# TREATMENT OF SUGAR INDUSTRY WASTEWATER BY UPFLOW ANAEROBIC SLUDGE BLANKET REACTOR

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**Abstract -** *In India we have about 380 sugar industries; also it is world's second biggest sugar producer. The production of sugar was estimated to be around 26million tonnes and Indian sugar mills generate 0.16 to 0.76 $m^3$ of wastewater for every tonne of cane crushed by them. The sugar industry wastewater contains high amount of COD, BOD, TS and pH which is highly acidic in nature. In present study a laboratory scale Hybrid Up flow anaerobic sludge blanket reactor was constructed for treating sugar industry wastewater by using polypropylene pall rings as filter media. The reactor is being operated at different hydraulic retention time that is 72, 64, 56, 48, 40, 32, 24, 16 and 8 hours. Also we aim to obtain the optimum HRT of the reactor. COD feed concentration was 5400mg/l and 78% of COD removal was achieved at 48hour HRT.*

***Key words:*** *BOD (Biochemical Oxygen Demand), COD (Chemical Oxygen Demand), TS (Total Solids), HRT (Hydraulic Retention Time).*

## INTRODUCTION

Sugar is made from sugarcane, and was discovered thousands of years ago in New Guinea. The route was then traced to India and Southeast Asia. India was the first to begin with the production of sugar following the process of pressing sugarcane to extract juice and boil it to get crystals.

The government of India in 1950-51 made serious industrial development plans and has set many targets for production and consumption of sugar. These plans by the government projected the license and installment capacity for the sugar industry in its Five Year Plans. India is well known as the original home of sugar and sugarcane.

India is the world's second biggest sugar producer. India's share in global sugar production in 2022 is forecast at 15 per cent at around 32 million tonnes. Sugar production in the period 2015-16 is estimated to be around 26million tonnes, about 2 million tonnes less than last year. The drop has been mainly due to extended dry weather in Maharashtra and Karnataka.

Consumption in 2015-16 was estimated to be 25 MT. The country had produced 28.1MT of sugar in 2015. Maharashtra, the country's leading sugar producing state, has projected sugar output to decline to 8.6MT in the 2015-16.marketing year, compared with 10.5MT last year. In India there are about 380 sugar factories, of which 105 are in Uttar Pradesh.

**TABLE 1:** EFFLUENT GENERATIONS IN VARIOUS, UNITS OF SUGAR FACTORY.

| Process |
|---|
| Mill house |
| Boiling house |
| Boiler house(Blowdown) |
| Pump cooling water |
| Sulphur furnaces |
| Lime hydrator |
| Excess Condensate |
| Final effluent |
| Spray Pond over flow |

Karnataka Sugar Industry ranks 3rd in terms of its contribution of sugar in the total sugar production in the country. Karnataka stands 4th in the country in the cultivation of sugarcane. The Sugar Industry in Karnataka has around 41 sugar factories which are distributed all over the state.

### Biological Wastewater Treatment Method.

It is a process that seems simple on the surface since it uses natural processes to help with the decomposition of organic substances, but in fact, it's a complex, not completely understood process at the intersection of biology and biochemistry.

Biological treatments rely on bacteria, nematodes, or other small organisms to break down organic wastes using normal cellular processes. Wastewater typically contains a buffet of organic matter, such as garbage, wastes, and partially digested foods. It may also contain pathogenic organisms, heavy metals, and toxins.

The goal of biological wastewater treatment is to create a system in which the results of decomposition are easily collected for proper disposal.

### Aerobic and Anaerobic

In biological treatment processes, it is important to briefly discuss the terms aerobic and anaerobic. Aerobic, as the title suggests, means in the presence of air (oxygen); while anaerobic means in the absence of air (oxygen). These two terms are directly related to the type of bacteria or microorganisms that are involved in the degradation of organic impurities in a given wastewater and the operating conditions of the bioreactor. Therefore, aerobic treatment processes take place in the presence of air and utilize those microorganisms (also called aerobes), which use molecular/free oxygen to assimilate organic impurities i.e. convert them in to carbon dioxide, water and biomass. The anaerobic treatment processes, on other hand take place in the absence of air (and thus molecular/free oxygen) by those microorganisms (also called anaerobes) which do not require air (molecular/free oxygen) to assimilate organic impurities. The final products of organic assimilation in anaerobic treatment are methane and carbon dioxide gas and biomass.

