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A Review on Hybrid ABR with Comparing ABR for Treatment of Sugar Industry Wastewater

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Abstract: ***Water, is one of the prime, element, involved, in, the, creation of healthy life as well it's development. Since, water, is, such, an essential , resource, for, survival, of, both, plants, and, animals, hence, it's our, responsibility, to, manage, this, resource, for, the, sustainable, benefit, of, all, present, and, future, living, element., Because of the, high, pollution, potential , sugar, industry, is, considered, as, one, of, the, topmost, pollution, creating, industries, affecting, our, environment and ecosystem .Wastewater, from, sugar, industry, bears, complex, properties, and, its, treatment, is, considered, as, one, of, the, difficult , tasks, for, environmental, engineers, in, terms, of, its, treatment, as, well, as, using it again for a particular purpose ., The, brown, colour,, high, temperature,, low, pH,, high, COD,, high, BOD,, TDS,, odour, problems, and, excessive, percentage, of, dissolved, organics, and, inorganics, are, major, properties, of, the, sugar, industrial, effluent., This, effluent, if, discharged, untreated,, poses, problems, for, both, marine, and, terrestrial, ecosystems., The, cost, effective, and, economical, treatment, of, sugar, industrial, waste, is such a difficult task,,therefore, an, appropriate, and, cost-effective, method, to, meet, the, discharge, standards, is, needed., The, aim, of, this, paper, is, to, review, the, hybrid, anaerobic, baffled, reactor, for, the, treatment, of, sugar, industry, wastewater, and, compare, it's, performance, with, respect, to, the, ABR., The, results, presented, in, this, paper, are, from, case, studies, done, on, a, laboratory-scale, Hybrid, ABR, &, ABR, treating, sugar, industry, wastewater, at, different, Hydraulic Retention Time ., The, purpose, of, this, study, is, to, see, the, performance, of, an, anaerobic, baffled, reactor, (ABR), and, a, hybrid, ABR, (HABR), for, the, treatment, of, sugar, industry, under, ambient, conditions, and, compare, the, ability, of, the, two, systems, to, meet, effluent, discharge, standards., In, steady, state, the, COD, removal, efficiencies, of, the, HABR, were, 2.2%, greater, than, those, of, the, ABR, at, all, HRTs., The, HABR, met, COD, and, BOD5, effluent, discharge, standards, using, a, 24-hour, HRT,, while, the, ABR, achieved, these, standards, only, with, a, 48-hour, HRT., The, HABR, was, found, to, be, suitable, for, conventional, sugar, industry, wastewater, treatment.***

Keywords: BOD(Bio chemical oxygen demand), COD(Chemical oxygen demand), TS(Total Solids), HRT (Hydraulic retention time).

I. INTRODUCTION

Sugar industries as we all know are the backbone to economic development of the nation. In India there are about more than 700 sugar industries out of which more than 150 are in Uttar Pradesh, also it is the world's second biggest sugar producer. Indian sugar mills generate a lot of waste water for every tonne of cane crushed by them. The waste water from sugar industry generally contains carbohydrates, nutrients, oil and grease, chlorides, sulfates, and heavy metals. Also sugar industry waste water contains low pH, high-temperature, high chemical oxygen demand, high biochemical oxygen demand, high total solids and high percentage of dissolved organic and in organic matter, also it is characterised by its brown colour as well as order problem.Treatment and safe disposal of sugar industry waste water is necessary because of its high pollution potential as well as unpleasant smell. Considering all these problems in low-cost efficient treatment is essential for sugar industry. Here it is shown that how hybrid reactor works in treating sugar industry which is a mixture of Baffle wall reactor and trickling filter by comparing it's performance with anaerobic baffled reactor in treating sugar industry waste water.

