokyo - Japan.

## RESULTS AND DISCUSSION

measured in slurry sludge (before treatment) and in dewatered sludge (after treatment):

**Table I; Results of TVS, Cl, Al and $NH_{4i}$**

| Parameters | TVS | Cl | Al | $NH_4$ |
|---|---|---|---|---|
| Unit | % | mg/l | mg/l | mg/kg |
| Slurry Sludge | 96.0 | 6747.9 | 0.00215 | 238 |
| Dewatered Sludge | 81.7 | 5100.8 | 0.00189 | 306 |

TVS: Total Volatile Solids.

Table I showed that the chlorides in slurry sludge and in dewatered sludge were found to be 6747.9, 5100.8 mg/l respectively. These chlorides inhibit the growth of plants, bacteria and fish in surface waters; high levels can lead to breakdowns in cell structure. If the water is used for irrigation purposes, surface salinity increases through evaporation and crop yields fall. When flushed from the soil by rain, chlorides re-enter the eco-system and may ultimately end up in the groundwater/

Figure.1. shows that the BOD in slurry sludge and in dewatered sludge were found to be 33600, 40000 mg/L, respectively. These values are too high.

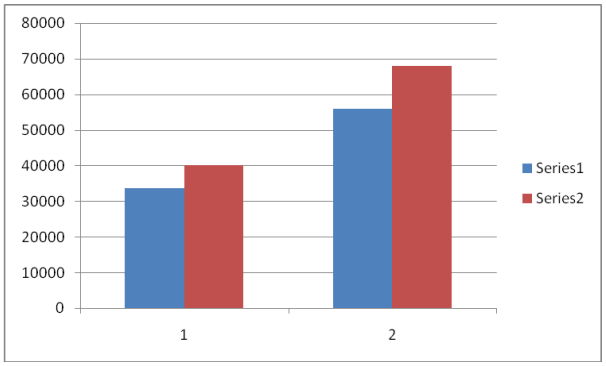


**Figure1. BOD (1) & COD (2) mg/l in slurry sludge (series 1) and dewatered sludge (series 2).**

The BOD5 analysis, is widely used to assess the environmental demands. It should also be noted that, while BOD is a measure of the oxygen requirements of bacteria under controlled conditions, many effluent components take longer than the period of analysis to break down. This longer breakdown period means that the environmental impact is spread over a larger area as wastewater components are carried over greater distances before breaking down.

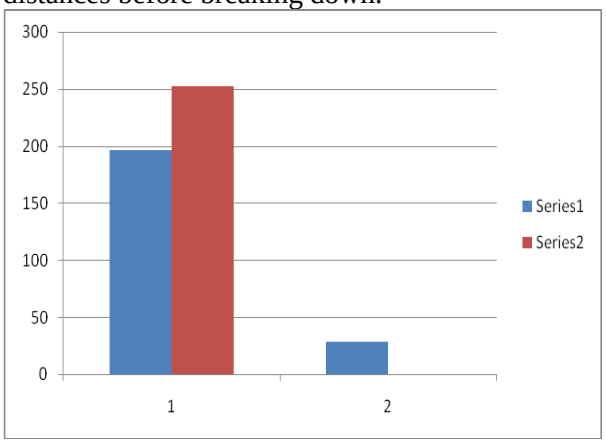


**Figure 2: $NH_3$ (1) and $NO_3$ (2) mg/kg in slurry sludge (series 1) and dewatered sludge (series 2).**

Figure 2 showed that ammonia in slurry sludge and in dewatered sludge were found to be 238, 306 mg/kg, respectively. Ammonia is a source of nitrogen and when it is dumped, it will be mixed with soil and produce significant amounts of nitrogen compound and consequently negatively affect the plant growth.

Figure 4 shows that chrome in slurry sludge and in dewatered sludge were found to be 13.23, 5.897 mg/l, respectively. The chrome is highly resistant o biological breakdown.