### Hybrid Upflow Anaerobic Sludge Blanket(UASB) reactor

Karnataka Sugar Industry ranks 3rd in terms of its contribution of sugar in the total sugar production in the country. Karnataka stands 4th in the country in the cultivation of sugarcane. The Sugar Industry in Karnataka has around 41 sugar factories which are distributed all over the state. Aerobic digester that combines a UASB reactor with anaerobic filters. This combination is an advanced form enabling improved solid retention time in the treatment of wastewater. This wastewater can be built up in the secondary chamber and must be removed daily or an explosion is imminent to occur.

Upflow Anaerobic Sludge Blanket Reactor Wastewater Treatment is a wastewater treatment system using biology that without using of air or oxygen. It aimed to remove organic pollution in wastewater, slurries and sludge. Anaerobic microorganisms convert organic pollutants into a "biogas" which contains methane and carbon dioxide.

### Statement of Problem

In India, sugar Industry is one of the major agro based industries. Treatment and safe disposal of sugar industry waste water has been cause of concern for many decades because of its high pollution potential. Anaerobic treatment has gained importance in better treatment of sugar industry wastewater. The sugar industry effluent contains high chemical oxygen demand (COD). As per central pollution control board (CPCB) the typical value for COD is 250mg\L and pH of 5.5 to 9.0 for discharging the treated effluents to inland surface water. Considering all the problems above a low cost efficient treatment is essential for sugar industry.

### Objectives:

Treatment of Sugar Industry wastewater by Upflow Anaerobic Sludge Blanket Reactor.

a. To obtain the variation of BOD content with respect to different HRT at different levels.
b. To obtain the variation of COD with respect to different HRT at different levels.
c. To obtain the variation of pH with respect to different HRT at different levels.
d. To obtain the variation of Total Solids with respect to different HRT at different levels.
e. To obtain the optimum Hydraulic Retention time (HRT).

### Fabrication of Materials

A laboratory scale Upflow Anaerobic sludge blanket reactor was fabricated. The overall height of the reactor is 1220mm. The effective volume of the reactor is 18.2 liters and the effective height is 1070mm with a free board of 75mm.

A 10% of fresh cow dung slurry was seeded to the reactor to generate bacteria in it. Sampling ports were given to the reactors as shown in the figure. The sampling ports were fixed at various levels 25 %, 50 % and 75 % of overall height of the reactor and they are placed at 75mm from top as well as 75mm distance from bottom to arrest the packing material and reduce the choking problems at inlet as well as outlet.

### Packing material

According to literature review and previous studies use of packing materials has proven to be more efficient for treatment of wastewater. We have selected Polypropylene pall rings as packing material for the present study. The diameter of pall rings is 20mm and height is 14mm.

### Details of the reactor

**Table 2**: Design details of UASB Reactor

| | |
|---|---|
| Total height | 1220mm |
| Effective height | 1145mm |
| Inner diameter | 142.4mm |
| Outer diameter | 150.4mm |
| Thickness | 4mm |
| Diameter of Pall rings | 20mm |
| Height of Pall rings | 14mm |

