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STUDY ON THE ABILITY OF DELIGNIFIED DUST PARTICLES OBTAINED DURING SEPARATION OF COCONUT FIBRES, FOR BIOGAS PRODUCTION AND ITS RELATED CHEMICAL KINEMATICS

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Key words *: Coir pith, Delignification, EC & TDS, Biogas*

Abstract – During the separation of fibers, the dust particles which are also called as coconut coir pith fall away from the husk. This coir pith degrades at a very slow rate. To increase the degradation rate, the coir pith is treated for the reduction in Electrical conductivity and Total dissolved solids .The delignification process is conducted on coir pith to reduce the quantity of lignin present. During the anaerobic treatment of the EC and TDS reduced coir pith, biogas generation has been noticed. This study deals with the determination of the biogas production in the delignified coir pith. There was not a great change in the biogas production in the Delignified, EC & TDS reduced coir pith. It was almost the same as that produced from the EC & TDS reduced coir pith degradation.

INTRODUCTION

Coir pith contains Lignin and cellulose in an extensive level, it is impervious to biodegradation in typical normal conditions. This difficulty in the degradation is mainly due to the presence of high level of Electrical conductivity and the total dissolved solids. The reduction in the EC and TDS in coir pith was done successfully and the production of biogas has been quantified (Priya and Sampath Kumar, 2017). The secondary constraint in the coir pith that delays the degradation is the lignin. Delignification process is conducted in the coir pith using microorganisms (Priya and Sampath Kumar, 2017). The ability of the biogas generation from this delignified treated coir pith has to be verified.

METHODOLOGY

Materials used

Raw coir pith was collected from from the TANCI, coir industry situated in Krishnagiri district. The treatment was given for the coir pith to reduce the high amount of electrical conductivity and total dissolved solids. Delignification was conducted on the treated coir pith and was taken to the anaerobic digester.

Experimental setup

Anaerobic digestion of coir pith was carried out in a five liter capacity laboratory glass insitu fermenter (Lark make). The bio-fermenter has controls like pH, temperature, agitation and aeration by rotameter with air pump. Cow dung was used as seeding material. The waste was filled to 80% of the digester (working space) leaving a free space of 20% (Mahanta, *et al*., 2004). The experiment was conducted at room temperature.

The electrical conductivity and total dissolved solids reduction in coir pith was given using biological method. Delignification process was conducted and the delignified coir pith was taken to anaerobic digester (Priya and Sampath Kumar, 2017). The particle size of raw coir pith was between 0.80 to 2 mm.. The total solid to liquid ratio was 1:20. The BOD, COD, total solids, volatile solids, nutrients, VFA and the gas generated was noted

RESULTS

Observations of different parameters during the anaerobic degradation of pretreated (EC reduced) coir pith.

