Anaerobic Treatment Of Wheat Straw Wash Water

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ABSTRACT

Black liquor management for small and medium mills based on agri- residues is still a problem, though several technologies are developed. One of the non conventional technologies being practiced by many of the mills is Modified Copeland Process.

Wheat straw contains high surface silica and chloride which create trouble in burning wheat straw black liquor in Copeland Reactor. To remove chloride and silica from black liquor, wheat straw is washed before pulping which generates wash water rich in various pollutants. COD and BOD of wash water varies from 3000-3500 and 1300-1600 mg/l respectively.

Conventional aerobic treatment is not very effective to treat Wheat straw wash water. However, anaerobic treatment works well. Experience with anaerobic treatment of wheat straw wash water based on UASB technology is discussed in the paper along with economics due to bio gas production and burning in boiler to generate steam and power thus, saving fuel. UASB process also controls the emission of Green House Gases generated during open lagooning of waste water.

Conventional Chemical Recovery system is adopted by large pulp and paper mills based on forest based raw materials but mills based on agro-residues are lacking due to the characteristics of black liquor generated in these mills. Various non conventional methods of chemical recovery were developed but none has attracted these mills except the Copeland process. Shreyans Industries Ltd. has gone for the first time in India to use Copeland Process. Based on the experience of Copeland process running in bagasse based mills, Shreyans Industries brought the technology, but it did not work well.

Wheat straw contains higher Chloride than bagasse, see table-I. During pulping most of the Chloride goes to black liquor which brings down the eutectic point of Sodium Carbonate being used as bed material in fluidized bed reactor of Copeland process. Lower eutectic point of Na_2CO_3 results in its agglomeration and hence, defluidisation of bed material suspending the process. The bed has to be cleaned and charged again to start the process.

To over come the problem of defluidization, experiments were carried out and it was found that washing of Wheat straw removes Chloride in black liquor making it suitable for using in Fluidized Bed Reactor. The wash water generated at Wheat straw washing is very rich in COD (3000-3500 mg/l) , B.O.D (1300-1600 mg/l) and Chloride 1000-1200 mg/l as NaCl. Effluent Treatment of Wheat straw wash water based on Conventional Aerobic system is difficult. Hence, anaerobic treatment was done in anaerobic lagoon. No doubt, pollution load was reduced and anaerobically treated wash water was made suitable for further treatment by aerobic method but, Green house gases (GHG) generated during anaerobic lagooning were released to the atmosphere. To check GHG emission UASB system is preferred due to bio gas collection and utilization is possible through this process. The bio gas generated in anaerobic treatment plant is a good fuel. Keeping Environment and Economy into view it was decided to go for anaerobic treatment of wheat straw wash water employing UASB system.

To the best of our knowledge, there was no UASB plant in operation to treat

Table-I
Chloride content in Agricultural residues.

Raw material	Chloride % as Nacl	
	As such	After Wet cleaning
Bagasse	0.1-0.25	-
Wheat straw	1.0-1.8	Below 0.3
Sarkanda	0.4-1.1	Below 0.2
Rice straw	0.5-0.8	Below 0.2

Table-2
Characteristics of Wheat straw wash water

Parameters	Waste water before anaerobic treatment	Waste water after anaerobic treatment	Reduction (%)
pH	6.0-6.5	7.0-7.3	-
Flow (m^3/day)	2000-3000	2000-3000	-
Chloride (mg/l as NaCl)	1000-1200	1000-1200	-
COD (mg/l)	2500-3500	800-1100	68
BOD (mg/l)	1100-1500	90-120	92

