



REMOVAL OF ODOUR AND GASEOUS POLLUTANTS FROM LEATHER AND DYEING EFFLUENTS

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ABSTRACT

Leather and textile industries places major role in Indian economy and industrial development. These sectors have contributed significant growth by providing job opportunities. Both these industrial effluents consist of highly complex organic, inorganic substances and heavy metals from the production process. The industries should achieve Zero Liquid Discharge as per the Pollution Control Board norm's, Zero Liquid Discharge process involves Collection cum Equalization, Primary, Secondary, Tertiary treatment system involves Reverse Osmosis and Reject Management System. The factors affecting the quality of effluents are pH, Temperature, Color, Biological Oxygen demand, Chemical Oxygen Demand, Total Dissolved Solids and Total Hardness. A source of odour in the effluents will be Ammonia, Sulphate, Volatile Organic Compounds, etc. These produce the gaseous pollutants such as hydrogen sulphate, carbon dioxide, methane and other trace elements from the treatment system. Hydrogen sulphate is a toxic, irritable, and flammable gas that causes health effects at exposure to low concentrations while having the ability to be fatal at higher concentrations. This study is about removal percentage of toxic gaseous substances by addition of oxidation chemicals such NaOCl, H₂O₂ and O₃ as in the optimized level and eliminating the foul odour and toxic gases from the wastewater as collection tank and the best removal efficiency is found by using the O₃ method and also for the sludge treatment, Fe compound is used to remove foulodour.

Keywords — Leather and Dyeing industries, Zero Liquid Discharge, complex organic, inorganic substances and heavy metals, NaOCl, H₂O₂ and O₃ Method, Remove odour and toxic gases.



I. INTRODUCTION

Wastewater collection and treatment systems are major source of odour emissions. The anaerobic decomposition of the wastewater generates Sulphur compounds and nitrogen compounds. Among odour emissions, H₂S is the most dominating and readily detected. In an effort to remove H₂S from wastewater collection and treatment systems, researchers have examined the use of biological and chemical treatment methods. Although biological treatment processes are inexpensive and creates no environmental pollution, they are very sensitive to temperature and pH ranges and is therefore unreliable. The slightest change within the composition would affect the effectiveness of the treatment. Whereas, chemical treatment processes have higher operating costs, and are more consistent. As a result, chemical treatment was considered for investigation while by the operators. This method employs various chemicals as oxidizing agents. Nonetheless, in order to adequately choose an oxidant that is most efficient and cost effective of those methods readily available for the given conditions further research is needed.

1.1 HYDROGEN SULPHIDE PRODUCTION

To effectively treat Hydrogen sulphide in wastewater collection systems, one must understand the mechanisms of its production. In collection systems, hydrogen Sulphide is produced when bacteria consume sulphate oxygen from organic processes. Sulphate-reducing bacteria grow in a "slime layer" that coats the sewer's wetted perimeter. These bacteria use oxygen in the most readily available form: first, from elemental oxygen followed by nitrate oxygen and then sulphate oxygen. As nitrate is usually not available in wastewater, bacteria will consume sulphate oxygen after depleting elemental oxygen, leaving bi-sulphide ions to combine with hydrogen and forms aqueous hydrogensulphide.

1.2 NEED FOR HYDROGEN SULPHIDE REMOVAL

Subbukrishna et al., 2009 found that H₂S is a highly toxic and corrosive gas and is a major pollutant in fossil fuel based industries; Sulphur based chemical Industries like tanneries and Dyeing's. The toxicity of Hydrogen Sulphide is more than hydrogen cyanide. Therefore, Hydrogen Sulphide removal is necessary for effluent treatment plants to avoid accident.

1.3 MOST COMMON PROPERTIES OF SULPHIDE IN EFFLUENT

- ✓ Gaseous phase molecule.
- ✓ Soluble in water- carried by wastewater flow.
- ✓ Odorous- rotten eggs.
- ✓ Highly corrosive- precursor to H₂SO₄ (Sulphuric acid) formation.
- ✓ Dangerous in confined space.

1.4 HEALTH EFFECTS OF H₂S

The levels of H₂S in the air and potential health problems are:

- 0.13 ppm

This is the odour threshold. Odour is unpleasant.

- 4.6 ppm

Strong, intense odour, but tolerable. Prolonged exposure may deaden the sense of smell.