Hybrid ABR is hybridised form of anaerobic baffled wall reactor. This combination is an improved form causing better or upgraded solid retention time in the treatment of waste water. Wastewater treatment by hybrid reactor system has become wide spread as it provides advantage of both the suspended and attach growth phase. The 'hybrid' designation on this system indicates the combination of suspended biomass into attached biomass. At the same time it may used to treat some rate limiting substrate, prime concerned pollutants, volatile organic compound etc. in addition , nitrification also . Here hybrid reactor , a combination of baffle wall reactor and trickling filter has been deigned in which pall rings are used as packing media.

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II. OBJECTIVES OF THE REVIEW

1) To study the hybrid anaerobic baffled reactor for treatment of sugar industrial wastewater and compare it's performance with the anaerobic baffle wall reactor .
2) To study the variation of COD, BOD, TS & pH with respect to different HRTs in HABR & get the optimum HRT.
3) To compare the COD & BOD efficiencies of HABR & ABR at different HRTs under steady state.

TABLE I
CHARACTERISTICS OF SUGAR INDUSTRY WASTEWATER

Characteristics	Values
COD	600-4380mg/L
BOD	300-2000mg/L
TS	870-3500mg/L
pH	4.6-7.1

Source: A.S.Kolhe, et al., (2008)

III. ANAEROBIC BAFFLE WALL REACTOR (ABR)

The anaerobic baffle wall reactor consists of compartments (up to 8) in one reactor which is baffled to forced to treat the incoming wastewater. ABR is an advanced form of septic tank with a series of baffles under which black, grey, or the industrial waste water is supposed to flow and offer the baffles towards inlet to outlet. The increased contact time with the active biomass(i.e. sludge) results in an improved treatment. The raw wastewater enters the ABR tank through the inlet which directs the flow to bottom of first compartment under anaerobic condition, granulated sludge blanket is formed which makes the solids from waste water gets trapped where anaerobic bacteria consume the organics as their food. The partially clarified effluent flows up over the baffle to the next compartment where same action is performed, finally the effluent is clarified until the last compartment where the BOD & COD levels are great greatly reduced and final effluent is free of suspended solids by around 75%.

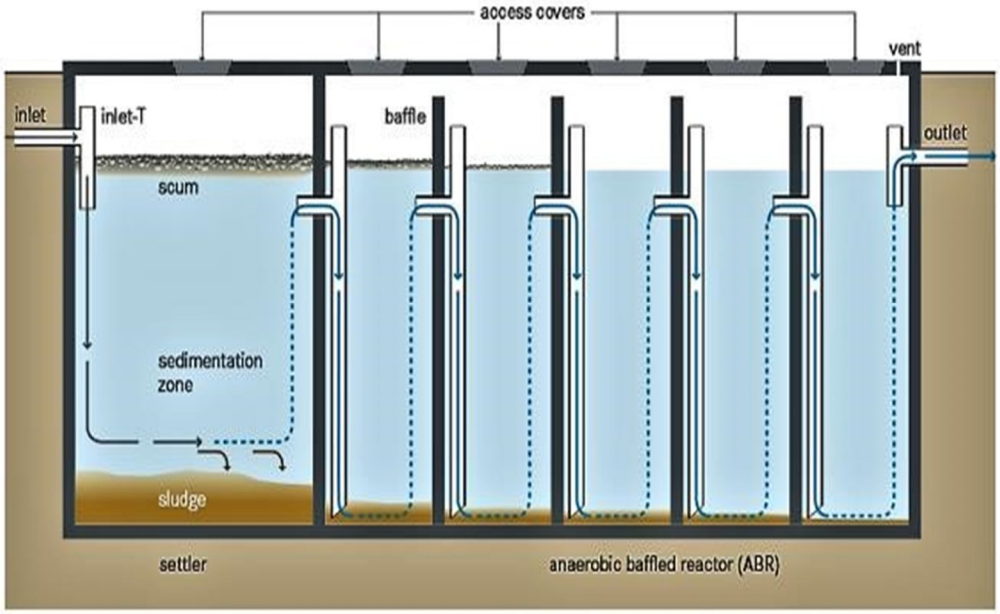


Figure 1: SCHEMATIC DIAGRAM OF ABR
Source: TILLEY et al. (2014)

