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Biochemical Methane Potential Test for Biogas Production from Tannery Ro Reject

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ABSTRACT
Most CETPs use Reverse Osmosis technology in their tertiary treatment. The major problem in this technology is the disposal of RO concentrate. The present disposal methods for the RO reject are energy intensive. This paper focuses on the concept of generating biogas from RO reject by codigesting it with secondary treatment plant sludge. This research paper focuses on biofuel generation from RO concentrate or reject. Biochemical methane potential test were conducted for different ratios of RO reject and secondary treatment sludge. From the results obtained it was observed that the mixture containing one part of seed sludge and two part of RO reject were the optimum ratio.

Keywords
RO reject, Seed sludge, Biochemical methane potential test.

1. INTRODUCTION
The leather manufacturing process comprise of various steps that involves conversion of raw skin which is a highly putrescible to leather, a stable material. These conversion processes normally involve a sequence of chemical reactions and mechanical processes generating large quantity of pollutant at each stage. The generation of pollution is significantly high in the pre-tanning operations compared to the post-tanning operations causing health hazards and intensifies environmental pollution.

Many tanneries have been close down because of their incapability to accommodate the emission standards and environmental regulations. The only way to cope up with the increasing standard stringency is to increase the innovation and viable alternative technology for the effluent treatment.

Reverse Osmosis is one of the prominent methods adopted by the industries for the reclamation of wastewater. The main reasons for numerous industries to adopt RO technology includes low energy consumption, the high rate of contaminant removal, simple design and operation, waste stream volume reduction.

While RO is an effective method for handling wastewater, what to do with that can be an issue. Mickley et al., has presented a survey of drinking water plants that included 137 plants where 48 % dispose of the concentrate to surface water, 23 % dispose to the head-works of wastewater treatment plants, 12 % utilize a land application process, 10 % dispose via deep well injection, and 6 % use evaporation ponds.

ESCWA (2012), stated that cost plays an important role in the selection of a brine-disposal method. The cost of disposal ranged from 5 – 33 % of the total cost of desalination for all methods. The cost of disposal depends on the characteristics of reject brine, the level of treatment before disposal, means of disposal, volume of brine to be disposed of, and the nature of the disposed environment.

Joo et al., reviewed the characteristics of brine disposal from desalination plants and state that brine disposal comes in a different category than sewage disposal. There is no way to reduce brine to simpler and harmless compounds as they are already the simplest of inorganic compounds. The study also state that no good way exists to reclaim the carrying water from the dissolved solids, for if there were, it could be used in the desalting process. While the quantities of materials are very large, emphasized that these materials do not look attractive economically.

Del Bene et al., state that there are various options for the disposal of reject brine from inland desalination plants. These include waste minimization, discharge to surface water, deep wells, land application, evaporation ponds, and wastewater evaporators.

Khordagui et al., identified the following options for disposal of reject brine from RO plants: pumping into specially designed, lined evaporation ponds; deep-well injection; disposal into surface water bodies; disposal through pipelines to municipal sewers; concentration into solid salts; and irrigation of plants tolerant to high salinity (halophytes).

Squire et al., conducted a study. This study indicate that removal of endocrine disrupting chemicals (EDCs) and pharmaceuticals or personal care products (PPCPs) with chemical processes are insignificant, whereas coupled adsorption and advanced oxidation processes are effective for degrading some EDCs and PPCPs. The biological treatments are ineffective as they are limited to the r emoval of polar contaminants. Hence to balance wastewater reuse against increased water consumption, a more advanced and cost-effective treatment should be developed.

The applications of adsorbents and reactive oxygen species generators in soil are effective in treating RO concentrates. Compared to other treatment methods, this system is capable of effectively removing organic coloring components, bad odors, volatile organic compounds, radionuclides, ammonia, sulfur, phosphorus, and various heavy metals. While an environmental treatment method that adds chemicals for an adsorptive effect or utilizes additional processes may not be economical or efficient due to the costs of electricity, equipment, and chemicals associated with these additional processes. Hence the objective of this research is to assess the feasibility of the combined physical and chemical processes in removing contaminants in RO concentrates.

2. MATERIALS AND METHODS

2.1 Sample Collection

The samples are collected from the Pallavaram common effluent treatment plant. The required amount of sample for the experimental purpose is taken and maintained in a closed airtight container.

2.2 Seed Sludge Preparation

The secondary treatment plant sludge is collected from the Pallavaram CETP. The sludge is then dewatered by gravitation. With the dewatered sludge the following nutrients are added for microbial enrichment.