- 10 - 20 ppm

Causes painful eyes, nose and throat irritation, headaches, fatigue, irritability, insomnia, gastrointestinal disturbance, loss of appetite, dizziness. Prolonged exposure may cause bronchitis and pneumonia

- 50 ppm

May cause muscle fatigue, inflammation and dryness of nose, throat and tubes leading to the lungs. Exposure for one hour or more at levels above 50 ppm can cause severe eye tissue damage. Long-term exposure can cause lung disease.

- 100 - 150 ppm

Loss of smell, stinging of eyes and throat. Fatal after 8 to 48 hours of continuous exposure.

- 200 - 250 ppm

Nervous system depression (headache, dizziness and nausea are symptoms). Prolonged exposure may cause fluid accumulation in the lungs. Fatal in 4 to 8 hours of continuous exposure.

- 250 - 600 ppm

Pulmonary edema (lungs fill with fluid, foaming in the mouth, chemical damage to lungs).

- 300 ppm

May cause muscle cramps, low blood pressure and unconsciousness after 20 minutes.

- 300 - 500 ppm

May be fatal in 1 to 4 hours of continuous exposure 500ppm

Paralyzes the respiratory system and overcomes victim almost instantaneously. Death after exposure of 30 to 60 minutes.

- 700 ppm

Paralysis of the nervous system 1000 ppm immediately fatal. If caught in time, poisoning can be treated, and its effects are reversible. Some workers may experience abnormal reflexes-dizziness, insomnia and loss of appetite that lasts for months or years. Acute poisoning does not result in death, may produce long-term symptoms such as loss of memory or depression, paralysis of facial muscles (Canadian Centre for Occupational Health and Safety, 1985).

1.6 ODOUR CONTROL TECHNIQUES

If vapour phase odour control, Duangmanee et al., 2009 there are several choices such as

- | | |
|-------------------------|-----------------------|
| a) Thermal Oxidation | c) Chemical Oxidation |
| b) Biological Treatment | d) Chemical Scrubbing |

1.6.1 Thermal Oxidation

Thermal oxidation systems burn odour-causing compounds directly or catalytically either with or without heat recovery (Zulkefli et al., 2016). Typically they are used to deal with volatile organic compounds with odour control being a secondary benefit. Thermal oxidation treatment involves high installation and operating costs (using fuels as "oxidizing" material) which are recommended only in specific cases. As a result they are used only for very high strength odours or very difficult to treat compounds.

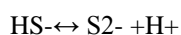
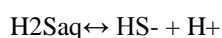
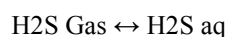


1.6.2 Bio Filters

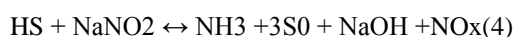
A bio filter filled with organic media, such as soil, compost, peat, woodchips or any combination thereof, is one of the most cost effective methods to remove low levels of Hydrogen Sulphide and other volatile organic compounds. The bio filter can also be augmented with microorganisms to increase its hydrogen sulphide removing efficiency. Chung et al., 1996 used a bio filter filled with immobilized *Thiobacillus Thioparus* CH11 in Ca-alginate and found that more than 98% of hydrogen sulphide could be removed at a Hydrogen sulphide loading rate of 25g/m³-hr. Ammonia and hydrogen sulphide can be removed simultaneously with a bio filter filled with woodchips. 85-90% removal efficiencies were obtained when a bio filter was used to treat gas with 80-100 ppmV of hydrogen sulphide and ammonia respectively. Elias et al., 2002 used a pelletized mixture of pig manure and sawdust packed in a lab-scale bio filter and found that 90% of 170 ppmV of hydrogen sulphide could be removed when the superficial gas flow rate was 200 m/hr.

1.6.3 Chemical Processes for Hydrogen Sulphide Removal

In chemical processes, chemicals are added into liquids containing sulphide to either oxidize sulphide or to shift volatile sulphide and hydrogen sulphide, to the non-volatile nature. According to Eq. (1) to (3), adding base into the solution would transform hydrogen sulphide to bisulphide and sulphide, preventing odorous sulphide from vaporizing.



At 25 °C and pH of 7, the hydrogen sulphide in a vessel headspace is 3700 ppmV, at pH of 8, the concentration will be reduced to 830 ppmV, and at pH of 10, the concentration further comes down to 10 ppmV. Adding base solution may help to reduce hydrogen sulphide, but, at pH above 8, anaerobic digestion will be inhibited. Oxidizing agents, such as chlorine, can be used to oxidize sulphide (Droste et al., 1997). Besides chlorine, other oxidizing agents, such as ozone, hydrogen peroxide, and nitrite, can be used. The dosage of the oxidizing agents can be problematic since the agents not only oxidize sulphide, but also oxidize other organic and inorganic compounds present in wastewater. Adding chlorine or nitrite in wastewater produces unwanted by products, such as carcinogenic THM, NO_x, and ammonia (Droste et al., 1997; Kohl and Neilsen, 1997).