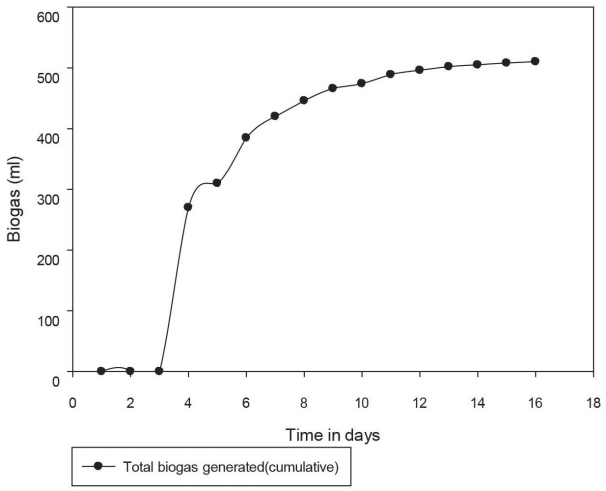

Fig. 1. Total Biogas generated during anaerobic degradation

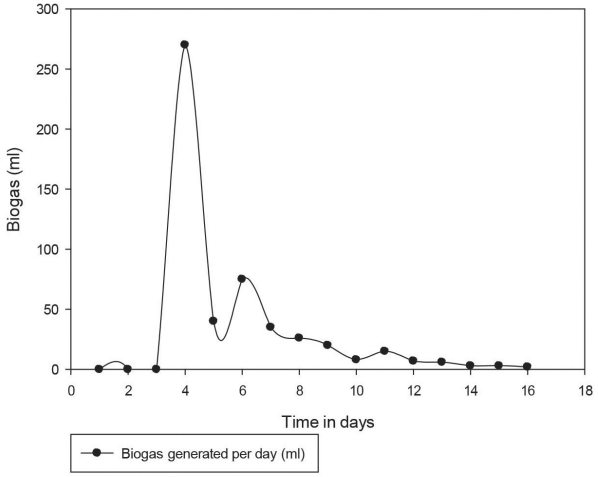

Fig. 2. Biogas generated per day during anaerobic degradation

DISCUSSION

The amount of biogas production was not seen to have any increase compared to the value of biogas generated from the EC & TDS reduced Coir pith. This could be due to the fact that most of the cellulose was released or escaped during the delignification process, thus not showing any prominent increase in the biogas production. However the methane content percentage in the