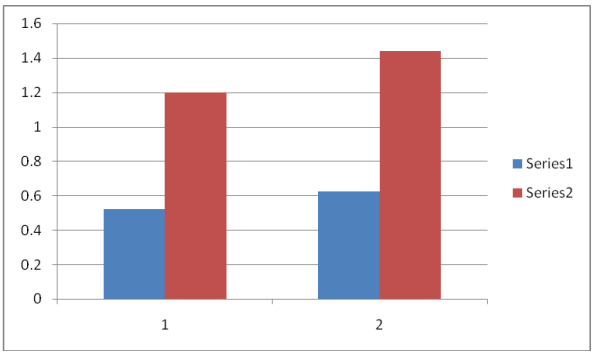


**Figure3. $SO_3$ (1) & $SO_4$ (2) % in slurry sludge (series 1) and dewatered sludge (series 2).**

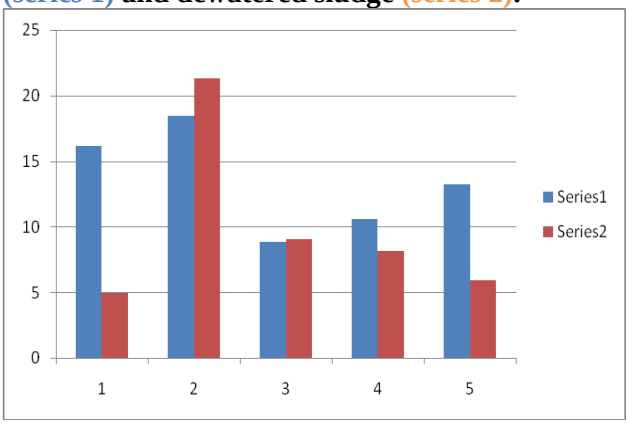


**Figure 4: Fe (1), Ca (2), Na (3), K (4), and Cr (5) mg/l in slurry sludge (series 1) and dewatered sludge (series 2).**

If the chrome precipitates as chromium hydroxide, it persists in the ecosystem for an extended period of time. Even in low concentrations, it has a toxic effect upon daphnia, thus disrupting the food chain for fish life and possibly inhibiting photosynthesis.

**Conclusion:**

This paper is on the composition of Afrotan tannery sludge before treatment (slurry sludge) and after treatment (dewatered sludge). Slurry sludge and dewatered sludge contain high amounts of BOD, COD, TVS and $NH_4$ but have low values of Fe, Ca, Na, K and Al. Afrotan Tannery fills dewatered sludge in land, and this sludge's contaminates the soil. The study recommended that it is very important to avoid contamination soil with sludge and to conduct further studies on dewatered sludge's to utilize it in agriculture or others purposes.

**Acknowledgement**

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**References**

[1] CCP, 1999 (Cleaner Production Program) 1999. Revised National Environmental Quality Standards (NEQS). http://www.cpp.org.pk/legal/RevisedNEQS.pdf.

[2] M. Eddy (2003), Wastewater Engineering, Treatment Disposal and Reuse, McGraw Hill.

[3] Rydin, 2011.'Risk Management of Chemicals in the Leather Sector: A case study from Sweden', Vol. I in Global Risk Based Management of Chemical Additives: Production Usage and Environmental Occurrence, 2011, pp. 207 - 223.

[4] Frendrup, 1999. Practical Possibilities for Cleaner Production in Leather Processing, Danish Technological Institute, 1999.

[5] Hauber and Knödler, 2008. Innovative techniques: Determination of Best Available Techniques (BAT) in the tanning industry as a contribution to complying, Leather Institute Reutlingen, Germany, 2008, p. 66.

[6] Italy, Italian BAT Contribution, 1998.

[7] European Commission (2013) - Integrated Pollution Prevention and Control (IPPC): Reference Document on Best Available Techniques for the Tanning of Hides and Skins",.

[8] Alfatih A. Yassen, Gurashi A. Allah, A. Alsalam A. Almaged. Recovery of basic chromium sulphate. Case study Afrotan tannery Company. Journal of Applied and Industrial Sciences, 2015, 3(3):87-93, ISSN: 2328-4595 (PRINT), ISSN: 2328-4609.