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IV. HYBRID ANAEROBIC BAFFLED REACTOR (HABR)

The hybridised form of ABR is a combination of baffle wall reactor and trickling filter in which pall rings have been used here as filter media. The term ''hybrid'' indicates the integration of suspended biomass into attached biomass. Comparing to the ABR process, here the wastewater undergoes the reactor from inlet where so;ids washed out from baffles undergoes filter media and this allows the water movement in each chamber by baffles and the remaining organic matter is removed efficiently by the packing installed, allowing the effluent to have reached the desired COD, BOD, TS and pH levels. The compartments of HABR in which packing is present is both a biochemical and a solids settling chamber,so that solids washed out from the baffled reactor can be collected in the settling chamber. Higher loading rates are possible with this reactor due to minimal solids washout during elevated gas mixing. The ability of enhancing solids retention makes HABR quite suitable for high strength wastewater treatment, hence sugar industry wastewater.

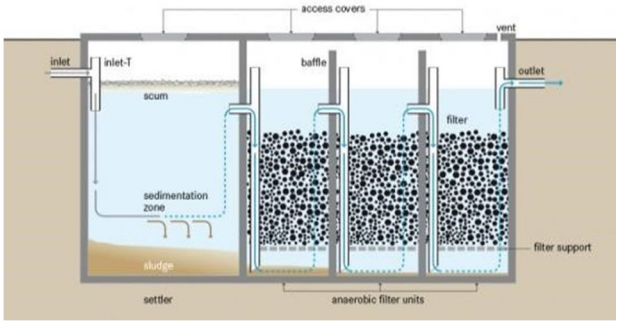


Figure 2: SCHEMATIC DIAGRAM OF HABR
Source: TILLEY et al. (2014)

V. FINDINGS FROM THE STUDY

The results from the study done by Prajwal.S.Gundka, et al. (2019) shown in figure 3 & figure 4 states that under steady start up period COD, BOD and Total solids are removed to about more than 50% and pH is increased at 24 hrs HRT and the study done by Gholamreza et al. (2017) shown in figure 5 shows that under steady state COD & BOD removal efficiency of hybrid ABR is more than that of ABR.

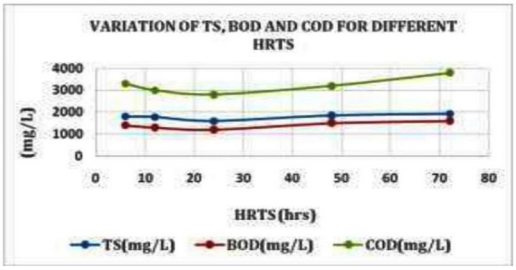


Figure 3: Variation Of TS , Bod & Cod For Different HRT In HABR During Start-Up Period
Source: Prajwal.S.Gundka, et al. (2019)

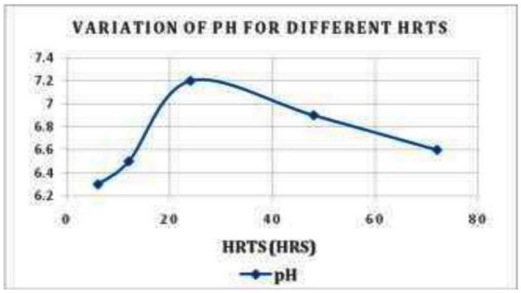


Figure 4: Variation OF pH FOR Different HRT IN HABR During START-UP Period
Source: Prajwal.S.Gundka, et al. (2019)