$(NH_4)_2H\ PO_4$	:	26.7 g/l
$CaCI_2.2H_2O$	:	16.7 g/l
NH_4Cl	:	26.6 g/l
$MgCl_2.4H_2O$	:	120 g/l
KCL	:	86.7 g/l
$MnCl_2.4H_2O$	:	120 g/l
$CoCl_2.6H_2O$	:	2.00 g/l
H_3BO_3	:	0.38 g/l
$CuCl_2.2H_2O$	:	0.18 g/l
$NH4MoO_4$	:	0.17 g/l
$ZnCl_2$	:	0.14 g/l
$FeCl_2.4H_2O$	:	370 g/l
$Na_2S.9H_2O$	:	500 g/l
Biotin	:	0.002 g/l
Folic acid	:	0.002g/l

2.3 Biochemical Methane Potential Test

The BMP assay is used as an index of the anaerobic biodegradation potential. The BMP is measured with the BMP test, which is done by measuring the bio-methane or biogas produced by a known quantity of waste in an anaerobic condition. Biochemical methane potential (BMP) tests is performed in a 500 ml Erlenmeyer flask. The batch system is sealed for the duration of the process. Anaerobic sludge is added to the serum bottle with a tube having its outlet end dipped in the water in the flask. This is done to minimize the contact of oxygen. The flask is tightly capped and connected to a liquid displacement system which containing 5 % NaOH. NaOH solution is chosen because it absorbs CO2 and allows CH4 to pass through it. This BMP test is conducted for different substrate ratio. The biogas and other process performance parameters are evaluated using batch reactors at different feed stock to sludge ratios. The setup is kept and analyzed for a period of 30 days.

2.3.1 BMP Assay

The RO concentrate was subjected to bio methane potential assay. It co-digested with secondary biological sludge and seed sludge. The sample was taken in the different ratio:

- Seed sludge (500 ml)
- RO reject (250ml) + seedsludge (250 ml)
- RO reject (334ml) + seedsludge (166 ml)
- RO reject (375ml) + seedsludge (125 ml)

The BMP assay was performed for the samples. The gas production was analyzed once in 3 days using water displacement method. The other parameters like COD, ammonia, alkalinity and VFA were analyzed periodically.

3. RESULTS

3.1 Initial Characteristics of RO Reject

The initial characteristics of the RO reject collected from Pallavaram CETP was analyzed to be

Table 1. Initial Characteristics of RO reject

Parameter	Values
pH	8.18
TDS mg/l at 105° C	46000
VDS mg/l at 550° C	8000
VDS mg/l at 850° C	9000
TSS mg/l at 105° C	20474000
VSS mg/l at 550° C	4000
VSS mg/l at 850° C	1000
COD (mg/l)	1344
Alkalinity (mg/l)	33,000
Ammonia (mg/l)	364
TKN (mg/l)	327.6

3.2 Cumulative Gas Production

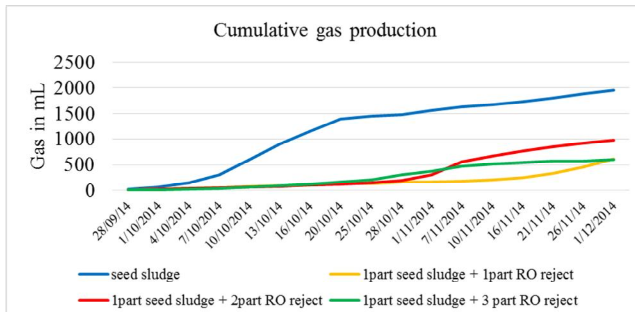

Figure 1. Cumulative Gas Production

The graph suggests that the optimum ratio from which the maximum gas production is obtained could be one part of seed sludge and two parts of seed sludge.

3.3 Volatile Fatty Acid

VFA plays a major role in the production of biogas. In addition to this higher amount of VFA may inhibit the activity of methanogen (Ahring et al.,).From the below graph the maximum range was from 500 mg/l – 6000 mg/l in the optimization study. Hence the biogas production was not affected by the VFA production and the reactor was stable.

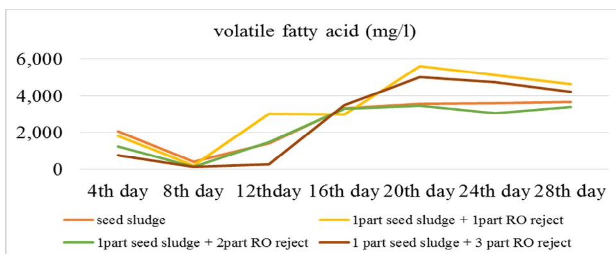

Figure 2. Volatile fatty acid

3.4 Alkalinity

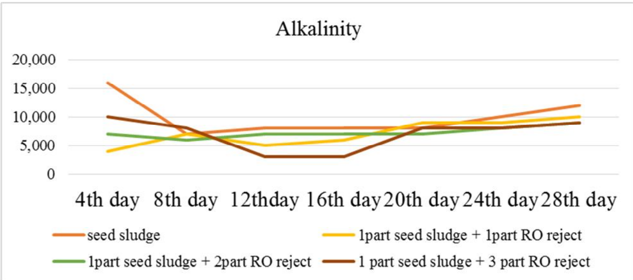

Figure 3. Alkalinity

The graph depicts the course of alkalinity during the study on different substrates. The alkalinity increased as the digestion proceeds. The alkaline pH is conducive to high alkalinity and NH3 formation that is detrimental to methanogenesis reduces the biogas yield. The alkalinity addition reduced the waste quantity, the organic content of the solid waste and the biodegradation time. (Agdag et al., 2005).

