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Rice Parboiling and Effluent Treatment Models; a Review

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Abstract: *Paddy parboiling is an important aspect of rice processing which determines to a large extent. It is a hydrothermal treatment of the rice kernels. Parboiled rice might sound like it's precooked, but it's not; Instead, It's processed quite differently from other types of rice. Water is the most important factor involves in the preprocessing of rice, and after processing a certain quantity of water will be exerted as waste water, rather than the absorbed water by paddy. The effluents discharged by these rice processing industries pose an ecological hazard to human beings as well as pollute the water and soil as it contains it contains high amount of organic matter, high chemical oxygen demand, high biological oxygen demand and high amount of phosphate. Therefore the treatment of such effluent is highly essential to render the effluents suitable for discharge into surface water or on land. There are several types of treatment models which are successfully proven by the researchers such as Coagulation / Flocculation, Bio remediation, Treatment by bio reactor, Photo remediation and Chemical treatment.*

1. INTRODUCTION

It is estimated that the 80% of world population uses rice as major source of calories [6]. Rice serves as the stable food for more than half of world's population and about half of world's population and about half of the world paddy is parboiled [56]. The main objective of parboiling is to gelatinize the starch [57] which improve some properties of the rice. Parboiling involves partial boiling of paddy before milling in order to increase its nutritional. Value to change the texture of cooked rice and reduce the breakage in milling. The word often used when referring to parboiled rice, it's also called as converked rice. Raw rice or paddy is dehusked by using steam; this steam also partially boils the rice while dehusking. This process generally change the color of rice from white to a bit reddish. The three basic steps of parboiling are soaking, steaming and drying [1]. The parboiling treatment is practiced in many parts of the world. Parboiling drives nutrients, especially thiamin, the rice bran layers are rich in proteins, fibers vitamins and fats [58] which migrate into the endosperm of the rice during parboiling [59] parboiled white rice is 80% nutritionally similar to brown rice. Waste water [effluents] coming from rice mill operation contain high concentration of organic and inorganic substances causing significant polluting phenomena [6]. The physiochemical characteristics of the effluent revealed an alkaline pH (8.0), with low concentration of Do (0.9mg/L) and moderate concentration of COD (630 mg/L). Chloride (140 mg/L) and TDS (670 mg/L). The total suspended solids (530 mg/L) and BOD (459 mg/L) were much higher than the recommended standard sent by ISI (1979) for the discharge of effluent into in land surface waters and well as on land for irrigation. Indicating the presence of high amount of organic matter in the effluent [20]. The proper treatment for rice mill effluent is very much important to reduce the adverse effects. Effluent is treated by many different techniques such as adsorption, membrane filtration, coagulation flocculation, and advanced oxidation process such as ozone, photochemical and fentons method etc.[23, 28, 29, 30, 45,55]. These technologies take considerable time and require an extensive setup for treatment of effluents

2. AN OVER VIEW OF PARBOILING

Parboiling is an energy and labor intensive pre milling process aimed at improving the quality of rice [3]. Parboiled rice obtained by treating paddy rice with water and heat before it is dried and milled. In south Asia 90% of the world's parboiled rice is produced and consumed [4]. Use of parboiled rice seems to have been increasing in recent times. Milling of paddy without any pretreatment is highly susceptible to breakage and loss of minerals and vitamins. To reduce breakage and loss of minerals

and vitamins. Pretreatment known as parboiling was developed. The purpose of the process is to produce physical and chemical modification in the cereal with economic, nutritional and practical advantages. During parboiling irreversible swelling and fusion of starch granules occurs and changes starch from crystalline to amorphous form [9, 10, 11, 14, 15, 16]

3. PARBOILED RICE EFFLUENT

The rice mill effluents, carry high load of suspended and dissolved organic matters causing serious

environmental pollution [6] High BOD (1350 – 1800 ppm) of effluent water [6]. The sperm quality can used as a bio in dicator for waste water toxicity and release of waste water to surface water could

affect the fertility of fishes [13]. Soil respiration and enzyme activities were inhibited by about 25 –34 % and cause adverse effects on soil [18].