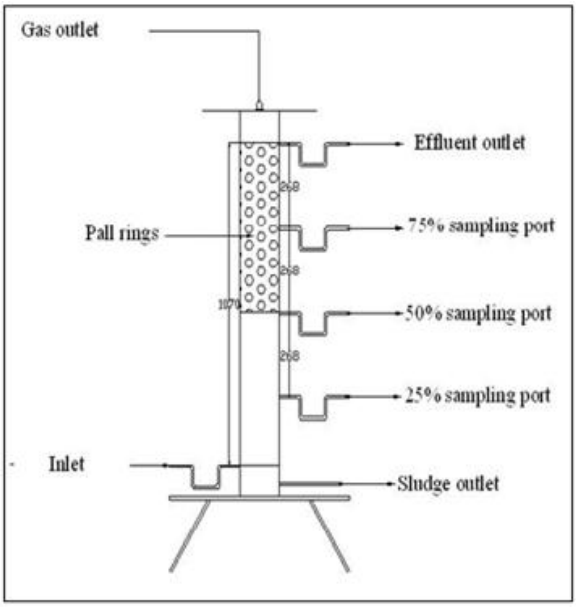


**Fig 1**: Schematic Diagram of UASB Reactor

**Results:**

1) Parameters at 100% level of reactor

**Table 3**: 100% level

| HRT in Hours | pH | TS in mg/l | COD in mg/l | BOD in mg/l |
|---|---|---|---|---|
| 72 | 6.5 | 320 | 5250 | 1440 |
| 64 | 6.6 | 390 | 4980 | 1410 |
| 56 | 6.53 | 650 | 4880 | 1355 |
| 48 | 8.8 | 790 | 4520 | 1300 |
| 40 | 8.6 | 780 | 4690 | 1290 |
| 32 | 7.6 | 760 | 4820 | 1360 |
| 24 | 6.3 | 690 | 4940 | 1390 |
| 16 | 6.53 | 750 | 5100 | 1420 |
| 8 | 6.59 | 780 | 5200 | 1440 |