1.6.4 Chemical Scrubbing and Oxidation

Multi stage scrubbers can remove a wide range of odour causing compounds in the form of both acidic and basic. They have been proven to be effective in many applications. Typically these systems are employed with high intensity odours in large air volumes. There are several types of wet scrubbers including packed bed, mist, and venture scrubbers. All are designed to maximize the contact between the odorous compounds of the foul air stream and a "scrubbing" chemical solution. The compounds are absorbed and then oxidized by the chemicals. The size of chemical scrubbing systems is intermediate between thermal and biological systems as are the operating costs. A disadvantage of wet chemical scrubbing systems using hypochlorite is a potential for emission of chlorinated compounds and particulate from the scrubber exhaust stack, as well as a potential for



emission of a bleach odour if chemical feed is not properly controlled. The use of ozone as the oxidant can minimize these problems.

1.6.5 Recommended Odour Control Design

In treating air with both acidic and basic odour compounds, the scrubbing process includes two treatment phases, the first with acid (sulphuric acid) and the second with an alkaline oxidizer (caustic soda and ozone). This ensures the efficient removal of alkaline or acid organic and inorganic odour causing substances, viruses and bacteria. If only acidic odour compounds are present a single stage scrubber can be used. Horizontally oriented back flushing type scrubber equipped with spray nozzles and a packed bed is recommended.

1.7 MEASUREMENT OF ODOURS

The following are some parameters to express the concentration of odours: Perceptibility Threshold (ATC), defined as the minimum concentration that can be detected by 100% (in some cases by 50%) of the persons involved with an olfactory analysis. In some cases the geometric mean of the measurements of the single members is used.

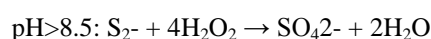
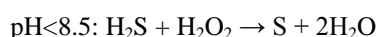
Odour Number (TON), or the number of dilutions needed to reduce the concentration of the sample to the ATC. Maximum Exposure Concentration (TLV). This represents the maximum concentration at which persons can be exposed for a period of 8 hours a day, 5 days a week and 50 weeks a year (weighted average over 8 hours), for a work life of 40 years.

Maximum Allowable Concentration (MAC): Maximum concentration which should never be exceeded.

1.8 CHEMICALS USED FOR THE RESEARCH METHODOLOGY

1.8.1 Hydrogen Peroxide

H₂O₂: is used to chemically oxidize H₂S based on the following reactions:



Generally, 90% of the peroxide is reacted within 10 to 15 minutes, with the reaction completed in 20 to 30 minutes. Peroxide also reacts with other components of wastewater that exhibit an oxygen demand such as BOD and ammonia nitrogen. For this purpose an additional amount of H₂O₂ must be added to the required amount needed for H₂S so that the demand of the other oxygen-requiring substances may be satisfied. H₂O₂ is commercially available as solutions of 35-, 50- and 70-percent H₂O₂ by weight. Throughout this study a solution of 50-percent H₂O₂ by weight was used. For handling purposes, it is not recommended that solutions stronger than 50-percent be used. H₂O₂ has certain advantage over other sulphide control alternatives. Such advantages include:

- ✓ Usable in gravity sewers or force mains applications.
- ✓ Relatively simple and inexpensive.
- ✓ Produces harmless by-products.
- ✓ Results in additional Dissolved Oxygen to the stream.
- ✓ Suppresses H₂S generation for 3 to 4 hours after H₂O₂ addition.



1.8.2 Sodium Hypochlorite

NaOCl may be considered as a liquid form of chlorine, kept in solution by the incorporation of caustic NaOH. Throughout this study a 12% concentration of NaOCl was utilized. It is used to oxidize Hydrogen Sulphide and organic odours based on the following equation leaving a by-product of (H₂SO₄) and NaCl.



Some advantages associated with the use of Sodium Hypochlorite as an oxidizing agent are:

- ✓ Fast reaction
- ✓ Provides residual H₂S control after reacting with ammonia
- ✓ Extensive history regarding its use in collection and treatment systems for odour control
- ✓ Inhibits the growth of biofilm

1.9 OBJECTIVES OF THE STUDY

The objective of the study is to reduce the gaseous pollutants compounds and foul odour through environmental safety method to leather and dyeing effluents and should avoid the accident from these gaseous compounds in these industrial effluents.