The processing capacity of rice mill varies from 50 tons to 150 tons per day. It is observed that volume of water required is 1 to 1.5 L per kg of paddy processed. The source of water is only discharged from parboiling unit. The volume of waste water generated is 0.4 to 0.52 L per kg of paddy processed. The waste water discharged daily is about 30 cumec [15, 44] to remove / reduce the concentration of organic or non-organic compound found in industrial waste water is toxic to microorganism. Pretreatment may be required before the Rice mill waste water can be discharged to a municipal collection system.

In other hand rice Mill effluent is 100% replacement for portable water to rise the strength of the concrete. Replacement of rice mill waste water provides the additional environmental and technical benefits for old related industries [21, 54]

Figure1shows the process detail of a rice mill and waste water 1, 2 and 3 contributes for the combined effluent. Chart 1 explains the general physiochemical characteristic of the effluent from a rice mill [20]

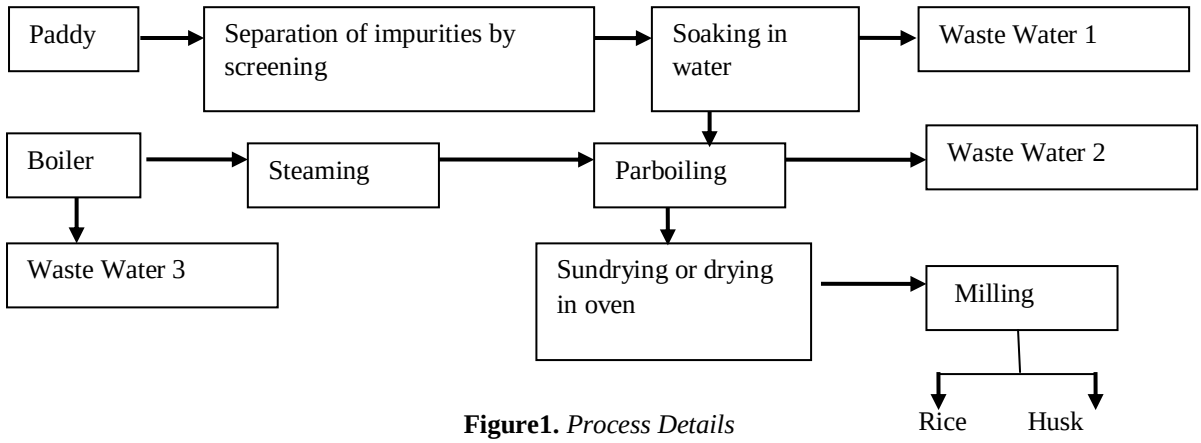

Figure1. *Process Details*

Chart1. *Physiochemical characterization of the effluent*

Parameters	Range
Color	Yellowish brown
Odor	Unpleasant
pH	7.2 – 8.8
Temperature [^{0}c]	35 – 48
Alkalinity (mg / L)	180.7 – 340.1
BOD (mg/L) at 20^{0}c	312.1 – 540.1
COD (mg/L)	400.2 – 892.1
Nitrate (mg/L)	0.3 – 0.8
Phosphate(mg/L)	10.1 – 35.2
Sulphate(mg/L)	28.4 – 70.1
Total solids (mg/L)	998.1 – 1459.1
TSS (mg/L)	432.5 – 576
TDS (mg/L)	522.1 – 833.1

4. RESEARCH VIEW

Parboiled Effluent Treatment Methods

4.1. Coagulation / Flocculation Method

4.1.1. Waste Water Analysis from Parboiled Rice Mill Unit by Coagulation

Waste water was collected from 2 sampling points of the rice mill by grab samplings. The analysis work was done in environmental engineering laboratory of M.Patel institute of engineering technology. Gondia as per the standards methods for examination of waste and Waste water [15, 44] collected waste water stored in 4^0c prior to analysis the same samples were used for the characterization of the waste water and to conduct various treat ability studies for characterization various parameters like pH, alkalinity, BOD, COD, TS, SS of the waste water were determined as per the standard methods of analysis of water and waste water

4.1.2. Coagulation Process in Laboratory

The coagulation process involves addition of to the waste water by readily mixing a proper dispersion of coagulant; this is followed by slow mixing aimed at formation of gelatiniow flocs which capture the particulate resulting in increased weight and are removed by settling the supernant under quiescent condition.