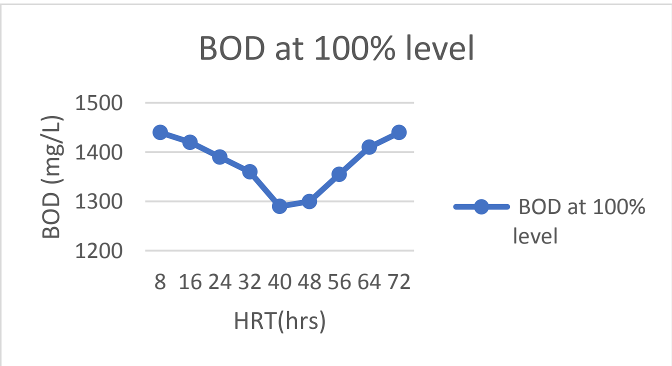


**Chart 1.1:** BOD AT 100% LEVEL

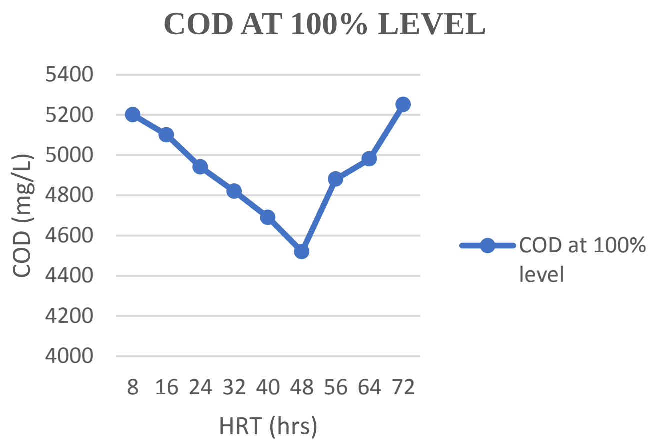


**Chart 1.2:** COD AT 100% LEVEL

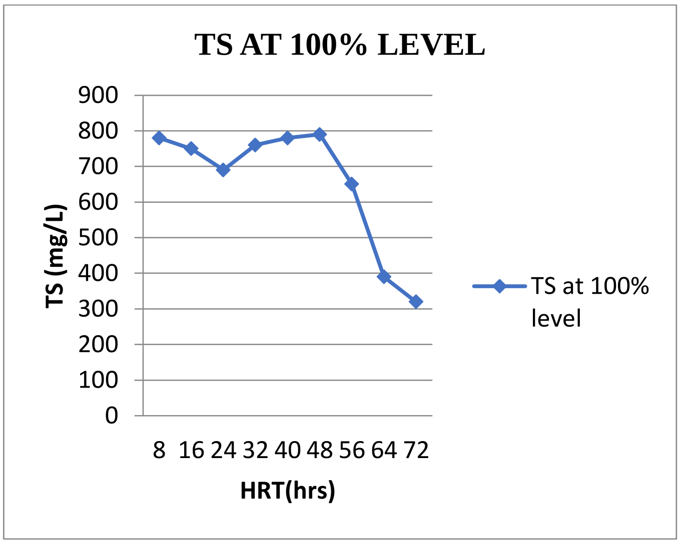


**Chart 1.3:** TS AT 100% LEVEL

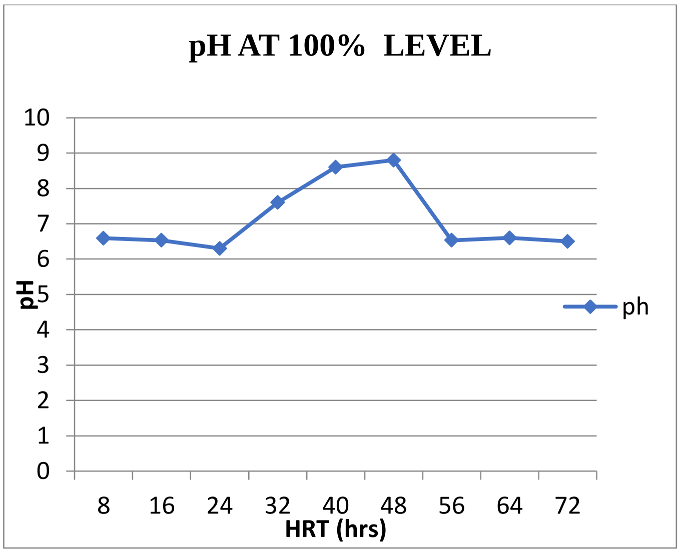


**Chart 1.4:** pH AT 100% LEVEL

2) Parameters at 75% level of reactor

**Table 4:** 75% LEVEL

| HRT in Hours | pH | TS in mg/l | COD in mg/l | BOD in mg/l |
|---|---|---|---|---|
| 72 | 6.51 | 380 | 5100 | 1420 |
| 64 | 6.56 | 450 | 4800 | 1350 |
| 56 | 7.41 | 580 | 4580 | 1300 |
| 48 | 9 | 780 | 4200 | 1100 |
| 40 | 8.4 | 760 | 4320 | 1150 |
| 32 | 7.9 | 780 | 4825 | 1260 |
| 24 | 7.45 | 750 | 4980 | 1290 |
| 16 | 7.44 | 740 | 5000 | 1340 |
| 8 | 6.5 | 740 | 5400 | 1390 |