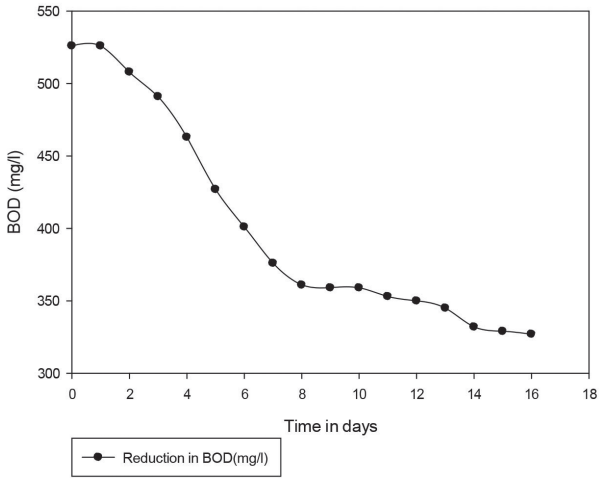

Fig. 3. Variation in BOD dring anaerobic degradation

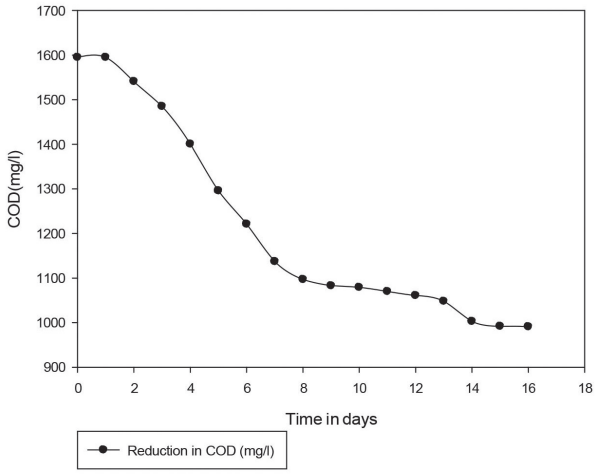

Fig. 4. Variation in COD during anaerobic degradation

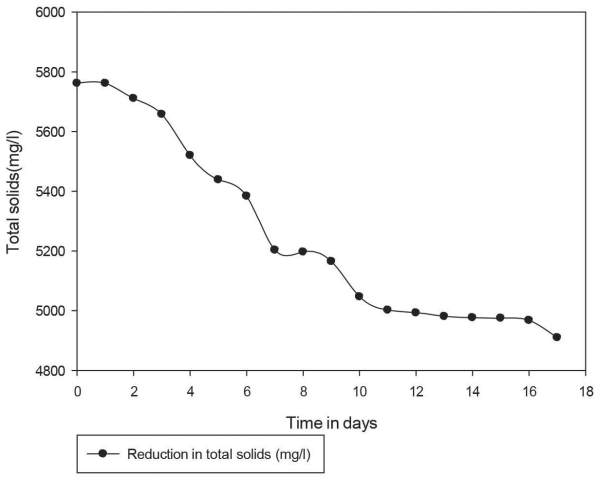

Fig. 5. Variation in Total solids during anaerobic degradation

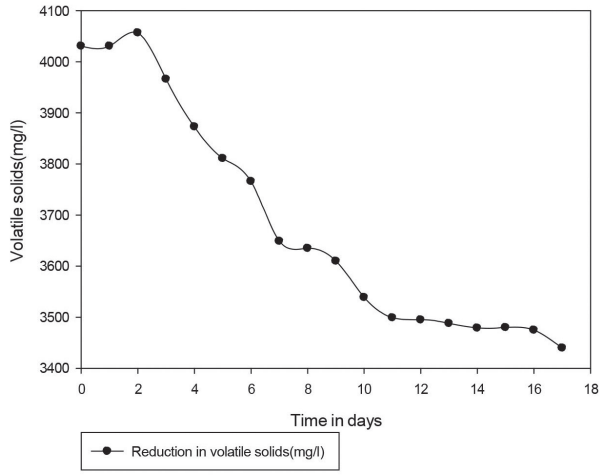

Fig. 6. Variation in Volatile solids during anaerobic degradation

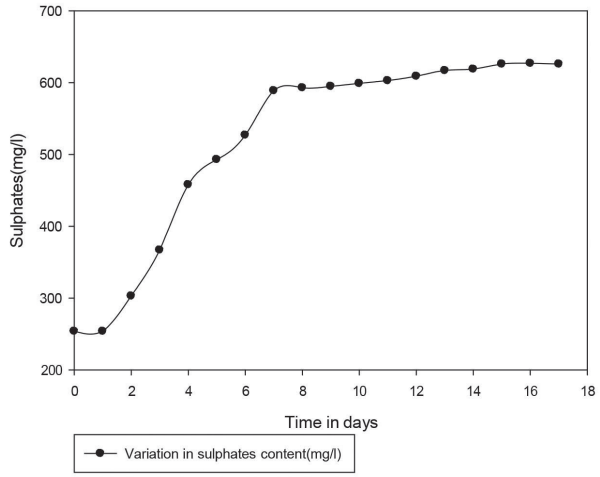

Fig. 7. Variation in sulphates content during anaerobic degradation

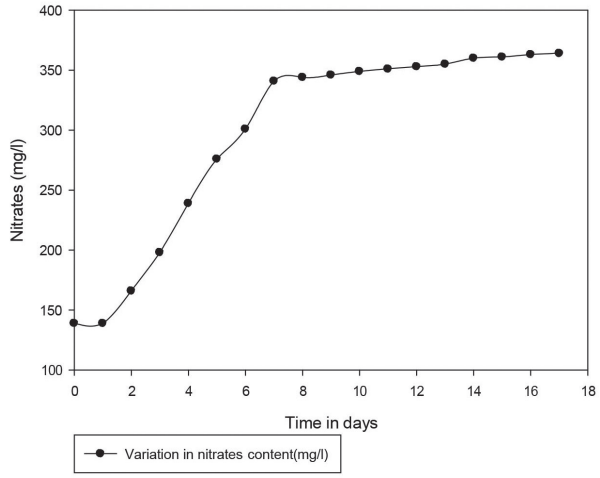

Fig. 8. Variation of nitrate content during anaerobic degradation

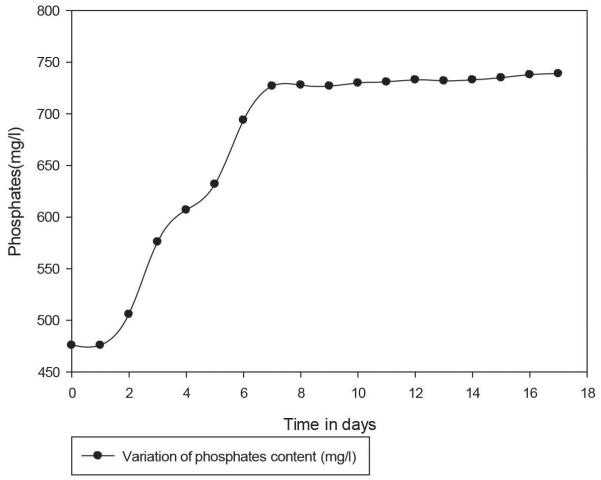

Fig. 9. Variation of Phosphate content during anaerobic degradation

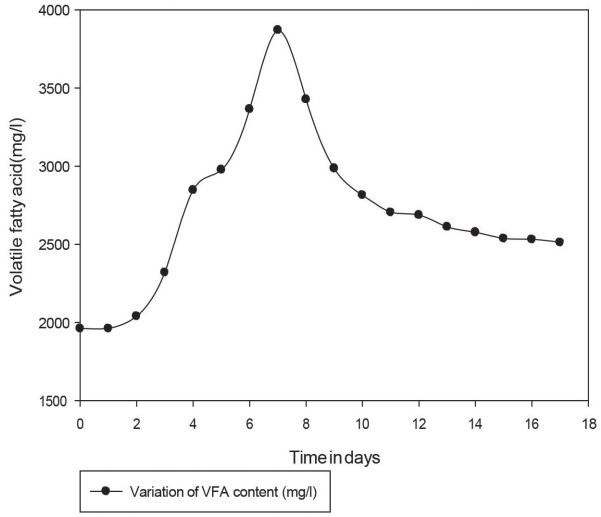

Fig. 10. Variation in VFA content during anaerobic degradation

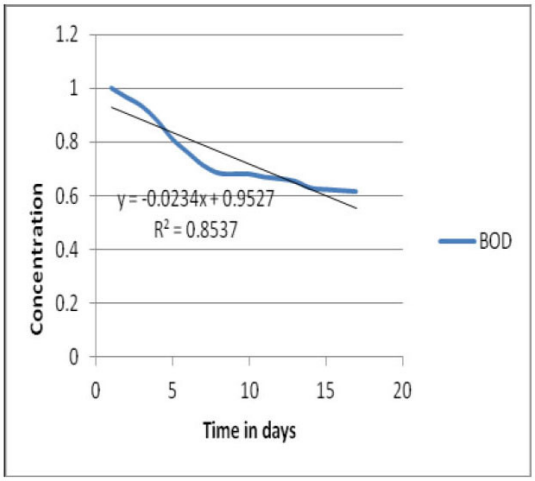

Fig. 11. Zero order Kinetics of BOD concentration

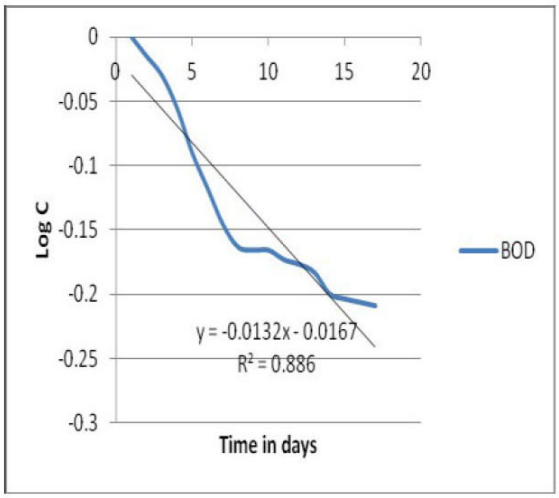

Fig. 12. First order kinetics of BOD concentration

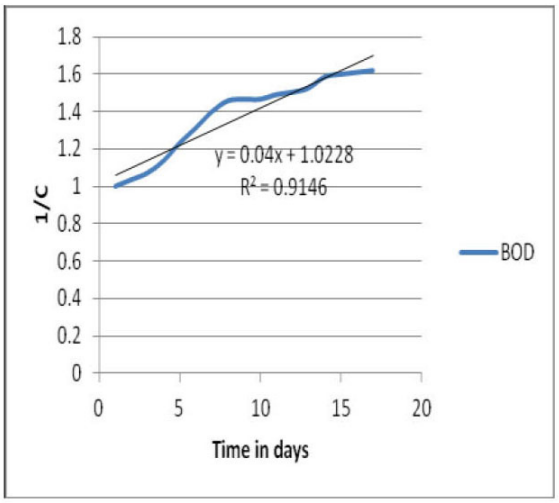