1. To analyse the gaseous compounds from Primary and Secondary treatment by adding coagulation and flocculation.
2. To find the optimum dosage of sulphide removal chemicals in these effluents.
3. Finally, to analyse amount of gaseous compounds liberated from these effluents.

2.1 COLLECTION OF SAMPLES FROM LEATHER AND DYEING INDUSTRIES

Effluents were collected from Leather and dyeing industries at erode. Our study focuses on pre- treatment of equalized wastewater and sludge handling method by chemical method which does not affect human being. These effluents and sludge were analysed by physio- chemical parameters such as pH, TDS, COD, Sulphate, Sulphide, Conductivity and Temperature.



Figure 1. Collection of samples from Leather and Dyeing Industries.

2.2 DOSAGE OF CHEMICALS

The different types of oxidation chemicals like Sodium Hypochlorite (NaOCl), Hydrogen Peroxide (H₂O₂), and ozone treatment are taken and identify the dosage of chemicals. The dosage of chemicals with raw effluents and sludge. The dosage of chemicals were used as 2ml/l , 4ml/l, 6ml/l and sulphide removal chemicals for



sludge 10gm/l, 20gm/l and 30gm/l its thoroughly mixed with stick and given the contact time at 1 hour finally analyse the treated effluent parameters and comparing the type of chemicals performance with the effluents and sludge.

2.2.1 Sodium Hypochlorite (NaOCl)

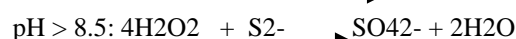
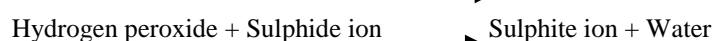
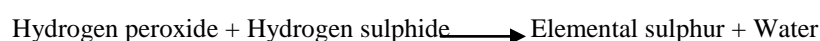
Sodium hypochlorite (NaOCl) considered a liquid form of chlorine. Throughout this study a 12% concentration of NaOCl was utilized. It is used to oxidize H₂S and organic odours based on the following equation leaving a by-product of Sulphuric Acid (H₂SO₄) and Sodium Chloride (NaCl).



After analyse the characteristics of raw effluents optimized level of 2ml/l, 4ml/l and 6ml/l chemicals were added and after the 1 hour contact time add SMBS to control residual chlorine and these treated effluent was analysed by APHA method.

2.2.2 Hydrogen Peroxide (H₂O₂)

H₂O₂ is used to chemically oxidize H₂S based on the following reactions:



After analyse the characteristics of raw effluents optimized level of 2ml/l, 4ml/l and 6ml/l chemicals were added and after the 1 hour contact time treated effluent was analysed by APHA method.

2.2.3 Ozone (O₃)

O₃ is used to chemically oxidize H₂S based on the following reactions Tri -atomic, liquid phase oxygen molecule.



- Very High oxidizing potential @ 2.07V (fourth highest)
- Hydrogen peroxide (1.77V)
- Chlorine (1.36V)

H₂O, H₂S, SO₂ in the products were determined and good H₂O and S mass balances were obtained.

After analyse the characteristics of raw effluents optimized level of 2ml/l, 4ml/l and 6ml/l chemicals were added and after the 1 hour contact time treated effluent was analysed by APHA method.

III. RESULTS AND SUGGESION

The tannery effluent Physical, chemical characteristics of equalised effluent is pH 12-14, Total Dissolved Solids is 22,500 mg/l, COD is 5800 mg/l, Sulphate is 2000 mg/l, Sulphide 400mg/l, Conductivity 42,560 and Temp is 26.9 °C and the tannery sludge parameters pH is 7.10, TDS is 25,000mg/l, COD is 1920mg/l, Sulphate is 2010mg/l, Sulphide 400mg/l, Conductivity is 41,300, and temp is 27.6.