3.5 Chemical Oxygen Demand

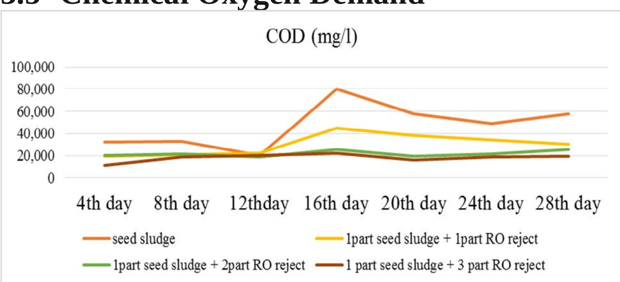

Figure 4. Chemical Oxygen Demand

The COD removal percentage was highest in the recycle BMP with 80 % and it is correlated with the maximum gas production rate of 320 ml.

3.6 Ammonia

When ammonia is added to the digester, the pH was increased. As ammonia inhibits methanogenesis then VFA accumulation occurs and this results in a consequent reduction in pH. BarisCalli et al., (2005) reported that inoculum acclimatized to free ammonia concentrations could be able to tolerate elevated free ammonia concentrations up to 800 mg/L. The graph shows that the maximum of 352 mg/l of ammonia was produced in due course of the study. Eventually this shows that there no ammonia inhibition based on the report of BarisCalli et al., (2005).

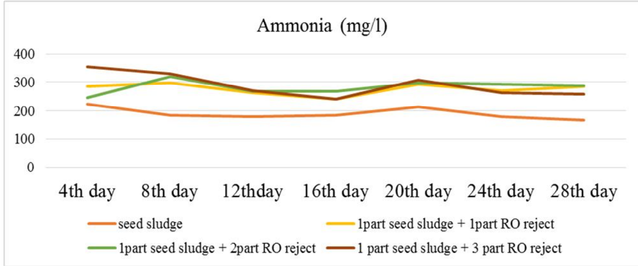

Figure 5. Ammonia

4. CONCLUSION

The BMP test and analysis were done successfully. It can be inferred from the results that the ratio with one part of seed sludge and two parts of RO reject is the optimum proportion. As this proportion generates a constant and steady bio gas throughout the batch period. It also has a high sludge retention time increasing the probability of granular sludge production.

REFERENCES

[1] Ahring, B. K., Sandberg., M and Angelidaki, I., 1995 "Volatile fatty acids as indicators of process imbalance in anaerobic digestors" Applied Microbiology and Biotechnology, 43(3), 559 – 565.

[2] Aqdaq, O. N and Sponza, D. T., 2005 "Effect of alkalinity on the performance of a simulated landfill bioreactor digesting organic solid wastes" Chemosphere, 59(6), 871–879.

[3] BarisCalli, Mertoglu, B., Inanc, B and Yenigun, O., 2005 "Effects of high free ammonia concentrations on the performances of anaerobic bioreactors" Process Biochemistry, 40(3– 4), 1285 – 1292.

[4] Delbene, J.R., Chandrababu, N.K., Muraidharn, C., Unni, N.B., Rao, P.G., and Ramasami, T., 2005 "Recouping the waste water: a way forward for cleaner leather processing" Journal of Cleaner production, 11(5), 591 – 599.

[5] Godini, S., Paramasivan, P and Sinha, P. K., 2011 "Sono-Photo Fenton Treatment of Liquid Waste Containing Ethylenediaminetetraacetic Acid (EDTA)" International journal of nonferrous metallurgy, 2, 89–94.

[6] Joo, M., Leslie, G., Wang, Y and Buetehorn. S., 2008 "Optimizing, mixing and nutrient removal in membrane bioreactors" Desalination, 250(2), 815 – 818.

[7] Khordagui, H.,1992 "Conceptual approach to selection of a control measure for residual chlorine discharge in Kuwait Bay" Environmental Management, 16(3), 309 – 316.

[8] Lofrano, G., Meric, S., Zengin, E.G., and Orhon, D., 2013 "Chemical and biological treatment technologies for leather tannery chemicals and wastewaters: A review" Science of the Total Environment, 461, 265–281.

[9] Mickley, C. M., 1993 "Membrane concentration disposal" American Water Works Association Research Foundation, 123, 18–30.