Fig. 13. Second order kinetics of BOD concentration

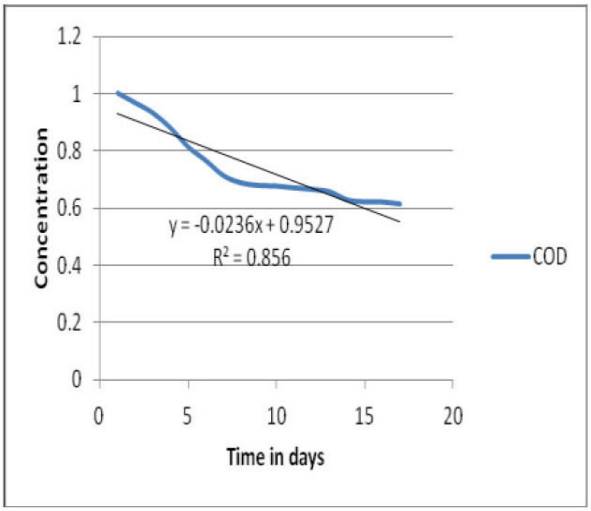

Fig. 14. Zero order Kinetics of COD concentration

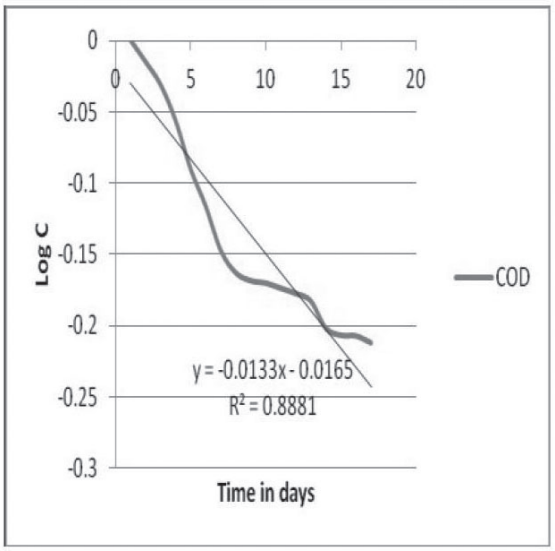

Fig. 15. First order Kinetics of COD concentration

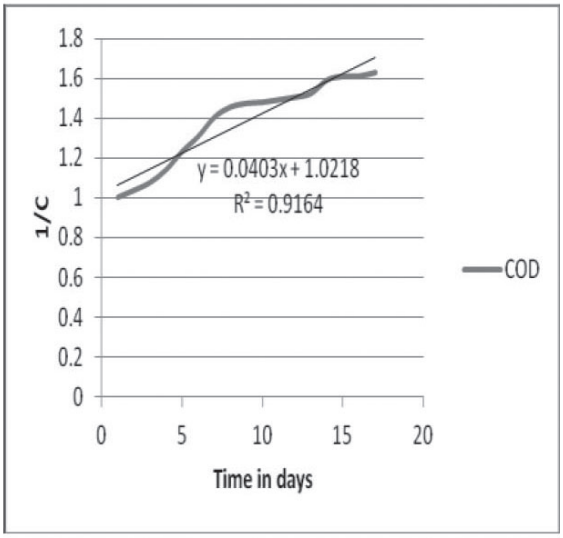

Fig. 16. Second order Kinetics of COD concentration

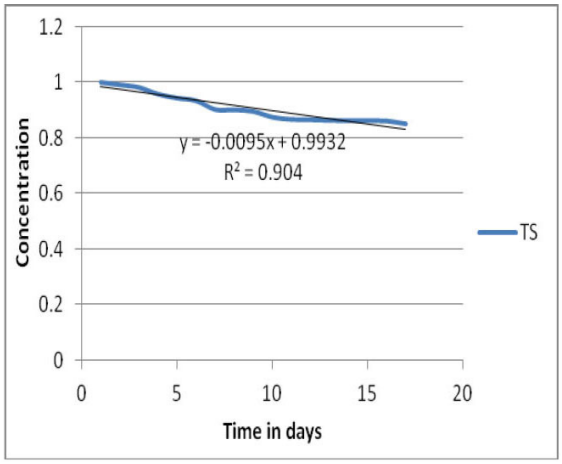

Fig. 17. Zero order Kinetics of Total solids concentration

biogas produced was better than that found in the EC and TDS reduced coir pith digestion.

The maximum biogas generated was 0.104m^3/Kg of VS/day. There was very little biogas generated after the 13th day onwards. The cumulative biogas generated was 511ml. The amount of biogas generated during the anaerobic digestion of pretreated coir pith and amount of biogas generated during the pretreated delignified coir pith were nearly same but the difference being that the duration to produce the biogas has reduced. We could obtain the same amount of biogas generation of 0.104 m^3/Kg of VS/day in 17 days itself. This shows that once the hindrances (EC, TDS, and Lignin) are treated in coir pith, the microorganism can easily access the cellulose and hemicellulose in the coir pith thus producing biogas. The methane content was 69%. The BOD/COD ratio is between 0.33 to 0.35. The VS/TS ratio was noted between 0.71 to 0.7. The quantity of sulphates was almost doubled and nitrate increment was 200%. The VFA (volatile fatty acid) value increased for seven days and then became almost constant. The biogas generation was noted from the third day. It was prominent that after eight to nine days, the rate of generation of biogas decreased drastically (Fig. 1). Also it was noticed that the biogas production was high during the third to seventh day and then slowly started decreasing (Fig. 2). The BOD reduction (Fig. 3) and COD reduction (Fig. 4) was 38.2% and 39%. TS reduction was noted to be 14% (Fig. 5). Similarly 15.3% of VS reduction was obtained (Fig. 6). There was a huge amount of increase in the sulphate content (1.07), nitrate content (Fig. 8) and phosphate content (Fig. 9) for seven to eight days, after which very negligible increase was observed.

