Phenol degradation and chemical oxygen demand analysis of coir retting wastewater using anaerobic treatment

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Abstract

Aim: The objective of this study degradation of phenol, COD using anaerobic treatment by treating coir retting wastewater and biogas production.

Methodology: Sludge from sewage treatment plant was collected from Anna University, Chennai, India. The retting pond wastewater was collected from Coir Industries, Kadayannallur. A laboratory scale cylindrical shaped anaerobic reactor made of glass was used in this study. The total volume of the reactor was 10 litre and the reactor mainly consisted of a cylindrical column of 7 litre capacity (working volume). The anaerobic reactor was fed with 6 litre of sludge and 1.5 litre of coir retting wastewater. The gas produced in the reactor was measured using a gas flow meter.

Results: The retting pond wastewater was treated by lab scale anaerobic reactor. The anaerobic treatment was carried out continuously for 15 days. Parameters such as pH, TSS, TS, MLSS, COD and phenols were analyzed regularly during these evaluations of the reactor performance. The concentration of phenol, TS, TSS and COD decreased gradually with time removal percentage of 76%, 96%, 91% and 96% respectively. About 96% of total COD wastewater could be converted into biogas.

Interpretation: The results indicate that anaerobic treatment has several advantages in the treatment of retting pond wastewater and also in the production of biogas.

Key words : Anaerobic treatment, Coir retting, Wastewater

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Introduction

The major cause of water pollution is discharge of untreated effluents from industrial, domestic and agricultural activities (Ojha *et al.*, 2015; Abdel-Satar *et al.*, 2017; Kia *et al.*, 2017; Kishi *et al.*, 2017). Among the pollutants, coir retting waste water is considered harmful and contaminate water bodies (Arora *et al.*, 2017); Kadir Turhan and Suheyla Uzman, 2008; Mary Helen *et al.*, 2011). Phenols, aromatic hydrocarbons and their derivatives have been widely found in the coir retting wastewater (Syamkumar *et al.*, 2014). Large quantity of toxic phenols and organic substances like pectin, pentosan, fat, tannins are discharged into water bodies from coir retting units (Basu *et al.*, 2015). These organic compounds without proper treatment can cause serious environmental pollution (Singh and Singh, 2006). The conventional waste water treatment methods for biodegradable organics are not highly efficient (Balcik-Canbolat *et al.*, 2016). The maximum permissible limit for phenol in domestic water is 0.1 mg l^{-1} . These phenolic compounds are toxic to aquatic micro-flora and fauna at low concentration and are lethal to fish at a concentration of 5-25 ppm (Mollaei *et al.*, 2010; Banerjee *et al.*, 2016; Kaur, 2017). Exposure of these phenol pollutants cause serious health issues in humans (Nuhoglu and Yalcin, 2005; Chakraborty *et al.*, 2010). Hence, removal of such harmful phenolic compounds from industrial effluents requires urgent attention (Ucun *et al.*, 2010). Coconut husks are outer jacket obtained from the coir retting processes which are a major source of pollution within the domestic fowl backwaters (Shibu *et al.*, 2013). As a result of retting, massive quantity of organic substances together with cellulose, pectosan, fat, tannic acid and poisonous polyphenols are discharged into water bodies (Syamkumar *et al.*, 2014). Several processes have been used to degrade these phenolic compounds present in coir retting wastewater such as granular or biological carbon filtrations, ozonation, chlorination, H_2O_2 / actinic ray method, O_3 /UV method, Fenton method, membrane and anaerobic treatment (Karadag *et al.*, 2015), Rajmohan *et al.* (2016). Martinez *et al.*, (2006). Among these methods, anaerobic treatment is not new and has been practiced for a long time without the need of electric power for the production of bio-methane and renewable energy (Wang *et al.*, 2015; Bishnoi *et al.* 2006). In anaerobic process, complex bio-solids can be efficiently broken down by microorganisms in the absence of oxygen, generating a methane-rich biogas for energy recovery and yielding a stabilized sludge that is suitable for land use (Yaqin 2015; Wang *et al.*, 2015). In view of the above, the present study aimed to treat and degrade phenolic and other harmful organic pollutants present in coir retting wastewater by anaerobic treatment.

Materials and Methods

Sludge from sewage treatment plant was collected from Anna University, Chennai, India. The retting pond wastewater was collected from Coir Industries, Kadayanallur.

A laboratory scale cylindrical shaped anaerobic reactor made of glass was used in this study. The total volume of the reactor was 10 l and the reactor mainly consisted of a cylindrical column of 7 l capacity (Working Volume). The anaerobic reactor was fed with 6 l of sludge and 1.5 l of coir retting wastewater. The gas produced in the reactor was measured using gas flow meter. Polyphenol concentration and biogas production of retting pond wastewater was estimated by the standard methods of APHA (2012). The Parameters such as pH, TSS, TS, MLSS, COD and phenol were analyzed at regular time intervals. The process was stopped when all the parameters were noticed to be normal / minimal and decreased the mixed liquor suspended solids (MLSS) concentration.

Data analysis was done by Box-Behnken (ANOVA) at The Predicted R^2 of 0.9973 is in reasonable agreement with the Adjusted R^2 of 0.9982; the difference is less than 0.2 design experiment. The Model F-value of 2939.70 implies the model is significant. P-values less than 0.0500 indicate model terms are significant.