3.1 For Tannery Effluent

a) By using NaOCl

	pH	TDS (mg/l)	COD (mg/l)	Sulphate (mg/l)	Sulphide (mg/l)	Conductivity (mg/l)	Temp. (°C)
Raw Effluent	8.07	18,520	5800	2000	400	37,560	26.9
NaOCl@2ml + 1gm SMBS	8.0	19,800	5110	2010	390	39,763	27.7
NaOCl@4ml + 2gm SMBS	7.65	20,150	4732	2050	365	40,313	28.1
NaOCl@6ml + 3gm SMBS	7.53	21,400	4001	2090	359	41,481	28.4

b) By using H₂O₂

	pH	TDS (mg/l)	COD (mg/l)	Sulphate (mg/l)	Sulphide (mg/l)	Conductivity (mg/l)	Temp. (°C)
Raw Effluent	8.07	18,520	5800	2000	400	37,560	26.9
H ₂ O ₂ @ 2 ml	8.10	18,580	4982	2025	361	37,950	27.3
H ₂ O ₂ @ 4 ml	8.9	18,725	4271	2076	331	38,103	28.1
H ₂ O ₂ @ 6 ml	9.5	18,750	3347	2115	327	38,228	28.1

c) By using O₃ liquid

	pH	TDS (mg/l)	COD (mg/l)	Sulphate (mg/l)	Sulphide (mg/l)	Conductivity (mg/l)	Temp. (°C)
Raw Effluent	8.07	18,520	5800	2000	400	37,560	26.9
O ₃ @ 2 ml	8.10	18,481	4110	2010	150	37,551	27.5
O ₃ @ 4 ml	8.9	18,619	3421	2050	103	38,503	28.0
O ₃ @ 6 ml	9.5	18,709	2300	2090	100	38,668	28.3

d) by using Fe compound

	pH	TDS (mg/l)	COD (mg/l)	Sulphate (mg/l)	Sulphide (mg/l)	Conductivity (mg/l)	Temp. (°C)
Raw Sludge	7.10	25,000	6300	2010	400	45,121	27.6
Fe compound 10gm	7.10	26,000	4259	2321	324	46,235	27.3
Fe compound 20gm	8.9	18,725	3291	2784	143	48,403	27.3
Fe compound 30gm	9.5	18,750	2127	3022	141	48,228	27.3

3.2 For Dyeing Effluent

The Dyeing effluent parameter such as pH is 10.0, TDS is 5600mg/l, COD is 3720mg/l, Sulphate 2250 mg/l, Sulphide is 700 mg/l, Conductivity is 950mg/l, Temp is 27.3 and the raw Dyeing sludge parameters pH is 7.40, TDS is 6800mg/l, COD 900mg/l, Sulphate 1760 mg/l, Sulphide 395mg/l, Conductivity is 14,450mg/l, and temp is 27.2.

a) By using NaOCl

	pH	TDS (mg/l)	COD (mg/l)	Sulphate (mg/l)	Sulphide (mg/l)	Conductivity (mg/l)	Temp. (°C)
Raw Effluent	10.0	5,600	2050	3720	300	9,510	26.9
NaOCl@ 2 ml + 1gm SMBS	9.5	5,983	1237	2010	283	9,938	27.3
NaOCl@ 4 ml + 2gm SMBS	9.2	6231	563	2050	267	10,765	28.1
NaOCl@6ml +3gm SMBS	8.7	6764	407	2090	261	10,322	28.1

b) By using H₂O₂

	pH	TDS (mg/l)	COD (mg/l)	Sulphate (mg/l)	Sulphide (mg/l)	Conductivity (mg/l)	Temp. (°C)
Raw Effluent	8.07	5,600	2050	3720	300	9510	26.9
H ₂ O ₂ @ 2 ml	8.10	5,634	1055	3324	230	9170	27.3
H ₂ O ₂ @ 4 ml	8.9	5,621	498	3100	163	9102	27.5
H ₂ O ₂ @ 6 ml	9.5	5,701	401	2998	157	8799	27.1



c) By using O₃ liquid

	pH	TDS (mg/l)	COD (mg/l)	Sulphate (mg/l)	Sulphide (mg/l)	Conductivity (mg/l)	Temp. (°C)
Raw Effluent	8.07	5,600	2050	3720	300	9,650	26.9
O ₃ @ 2 ml	9.90	5,606	984	3478	190	9,702	27.3
O ₃ @ 4 ml	8.50	5,632	407	3250	107	9823	28.1
O ₃ @ 6 ml	9.90	5,679	399	2890	102	10,124	28.3

d) by using Fe compound

	pH	TDS (mg/l)	COD (mg/l)	Sulphate (mg/l)	Sulphide (mg/l)	Conductivity (mg/l)	Temp. (°C)
Raw Sludge	7.40	6200	2230	1725	900	10,733	26.9
Fe compound 10gm	7.2	8210	984	1250	450	12,985	27.3
Fe compound 20gm	7.1	10,200	450	732	110	15,324	28.1
Fe compound 30gm	7.0	11,932	407	711	10	16,989	28.1

3.3 DISCUSSION

Among this various trials conducted in tannery, Dyeing effluents and sludge's water quality and sludge parameters are changed by addition of chemicals with different proportions. The results were obtained in the types of chemicals with wastewater and sludge.