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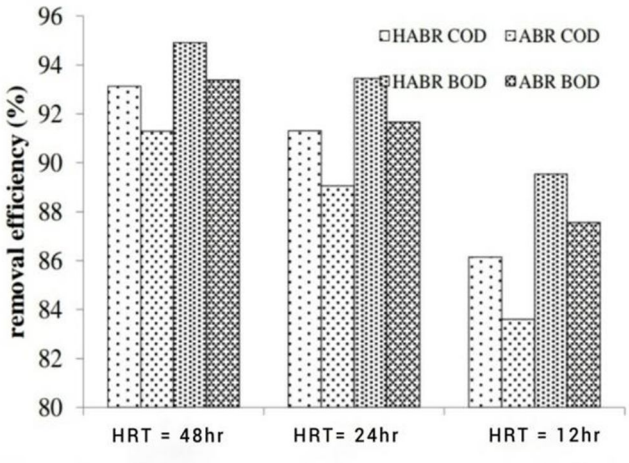


Figure 5: Average TS Removal under Steady-State Conditions
Source:Gholamreza Moussavi, et al. (2017)

VI. RESULT AND DISCUSSION

From the experimental results obtained from the study done by Prajwal. S. Gundkal, et al. for the treatment of sugar industry waste water by the help of multi-media filter technology during start up period it is observed that :

A. The COD is reduced from 5000mg/L to 2800mg/L at 24 hrs HRT,
B. The BOD is reduced from 2300mg/L to 1100mg/L at 24 hrs HRT,
C. The TS was reduced from 2000mg/L to 1300mg/L and the pH is increased to 7.2 at 24 hrs HRT,
D. Hence the optimum HRT of the hybrid reactor is 24 hrs.
E. The efficiency of the hybrid reactor is about 56%.

From the experimental results during steady state from the study done by Gholamreza, et al. it is observed that :

1) COD removal in the ABR reached 91.4, 89.1, and 83.5% at the end of experiments with HRTs of 48, 24, and 12 hours, respectively, while COD removal in the HABR reached 93.2, 91.4, and 86.1%, respectively;
2) BOD removal in the HABR measured 94.5, 93.4, and 89.5% at HRTs of 48, 24, and 12 hours, respectively, while BOD removal in the ABR measured 93.4, 91.7, and 87.6%, respectively.

VII. COMPARISON BETWEEN ABR & HYBRID ABR

A. The optimum HRT is obtained much earlier in HABR than in ABR.
B. The efficiency of HABR is more than ABR.
C. The Hybrid ABR met effluent COD, BOD, and Total solid standards at an optimum HRT of 24 hours, but the ABR met the standard only with an HRT of 48 hours.
D. The HABR is an efficient and appropriate system for sugar industry wastewater treatment, especially in developing countries.
E. The nutrient-rich effluent produced by the HABR can be reused in agricultural irrigation where it is not in direct contact with human beings or subsurface irrigation.
F. The use of support media into the hybrid reactors could improve the development of biofilm biomass to increase pollutant removal and system stability due to the high sludge retention time (SRT) leading to the formation of bacterial community such as nitrifying and denitrifiying bacterium. Hence, higher organic matter removal rates and better effluent quality are attained in these systems compared to normal or traditional treatment processes.

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VIII. CONCLUSIONS

The following conclusions were drawn :

1) The sugar industry wastewater was treated itself repeatedly in hybrid reactor, that includes simple and reliable biological processes as well as the hybrid reactor had sufficient reduction in the velocity of the flow, abundant air circulation naturally.

2) From Fig 3 and Fig 4, during the start up period, the COD is reduced from 5000mg/L to 2800mg/L at 24 hrs HRT, the BOD is reduced from 2300mg/L to 1100mg/L at 24 hrs HRT, the TS was reduced from 2000mg/L to 1300mg/L and the pH is increased to 7.2 at 24 hrs HRT, hence the optimum HRT of the hybrid reactor is 24 hrs & the efficiency of the hybrid reactor is about 56%.