Lab scale coagulation, flocculation treatment of waste water was carried out jar test to assess the renewal of suspended. Solid by means of concentrically available coagulant. For this purpose different coagulant like alum, $feso_4$, Ferric chloride, lime, polyaluminumchloride were used for studies. Among all the coagulants used, COD removal efficiency AAC was found to be the best with efficiency of 80%. This was also best in color removal [6] with the help of aerobic and aerobic treatment process we can do the test, the precipitation with simple coagulant and aeration system are quite promising treatment alternatives to the small scale parboiled rice mill unit [15,44]. This method shows 92% COD removal and 94%BOD removal after aeration of 12 hour [6]

4.2. Electro Coagulation Treatment of Parboiled Rice Waste Water

presently very few parboiled rice mill have effluent treatment plant and the biological treatment method is being used to treat the waste water for overcome these problems, electro coagulation process has been adopted as an alternate stand above treatment to reduce the area requirement and required times, but it is a costly methods for treatment of parboiled rice waste water [23, 45]. The process occurs in Steps during electro coagulation. 1) Anode dissolution; 2) Formation of OH irons and H_2 at the cathode 3) electrolytic reactions at electrode surfaces 4) adsorption of coagulant on colloidal pollutants and 5) removal by sedimentation or flotation [32]

4.3. Bio Remediation of Parboiled Rice Effluent by Methylotropic Yeast

Pichia Pastoris x – 33 is a bio remediator used for Bio remediation of parboiled rice effluent. Bio diesel – derived glycerol is an efficient supplement and carbon source for the bio remediation of parboiled (12) rice effluent. The effluent produced by rice parboiling contains nutrients that can be used by bacteria and yeast to produce single cell protein(SCP) [37,38] and in bio remediation to reduce the COD, BOD and TKN, there by diminishing the environmental impact of the effluent [35,36,39] The 55% reduction in COD , 45% reduction in TKN and 52% P- Pou^3 reduction in effluent was observed in culture of *P.pastoris* x-33 supplemented with $15gL^{-1}$ of bio diesel derived glycerol. [12]. to reduce the environmental impact of parboiled rice effluent it can be supplemented with bio diesel derived glycerol, and the resulting yeast culture was be used as probiotic. Glycerol is an important substrate for several species of microorganism. There are several protocols for *P.Pastoris* using glycerol as a main carbon source in order to increase biomass [40]

In addition of either bio diesel or P.a.glycerol produced a significant reduction in the phosphorus levels. Probably due to the increase in biomass production. Phosphorous removed from waste water by enhanced biological phosphorous removal plant was reported to accumulate in bacteria [41] and in *Saccharomyces cerevisiae* [42] in the form of inorganic phosphate granules, TKN removal efficiency of *P.Pastoris* in effluent alone was 6.8%, lower than those observed with the supplemented effluent 45 % efficiency was obtained with the addition of 15g L^{-1} of biodiesel glycerol [43]. However the

algae a microscopic Nageli demonstrated best nitrogen removal efficiency 73% [39] higher than those obtained by yeast culturing

4.4. Bio Remediation of Effluent by Microalgae and Cyanobacteria

The rice mill effluent as an excellent growth media for microalgae and cyano bacteria [2] the potential of microalgae and cyano bacteria for bio remediation of waste water by nutrient uptake combined with simultaneous biomass production is a well-recognized perception of today's world [2]. Microalage and cyanobacteria bio remediation remove 93.9% phosphorous and 100% ammonia nitrogen within 36 days treatment of rice mill effluent [RME] and 98.7%, 91.6% and 93.5% reduction in biological oxygen demand, chemical oxygen demand and total dissolved solid respectively [2]