3.3.1 Sodium hypochlorite (NaOCl)

Some advantages associated with the use of Sodium Hypochlorite as an oxidizing agent are:

- ✓ Fast reaction
- ✓ Provides residual H₂S control after reacting with ammonia
- ✓ Extensive history regarding its use in collection and treatment systems for odour control.
- ✓ Inhibits the growth of bio-film

However, there are some disadvantages associated with the use of NaOCl for H₂S control at wastewater collection systems and treatment facilities. One major downfall associated with the use of NaOCl in wastewater treatment is its tendency to react with organics as well as H₂S. Due to the high organic loads at collection systems or at the head works of treatment facilities, higher dosages would be required and would create higher chlorinated by-products within the systems. This increases the volatile organic compounds (VOCs) emission rates hampering the quality of the air. NaOCl also have a short shelf life due to its ability to lose strength rather quickly during normal storage conditions.

3.3.2 Hydrogen peroxide (H₂O₂)

Generally, 90% of the peroxide is reacted within 10 to 15 minutes, with the reaction completed in 20 to 30 minutes. Peroxide also reacts with other components of wastewater that exhibit an oxygen demand such as BOD and ammonia nitrogen. H₂O₂ is commercially available as solutions of 35-, 50- and 70-percent H₂O₂ by weight. Throughout this study a solution of 50-percent H₂O₂ by weight was used. For handling purposes, it is not recommended that solutions stronger than 50-percent be used.

H₂O₂ has certain advantages over other sulphide control alternatives such advantages include:

Usable in gravity sewers or force mains applications

- ✓ Relatively simple and inexpensive
- ✓ Produces harmless by-products
- ✓ Results in additional Dissolved Oxygen (DO) to the stream

Suppresses H₂S generation for 3 to 4 hours after H₂O₂ addition



However, at 50% H₂O₂ by weight safety issues for the handler as well as for other onsite operators became a major concern. At this concentration, H₂O₂ is extremely toxic and hazardous. Also, in the absence of catalysis, reactions may take several minutes. Therefore, H₂O₂ is often used in conjunction with a catalyst for greater efficiency. In addition, higher dosages are required for H₂S control in excess of 2 hours. However any residual left behind after oxidation would decompose to oxygen and water. Therefore, an increase in dosages would not pose a problem but would preserve aerobic conditions within the systems

3.3.3 Ozone (O₃)

The logical area of attaining direct measurable results by its usage is as follows.

- | | |
|--|---|
| a) BOD & COD control | e) Detoxification by direct oxidative of all toxins |
| b) Odour control | f) Prevention of sludge bulking |
| c) Optical clarity | |
| d) Oxidation & precipitation of all heavy metals | |
- into oxides

IV CONCLUSION

Results from this study shows that leather and dyeing effluents and sludge's is having higher concentration of TDS and foul odour. O₃ is the effective comparing to other chemicals for treating leather and dyeing effluents. Maximum removal efficiency of effluents and Fe compound is effective product to reduce bad odour from sludge's is given below for optimised level of 6mg/l oxidising agent. And the optimised level of 6ml/l of various oxidation chemicals are very effective and if add more than optimised level of 6mg/l an effluents treated water quality will be same and cost will be increased. It was found that 6mg/l oxidising agent is better for the treatment process.

4.1 In Tannery Effluent:

- The COD of treated effluent is reduced to 31% and sulphide is 10.25 % by using NaOCl.
- The COD of treated effluent is reduced to 42% and sulphide is 18.25 % by using H₂O₂.
- The COD of treated effluent is reduced to 60.34% and sulphide is 75 % by using O₃.

4.1.1 for Sludge

The COD of treated effluent is reduced to 80.6% and sulphide is 64.75 % by using Sulphide removal chemical.

4.2 In Dyeing Effluent:

- The COD of treated effluent is reduced to 80% and sulphide is 13 % by using NaOCl.
- The COD of treated effluent is reduced to 80.5% and sulphide is 47.6 % by using H₂O₂.
- The COD of treated effluent is reduced to 80.53% and sulphide is 66 % by using O₃.

4.2.1 for Sludge

The COD of treated effluent is reduced to 81.7% and sulphide is 99 % by using sulphide removal chemical.



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