Results and Discussion

The anaerobic reactor was filled with anaerobic sludge and slowly adapted step by step, and the retting pond wastewater was fed. The performance of anaerobic reactor was regularly observed. The results showed that the anaerobic treatment of retting pond wastewater is a slow process. They microorganism present in the sludge generally takes some time to consume organic and inorganic matter present in the retting pond wastewater. The process depends on the ambient condition of retting pond wastewater which consist high level of COD and polyphenols. The physico-chemical parameters of pretreated coir retting wastewater such as pH, TS, TSS, COD and phenol analyse are shown in Table 1.

After anaerobic treatment, the parameters such as pH, MLSS, TS, TSS, COD and phenol concentration were analyzed and the results are shown in fig. 1-7.

Anaerobic reactor was fed with activated sludge and the reactor was started with the initial MLSS concentration of 3100 mg l^{-1} . After the treatment period of 15 days, the final MLSS concentration in the reactor increased to 6750 mg l^{-1} . It was

Table 1 : Physico-chemical characteristics of coir retting wastewater

Parameters	Values
pH	6-8
TS	42350 ± 200
TSS	1450 ± 20
COD	32250 ± 50
Phenol	420 ± 60

Values are in mg l^{-1} , except pH

Fig. 1 : MLSS concentration of sludge.

Fig. 2 : pH of effluent wastewater.

Fig. 3 : Phenol concentration of influent and effluent wastewater.

Fig. 4 : COD concentration of retting pond wastewater.

Fig. 5 : TSS concentration of retting pond wastewater.

observed that organic and inorganic matters in the wastewater depend on the utilization of biomass activity (Fan *et al.*, 2015; Kumar *et al.*, 2014). The treatment process was stopped due to an exponential change in MLSS concentration after 10 days. When the MLSS concentration was stable, the removal efficiency of COD, Phenol, TSS, TS ratios were also stable after 10 days.

The perusal of data show that pH of coir waste water ranged between 6 - 8. This is an ideal condition for anaerobic process (Khalid *et al.*, 2011; Mahadevaswamy *et al.*, 2004). The balanced pH was maintained in anaerobic reactor by carbonic acid.

The retting pond wastewater containing phenols groundwater and land. The initial phenol concentration in retting wastewater was 420 mg l⁻¹ on 1st day of inlet retting pond wastewater. After anaerobic treatment, phenol concentration of effluent retting pond wastewater was 98 mg l⁻¹. The highest phenol removal of 76% was achieved after 15 days. The accumulation process was slow with sludge and retting pond wastewater after 10 days.

COD removal efficiency increased with time during the treatment of retting pond wastewater. In terms of COD removal,

anaerobic process efficiency is seen due to increased MLSS concentration from low (3100 mg l⁻¹) to high (6750 mg l⁻¹) value. COD removal was found to be 96%. The initial COD was found the value of 32250 mg l⁻¹. After the anaerobic treatment, the final COD was found to be 1170 mg l⁻¹. During 12th and 14th day of incubation period, the efficiency of the reactor increased slightly. Due to unstable MLSS concentration, COD removal efficiency decreased after 10 days of anaerobic treatment.

TSS tends to be a straightforward measure of pollutants weight obtained by separating particles from water sample using a filter, the fact that particles occur in nature is essentially a continuum sizes with defined quantity. At bottom, TSS relies on a cut-off based on the filter properties used. At the upper end, the cut-off should be too large to be "suspended" in water to exclude all particles. Removal of total suspended solids was found to be 91% after 15 days of anaerobic treatment. The initial TSS was found to be 1450 mg l⁻¹. After anaerobic treatment, the final TSS level was 120 mg l⁻¹.

Total solids that include the combination of total dissolved solids and total suspended solids. The concentration of total dissolved solids affects the balance of water in aquatic organisms

Fig. 6 : TS concentration of retting pond wastewater.

Fig. 7 : Biogas production.

cells. Higher concentrations of suspended solids can serve as hazardous carriers that easily adhere to suspended particles. TS removal of 96% was achieved after anaerobic treatment. The initial TS were found to be 42350 mg l⁻¹. After anaerobic treatment, the final TS were found to be 1450 mg l⁻¹.

Biogas produced during anaerobic experiment was measured by gas flow meter. Total biogas production was found to be 12.9 l after 15 days. Total biogas production increased with time. The amount of dissolved methane in the wastewater affected the intrinsic property of anaerobic process (Jun *et al.*, 2016; Moharram *et al.*, 2016; Elangovan and Sekar, 2016; Agarwal *et al.*, 2001).

The sewage sludge of high phenol concentration of 420 mg l⁻¹ was degraded in 15 days with 76% phenol removal in anaerobic reactor. The initial retting pond waste water consisted of high organic which cause more pollution to the environment. Anaerobic treatment of retting wastewater can solve the

environmental problem economically. The results of this study highlights the scope of anaerobic treatment of coconut husk retting pond wastewater and generation of methane. Degradability of polyphenols in coconut husk wastewater was not limited and the anaerobic treatment produced the biogas contains about 75% of methane. The biogas produced can be used as a potential fuel. About 96% of total COD was converted into biogas in the anaerobic treatment method. The process was found suitable to study in the field.

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