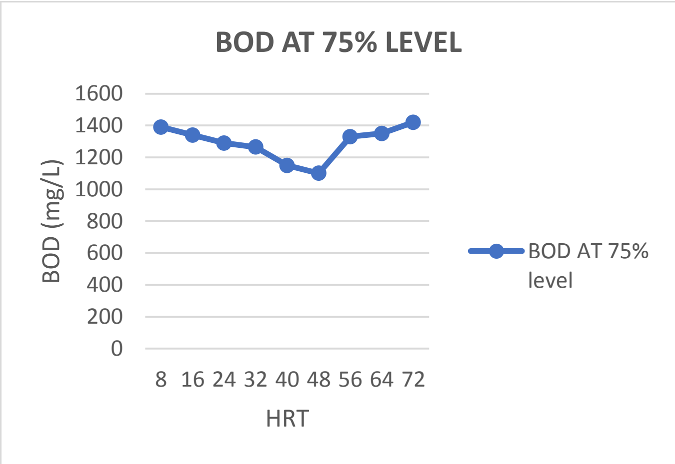


**Chart 2.1:** BOD AT 75% LEVEL

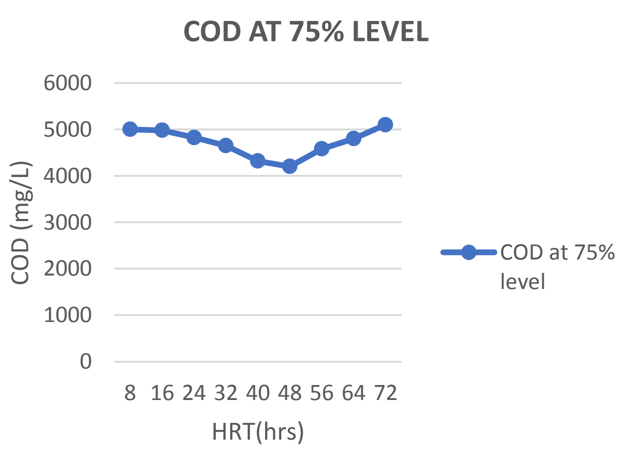


**Chart 2.2:** COD AT 75% LEVEL

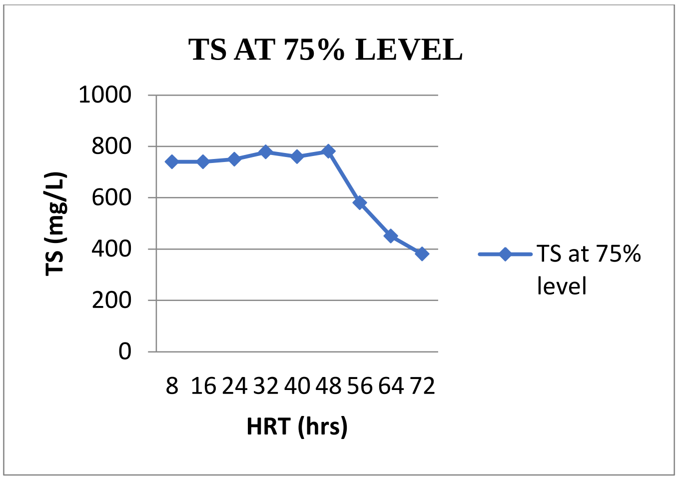


**Chart 2.3:** TS AT 75% LEVEL

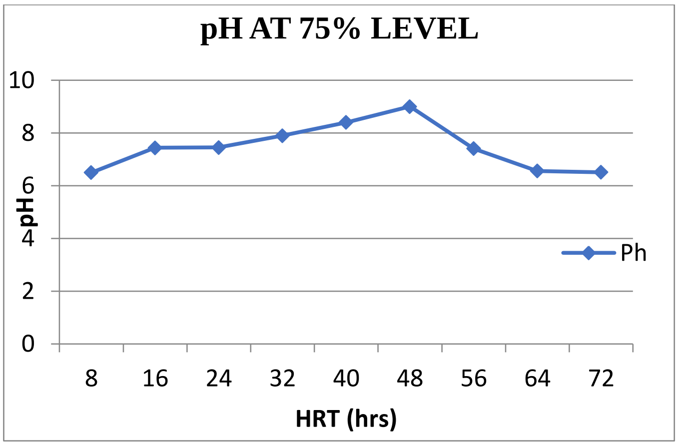


**Chart 2.4:** pH AT 75% LEVEL

3) Parameters at 50% level of reactor

**Table 5:** 50% LEVEL

| HRT in Hours | pH | TS in mg/l | COD in mg/l | BOD in mg/l |
|---|---|---|---|---|
| 72 | 6.57 | 360 | 5200 | 1421 |
| 64 | 6.74 | 420 | 4850 | 1400 |
| 56 | 7.5 | 529 | 4600 | 1360 |
| 48 | 8 | 723 | 4450 | 1150 |
| 40 | 7.9 | 720 | 4700 | 1200 |
| 32 | 7.51 | 712 | 4835 | 1245 |
| 24 | 7.3 | 720 | 4980 | 1380 |
| 16 | 6.7 | 722 | 5150 | 1445 |
| 8 | 6.4 | 725 | 5120 | 1488 |