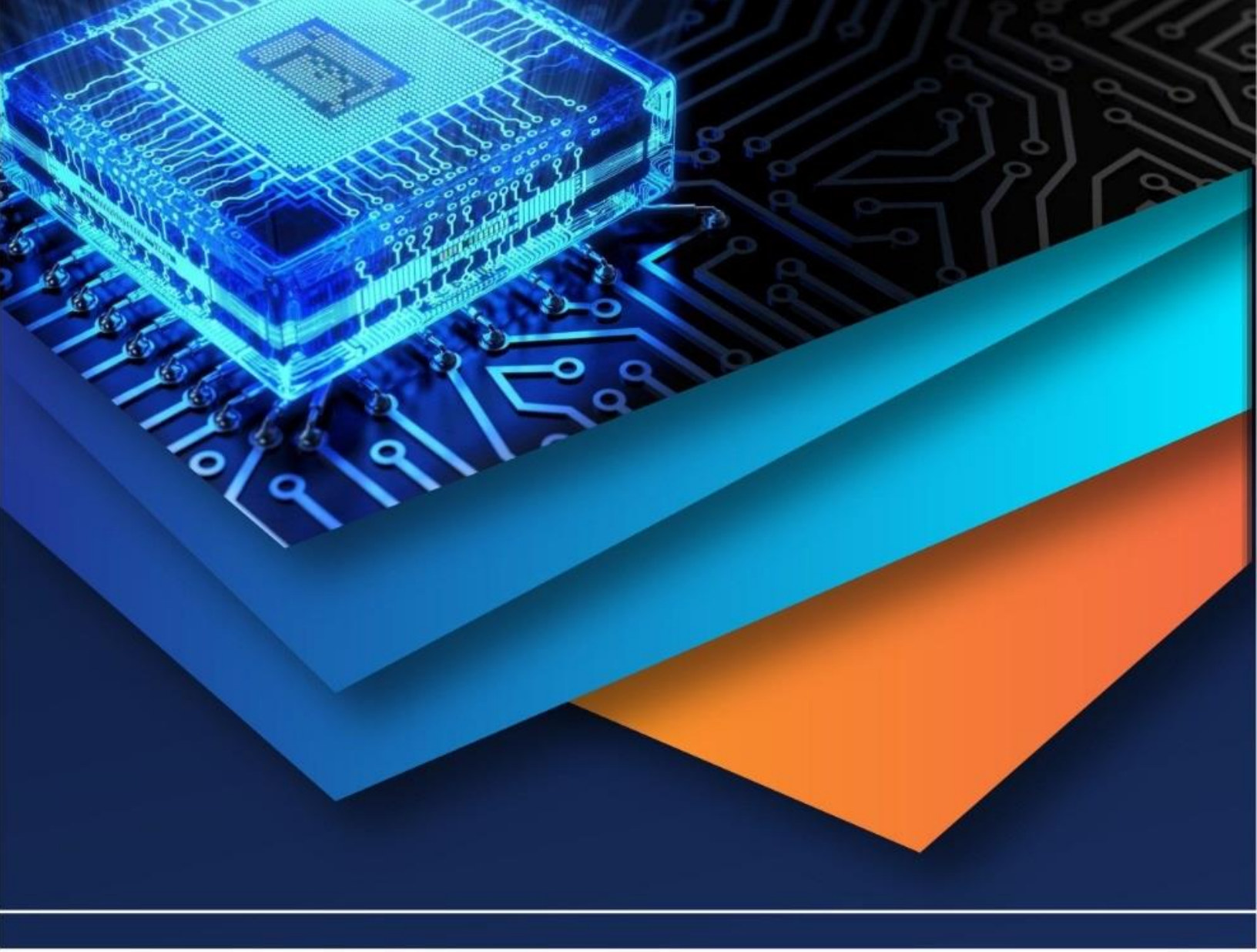
3) From Fig 5, under steady state, indicates that *the average COD & BOD removal in the HABR was 2.2% & 1.9% more than that in the ABR* respectively.

Hence the sugar industry wastewater can be efficiently treated by hybrid ABR.

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