Wastewater Treatment for Irrigation Purposes using ELECTROCHEMICAL COAGULATION

Jenna Bunag , Sergio O. Pinedo, Catalina Rivera, Gilbert Esparza, and Dr. Luis Cabrales
Department of Physics and Engineering, California State University at Bakersfield
Nick Eckelberry and An Shi
OriginClear

INTRODUCTION:

Wastewater from dairy industry is a potential source of irrigation water in the San Joaquin Valley. In this project, the technology developed by *OriginClear*, CHEMICAL COAGULATION and electro oxidation, flotation was used to evaluate its effectiveness in treating dairy wastewater.

OBJECTIVES:

Water Irrigation Regulations

- pH : 6.5- 8.5
- Oxygen Reduction Potential (ORP): 0-400 millivolts
- Turbidity : ~800 or less (NTU/FNU)
- Conductivity: Below 2,250 µS
- Chemical Oxygen Demand (COD): 0-150 mg/L

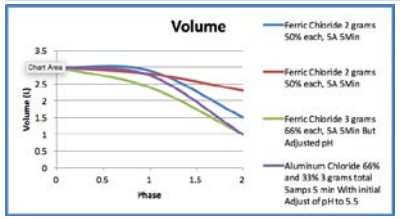
PROCEDURE:

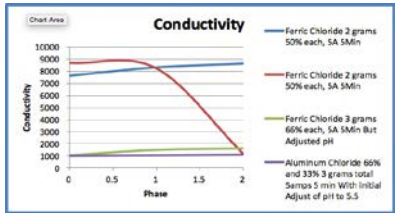
1. Insert 3 liters of raw water into containers for targeted jar test
2. If conducting pH adjustment, titrate HCl until pH reaches 5.5 (5 minutes settling time)
3. Insert the first dosage of coagulant (1mg/L or 2 mg/L)
4. Transfer the liquid portion of the resulted jar test into the electro-flotation device.
5. Insert the second dosage of coagulant (1 mg/L)
6. Turn on electro-flotation device to 5 Amperage of electrical current for 5 minutes

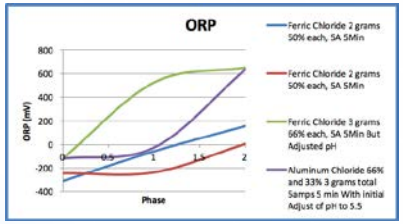
Electrochemical Reaction

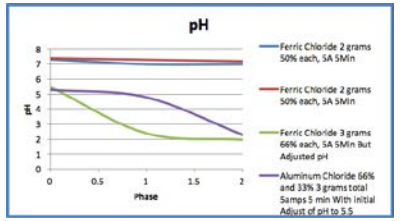
$$\text{Anode: } 2Cl^- + -2e^- \rightarrow Cl_{2(gas)}$$
$$\text{Cathode: } 2H^+ + 2e^- \rightarrow H_{2(gas)}$$

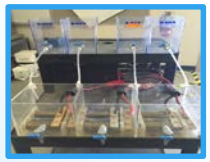
Graphical Representation of Testing Results:

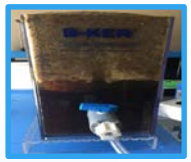









Testing Apparatus


Coagulation Jar Test


Coagulation & Electro Flotation


2nd Stage of Coagulation & Electro Flotation


Raw .vs. Treated Sample


Final Product

Product	Volume (WW) per day (gallons)	Volume (WW) per day (liters)	Dosage g/l	Total Product per Day (grams)	Pounds Per Day	Cost Per Pound	Cost Per Day	Cost Per Gallon
FeCl	200,000	757,000	1	757,000	1,665	$ 0.25	$ 416.35	$ 0.002
FeCl	200,000	757,000	2	1,514,000	3,331	$ 0.25	$ 832.70	$ 0.004
FeCl	200,000	757,000	3	2,271,000	4,996	$ 0.25	$ 1,249.05	$ 0.006
HCl	200,000	757,000	10	7,570,000	16,654	$ 0.22	$ 3,663.88	$ 0.018
HCl	200,000	757,000	20	15,140,000	33,308	$ 0.22	$ 7,327.76	$ 0.037

Californina is 15.2 cents per Kilowatt-hour

Kilowatt per hr	Watts per hour	watts per min	watts per 5min
12	0.012	0.0002	0.001
15.2	0.0152	0.000253333	0.0012667

Results and Discussion:

pH : Test 1 and 2 were conducted with no pH adjustment. Test 3 had a pH adjustment at the beginning of the experiment with a pH of 5.5.

Conductivity : In test 1, $FeCl_3$ and $AlCl_3$ increased the conductivity by 13% and 15%, respectively. During test 2, the conductivity for $FeCl_3$ had a reduction of 86%. For the rest of the coagulants the conductivity was above of 8400 µS. For test 3, $AlCl_3$ was 1,100 µS and $FeCl_3$ was 1,600 µS after the final stage.

ORP and COD:
Although COD of the treated water is not at the desired level, there was a significant decrease. The COD values reduced to 2,652 mg/L from the original amount of 4,220 mg/L of $FeCl_3$. $FeCl_3$ shows prominent improvement and also displays similar results when pH is adjusted to 5.5.

CONCLUSION:

Titration, jar tests, and a base/acid reaction were conducted in order to narrow the parameters used in the electrocoagulation phase. From the results of the collected data, the adjustment to the pH of $FeCl_3$ and $AlCl_3$ was the most successful treatment found for irrigational purposes. Future tests will be done in advanced oxidation and the electro-flotation stage to further improve results. In addition, we will verify halogenated compound existence by using a gas chromatography unit.

REFERENCES

"Energy Efficiency in Wastewater Management." *Filtration + Separation*52.6 (2015): 10. *Https://www.ysi.com/*. Web. 26 Feb. 2016.,"ORP Level Ozone, ORP Levels, Ozone, Oxidation Reduction Potential."*ORP Level Ozone, ORP Levels, Ozone, Oxidation Reduction Potential*. N.p., n.d. Web. 26 Feb. 2016.,Suslow, Trevor V. "Oxidation Reduction Potential (ORP) for Water Disinfection, Monitoring, Control and Documentation." (2004): n. pag. *Http://anrcatalog.ucanr.edu/pdf/8149.pdf*. Web. 26 Feb. 2016.,Home. (n.d.). Retrieved February 26, 2016, from http://www.originclear.com/, Mines, Richard O. *Environmental Engineering: Principles and Practice*. 1st ed. Vol. 1. N.p.: Wiley, 2014. Print. Mollah, Mohammad Y.A., et al. "Fundamentals, Present And Future Perspectives Of Electrocoagulation." *Journal Of Hazardous Materials* 114.1-3 (2004): 199-210. *Academic Search Complete*. Web. 5 Apr. 2016.