Cyano bacterium *Aphansthece microscopica Nagel* has been used to remove the nitrogen and organic matter in order to associate single Cell protein production with waste water treatment and promising of potential for biomas products [17] It remove organic matter expressed as COD and Total nitrogen occurred after 15 hour of cultivation being 83.44% and 72.74% respectively [g]

4.5. Treatment by Bio Reactor

Anaerobic fixed film fixed bed bio reactor has enormous potential for stabilization of parboiled rice manufacturing waste water. The reactor system packed with Biopac media should the BOD and COD reduction in the range 83 – 92.7% and 80.2 – 89% respectively (I) reactor packed with fugino spiral media showed the BOD and COD reduction in the range of 79.4% - 90.6% and 76.7% -86.1% respectively [24] Hence from the comparative results it can be concluded that for the treatment of parboiled rice manufacturing waste water biopac media is more efficient than fugino spiral media

4.6. Phytoremediation of Efficient by Lettuce

Phytoremediation Is An Emerging Technology Applied For Treatment Of Waste Water , It Is A Simple And Cost Effective Method [7] Free Floating Aquatic Plant Water Lettuce (*Pistia Stratiotes*) Used For Treatment Of Parboiled Rice Mill Waste Water Having Low Ph, High Chemical Oxygen Demand (COD) , Nitrogen And Phosphate [7]. Aquatic Plant Based Treatment (APT) System Remove 65% Soluble COD (SCOD); 98% Ammonical Nitrogen (NH_4 – N) 70% Nitrate Nitrogen (NO_3 – N) And 65% Soluble Phosphorous [7]

4.7. Chemical Treatment

Rice mill waste water was treated successfully with commercial grade 30% hydrogen peroxide solution. Chemical oxygen demand o effluent was reduce to 98% after treatment with hydrogen peroxide solution and a sludge production was minimum of all treatments which reduce the load of solid waste management [33]

4.8. Rice Parboiling Waste Water (RPW)

Is used as an alternative substrate for the bio production of caroteroids using the yeast *Phaffia rhodozyma* and found it to be promising as only source of nutrients [5]

5. CONCLUSION

Parboiling causes a gelatinization of the starch during the boiling and during cooling the amylase molecules re-associate with each other and form a tightly packed structure. The amylase in the center of the granule may form ordered structures that have an impact on the rigidity of the starch granule. These amylase crystallites, having melting temperature much higher than 100^0c may have an impact on the textured properties of the cooked parboiled rice [19]. The parboiling process moves micro nutrients contained in the bran which is usually removed inthe whitening process in the rice mill to the endosperm. Parboiled rice production generally requires huge amount of water for soaking of the paddy. Hence water pollution may arise if not properly treated. Water pollution (a cause by high levels of organic material present in waste water. The high chemical oxygen demand, suspended solids, conductivity, salinity and total dissolved solids still pose an economical problem from the industries. Since these have been employed as major parameters [6]. The characterization of waste water shows that waste water is highly biodegradable as is seen from COD /BOD ratio. However it is highly odors and colored needs treatment [12] The application of yeast to the treatment of liquid

waste has been in use to reduce to chemical oxygen demand [COD] biological oxygen demand (BOD] and nitrogen there by decreasing the environmental impact [35, 36] *pichia pastoric* x – 33 may improve the quality of parboiled rice effluents lowering the COD by 55%. Total nitrogen by 45% and phosphorous concentrations by 52% as well as producing a biomass that could be used as probiotic [12]. The rice seedlings watered with bioremediation micro algae and cyanobacteria treated rice mill effluent also showed improved growth effect on shoot height and leaf width [12] Water lettuce is removing organics and nutrients from parboiled rice mill effluent [7]. Liquid effluents from several rice mill have been treated by the use of coagulation and flocculation obtaining promising results in the removal of pollutants [8]. The drastic Environmental changes mainly due to rapid industrialization have emerged as major challenges over the world. It is very much necessary to increasing awareness of the fact that clean environment is necessary for smooth living and better health of human beings [6]

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