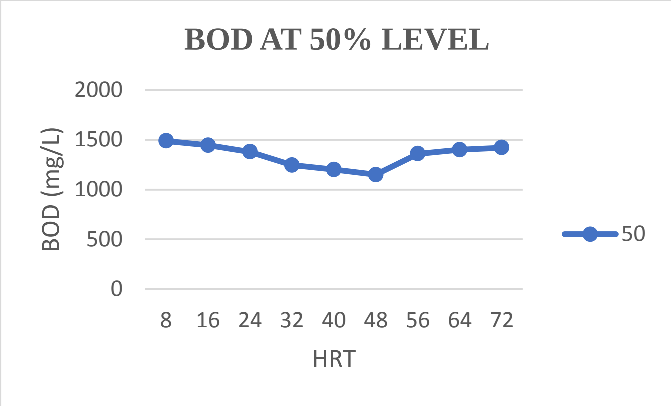


**Chart 3.1:** BOD AT 50% LEVEL

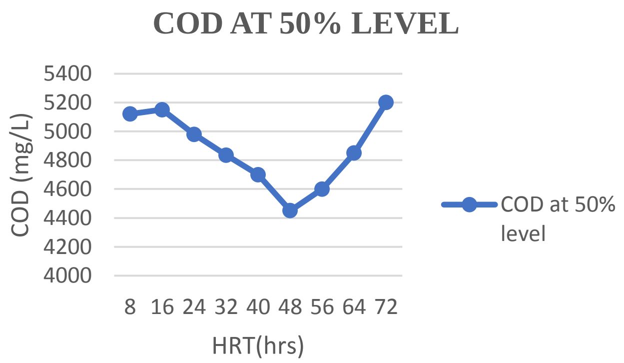


**Chart 3.2:** COD AT 50% LEVEL

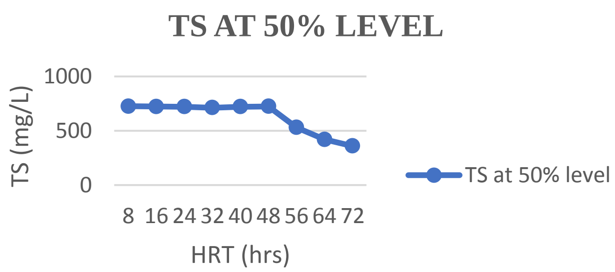


**Chart 3.3:** TS AT 50% LEVEL

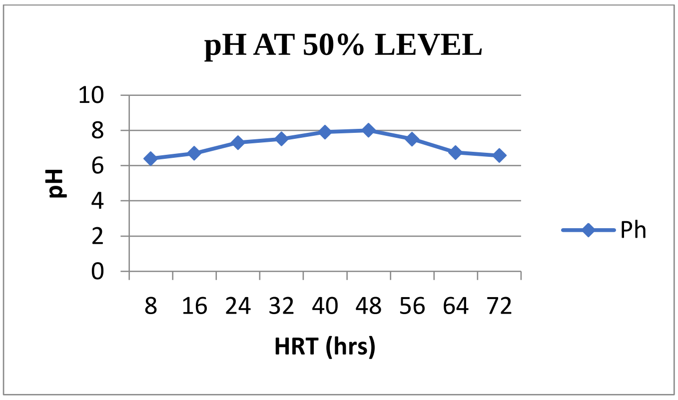


**Chart 3.4:** pH AT 50% LEVEL

4) Parameters at 25% level of reactor

**Table 6:** 25% LEVEL

| HRT in Hours | Ph | TS in mg/l | COD in mg/l | BOD in mg/l |
|---|---|---|---|---|
| 72 | 6 | 360 | 5320 | 1459 |
| 64 | 6.5 | 400 | 4900 | 1440 |
| 56 | 6.59 | 426 | 4720 | 1410 |
| 48 | 8.9 | 489 | 4500 | 1300 |
| 40 | 8.5 | 478 | 4650 | 1245 |
| 32 | 7.2 | 467 | 4780 | 1266 |
| 24 | 6.9 | 472 | 4950 | 1392 |
| 16 | 6.69 | 480 | 5100 | 1430 |
| 8 | 6.44 | 495 | 5200 | 1436 |

