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TREATMENT OF RICE MILL EFFLUENTS FOR POLLUTION CONTROL

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ABSTRACT

Rice mills manufacturing parboiled rice are heavily concentrated in various districts of Chhattisgarh. The rice mill effluents carry high load of suspended and dissolved organic matters causing serious environmental pollution. Anaerobic digestion which produces biogas is one possible solution. Alternatively, a process of chemical dosing and treatment has been investigated and the experimental results presented. It is concluded that for small and medium rice mills this system is more economical, convenient and effective.

INTRODUCTION

Rice mills manufacturing parboiled variety of rice are heavily concentrated in various districts of Chhattisgarh. The process of manufacturing the parboiled variety of rice involves hot water treatment of paddy in a series of cylindrical steel containers followed by steaming. After a baking period of 5-6 hours the waste water is discharged from the containers and is let off in the open in the surrounding areas around the mill. This discharged water which carries a high load of suspended and dissolved organic matter is the prime source of environmental pollution. The discharge of this effluent is about 4000-5000 lit per 100 bags of paddy processed in the plant. The prime environmental hazard of the rice mill effluents is their foul smell which develops in the discharged effluents with the passage of time. The effluents when let off in untreated form are great nuisance in the populated localities. Apart from the foul smell the effluents percolate through deep strata of soil and pollute the tubewell located in the surrounding areas. The pH of the rice mill effluents has been found to be in the range of 4.0-5.5 indicating acidic nature. This adversely affects the alkalinity of the soil. Over a long period of time the rice mill effluents may cause irreversible changes in the soil and underground water sources, thus affecting both human and plant lives. Typical characteristics of rice mill effluents are presented in Table 1 below.

MATERIAL AND MATHODS

It is possible to design a purely biological system consisting of Bio-reactor for treatment of these effluents. However, such a system is presently not being considered on account of very slow gas generation

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Table 1. Characteristics of rice mill effluents.

S. No.	Parameters	Values
1.	Colour	Turbid
2.	Odour	Foul
3.	pH	4.4
4.	Total solids	3.86 (g/L)
5.	Dissolved solids	3.68 (g/L)
6.	COD	2358 (mg/L)
7.	BOD	1556 (mg/L)
8.	Cl-	0.78 (g/L)
9.	SO4	0.17 (g/L)
10.	Oxalate	3.10 (mg/L)
11.	Fluoride	23.5 (mg/L)
12.	Na	0.46 (g/L)
13.	K	2.68 (g/L)
14.	Ca	0.45 (g/L)
15.	Mg	0.016 (g/L)

rates. Such a system will have to be studied from an altogether different approach. The present study centers on suitable chemical dosing and treatment in the presence of a bio-catalyst.

The disagreeable odour of these effluents is mainly because of sulfur containing molecules (thioalcohol) which necessitate its decomposition. The significant presence of dissolved solids demands an additional treatment.

At this point it is worthwhile to consider whether it would be possible to recycle this water because of the fact that the water requirement in a rice mill is quite substantial and if this treated water may be recycled for reuse it would have been best. However, it has been analyzed that though this treated water is within the prescribed tolerance limits but because of chemical treatment, traces of chemicals used in treatment still remain in the treated effluents. If this water is recycled for fresh parboiling cycle it is likely to destroy the natural flavor of finer quality of rice. However it is suggested that this treated water may be used either for irrigation purposes or initial washing operations in a rice mill. It is clarified that this treated effluent (water) should not be used for potable purposes. Another possibility is to use this water in boiler operations. This is a very promising possibility but before using it as a boiler feed water it should be subjected to the usual pretreatment operations. It is, therefore, suggested that before putting it in actual practice there should be proper analysis conforming to any 1BR regulated boiler operations.

Study of anaerobic digestion under normal conditions was also made with a view to analyze the possibility of bio gas generation. Anaerobic digestion is carried out in the absence of oxygen in which organic matter is degraded by fermentation. During such a process micro organisms convert the organic matter present in the effluents to CO_2, CH_4 and waste sludge. Because of deficiency of oxygen complete carbon is not converted in gaseous form. A satisfactory anaerobic digestion should preferably have nitrogen and phosphorus also along with carbon to sustain microbial growth. It has been reported that carbon to nitrogen ratio is quite important both being main nutrients for bacteria. Further, bacteria use carbon much faster than nitrogen. Temperature is an important consideration for such anaerobic digestion. It is a known fact that reaction rate doubles for every 12o - 15oC rise in temperature. Reaction time is another important parameter which determines the extent of digestion process and microbial growth of cells in the system. For an anaerobic biological system to survive, the net growth rate of the system should be in excess of the minimum time taken for micro organisms to reproduce itself in the system. In an anaerobic system the micro organisms reproduce less rapidly, therefore a longer retention time is required to compensate for the slow net growth rate.