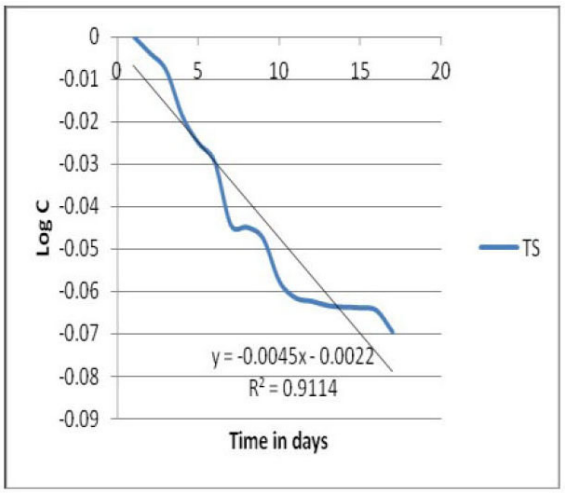

Fig. 18. First order Kinetics of Total solids concentration

Kinetic study

The study of rates of chemical processes are termed chemical kinematics. It includes investigation of the different conditions (experimental) that can influence chemical reaction speed and the information on yield and transition states. The factors that affect the reaction are the nature of the reactants, its physical state, the surface area of solids, its concentration, temperature, catalysts if any and pressure.

DISCUSSION

The k and R squared values are given in Table 1. By comparing the R squared values, we can conclude that the reaction was observed to follow second

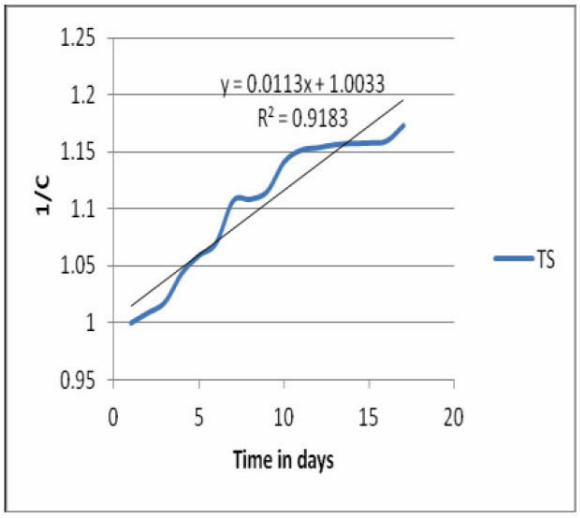

Fig. 19. Second order Kinetics of Total solids concentration

Table 1. Reaction rate constant (k) and R squared values for the plot of time versus concentration

Parameter	Zero order		First order		Secondorder	
	k	R2	k	R2	k	R2
BOD	0.026	0.8537	0.018	0.886	0.025	0.9146
COD	0.036	0.856	0.0124	0.881	0.031	0.9164
TS	0.022	0.904	0.004	0.9114	0.021	0.9183

order reaction. In the previous cases during when the raw coir pith was taken for anaerobic digestion and when the raw coir pith after decreasing EC and TDS was taken for anaerobic degradation, the reaction rate was seen to follow zero order kinetics. This shows clearly that the anaerobic

digestion has actually taken place after all the main hindrances, namely electrical conductivity, total dissolved solids and lignin were eliminated. After the elimination of all the constraints, the pretreated delignified coir pith was taken into the anaerobic digester. The cellulose got exposed to the anaerobic microbes (in digester). There can be more than one factors that can run the reaction, namely time, BOD, COD, Total solids etc. Specifically in this case, two or more than two factors control the biogas production rate.

CONCLUSION

The biogas generated from the pretreated (EC and TDS reduction) and delignified coir pith was $0.104 m^3$/Kg of VS/day. The methane content in the biogas generated was 69%. The BOD/COD ratio varied between 0.33 to 0.35. The VS/TS ratio varied between 0.7 to 0.71. The reaction kinetics follows second order reaction rate. This shows that two or more than two factors control the reaction.

The amount of biogas produced was almost the same as that during the degradation of pretreated (EC and TDS reduction) coir pith. This is because of the fact that during the EC reduction process, gradually the cellulose and hemicellulose get exposed to microorganisms present in the atmosphere and very slow degradation continues during delignification process also, thus considerable amount of it is lost.

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