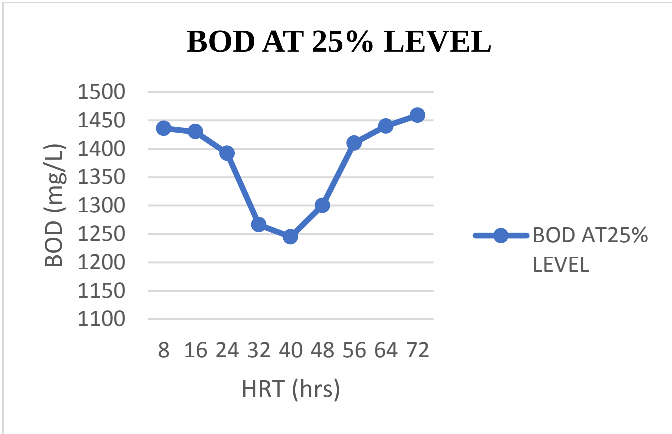


**Chart 4.1:** BOD AT 25% LEVEL

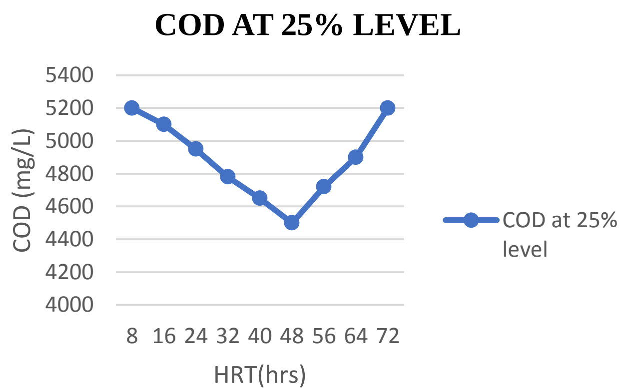


**Chart 4.2:** COD AT 25% LEVEL

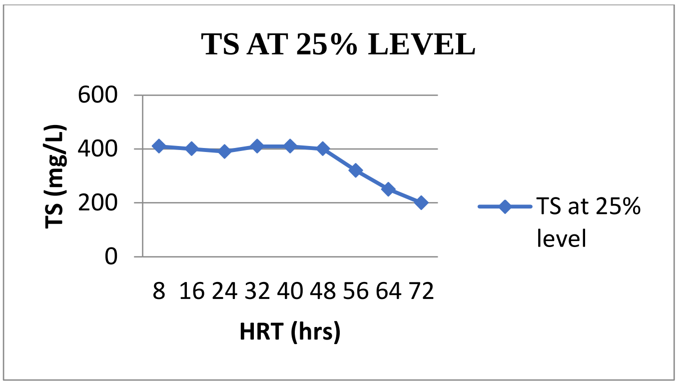


**Chart 4.3:** TS AT 25% LEVEL

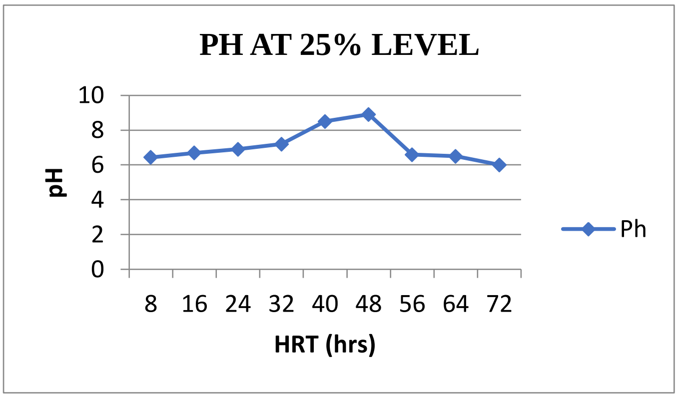


**Chart 4.4:** pH AT 25% LEVEL

**Conclusions**

The industrial wastewater was treated itself repeatedly in UASB Reactor, which means it involves simple, reliable, biological process. The UASB Reactor works in anaerobic condition. Handling of the excess sludge is not a problem because the amount of sludge produced can be utilized. Therefore, the proposed biological treatment process appears to be promising wastewater treatment with respect to the removal of COD and BOD.

From our results at 75% level of reactor we observed that:

- COD is reduced from 5400 mg/l to 4200 mg/l at 48 hours of HRT.
- BOD is reduced from 1500 mg/l to 1100mg/l at 48 hours of HRT.
- pH is increased from 6.37 to 9 at 48 hours of HRT.
- TS is increased from 300mg/l to 780mg/l at 48 hours of HRT.
- Hence optimum HRT of UASB Reactor is 48 hours.
- The efficiency of COD removal is 78%, and BOD is 73%.
- Hence the sugar industry wastewater can be efficiently treated by UASB Reactor.

**Scope for future study**

In future this reactor can be studied:

- By changing the filter media.
- By changing wastewater.
- By providing a mesh to separate the levels.
- By varying the HRT.
- By varying the dimensions of the reactor.
- By varying the parameters of the reactor.
- By varying the concentration of the reactor.

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