In the preceding paragraphs the principle on which a bioreactor system may be designed for treatment of rice mill effluents has been enumerated. However, such a bioreactor may not be economically viable for small and medium size rice mills because of their prohibitive cost. An alternative system of chemical dosing and treatment has been suggested as a substitute to biological treatment. This chemical treatment has been thought to be affordable to small and medium size rice mills and involved such steps so as to control the vital pollution parameters. The vital pollution parameters identified are:

(i) Extremely foul smell which is attributed predominantly to thioalcohols which are sulfur containing molecules and need to be decomposed through an oxidizing agent. The cheap and most easily available oxidizing agent for this purpose is suggested as bleaching powder in appropriate and optimized doses.

(ii) Presence of non settling fine solids because of which the effluent is in colloidal state making it necessary to use a coagulant such as ferric alum which is cheaply and easily available for use.

(iii) The acidic nature of the effluents having pH in the range of 4.0-5.5 requiring neutralization with an alkali such as lime.

(iv) Presence of dissolved solids quite in excess to the recommended value which would necessitate surface adsorption requiring an active adsorbent having large surface area per unit weight such as activated charcoal or rice husk charcoal.

Based on considerations outlined in the preceding paragraphs, experiments have been carried out for treatment of freshly collected rice mill effluents subjecting a measured quantity for batch wise treatment with various combinations of quantities of the treatment chemicals. The mixture was thoroughly mixed by stirring from time to time and then evaluating the parameters under study namely odour, suspended solids, pH and total dissolved solids after fixed intervals of time.

Table 2. A summary of the sample treatment.

S. No.	Parameters	Quantities
1.	Total volume collected from rice mill	10 lits.
2.	Effluent volume under study	1-1.5 lits.
3.	Lime	0.5-3 gms
4.	Bleaching powder	0.5-2 gms
5.	Ferric alum	1-2 gms
6.	Activated/ rice husk charcoal	1-5 gms
7.	Parameters studied	pH, TDS, COD
8.	Time interval for readings	24,48,72,96 hrs.

It was thought that to begin with the effect of individual parametric treatment be studied separately and individually with each additive and in the subsequent step the cumulative effect of adding all additives be studied when treated simultaneously in a single lot. However, after few experiments it became evident that both the above alternative methods produced identical results indicating that the individual treatments are non-interacting in nature. Thereafter, regular experiments were conducted by adding all the additives simultaneously.

Table 3. Results of treated sample.

S. No.	Parameters	Quantities
1.	Volume of effluent for treatment	1000 cc
2.	Bleaching powder added	1 gm
3.	Ferric alum added	1.2 gm
4.	Lime added	1.2 gm
5.	Activated charcoal added	5 gm

Table 4. Comparison of treated and untreated sample.

S. No.	Parameters	Initial	96 hrs	% Effectiveness
1	pH	4.5	8.4	100
2	TDS (g/L)	3.9	0.88	87.18
3	COD (mg/L)	2980	86	97.11

Experiments have been carried out for treatment with different quantities of additives and for varying periods of time.

It is observed that optimum conditions of treatment of rice mill effluents with respect to the vital pollution parameters namely foul smell, pH, TDS, COD are when the treatment involved mixing sequentially the following additives batchwise in the proportional quantities.

Table 5. Batchwise quantities of additives.

S. No.	Parameters	Additive / Chemical	Quantities g/l of effluent
1.	Dissolved solids	Activated charcoal	4.5
2.	Foul smell	Bleaching powder	0.8
3.	Non settling solids	Ferric alum	1.2
4.	pH	Lime	0.8
6.	Treatment period		43 hrs.

Under the above treatment conditions for time duration of 96 hrs gives the percentage effectiveness shows as follow (Table 6).

Table 6. Data of percentage effectiveness after 96 hrs.

S. No.	Parameters	% Effectiveness
1.	pH	Activated charcoal
2.	TDS	Bleaching powder
3.	COD	Ferric alum
4.	Foul smell	Lime

CONCLUSION

Rice mills manufacturing parboiled variety of rice are present in considerable numbers in Chhattisgarh. The effluents discharged by these rice mills pose an ecological hazard to human beings as well as groundwater and soil. Treatment of these rice mill effluents has been suggested by the method of chemical dosing in appropriate quantities so as to control vital pollution parameters like foul smell, total dissolved solids, pH and chemical oxygen demand (COD). The quantitive proportions of dosing chemicals eg. lime, ferric alum, activated charcoal and bleaching powder as well as time of treatment have been optimized

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