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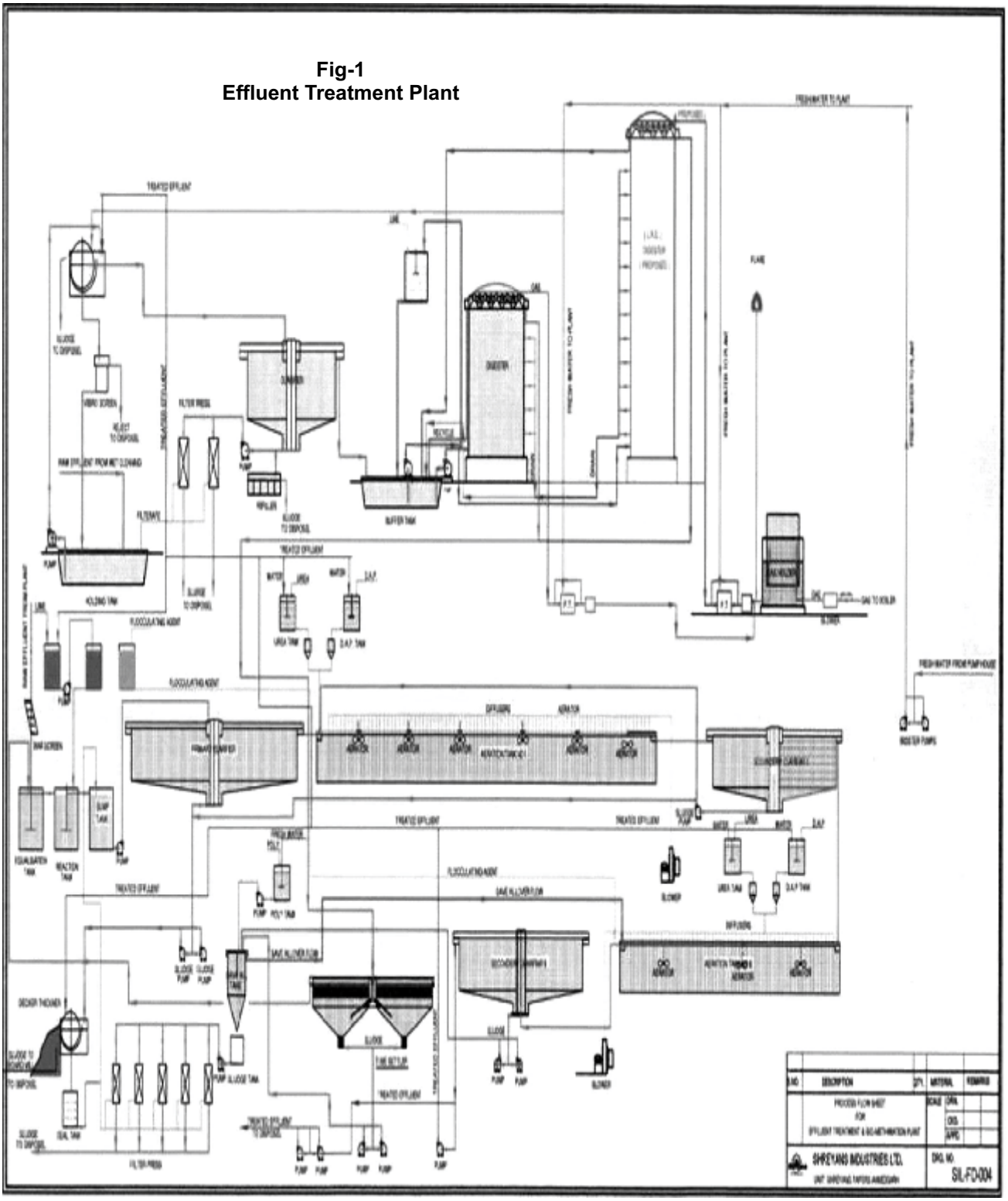
wheat straw wash water, though the system is working satisfactorily in Starch Industries, Distillery and Bagasse based pulp mill effluents. An experiment was done to find out suitability of wheat straw wash water treatment through UASB system. After getting encouraging results in laboratory an UASB plant was developed to treat Wheat Straw Wash water, collect the Bio-gas and utilize the same for co-generation. Plant is in operation since 2006. Characteristics of Wheat straw wash water before and after treatment in UASB is given in Table - 2.

Treatment system

As given in Fig.1 the wash water is collected in a tank from where pumped to Decker to remove contaminants such as carryover wheat straw and other impurities. Screened wash water is taken to Clarifier where suspended materials such as sand and silts etc are allowed to settle down. Underflow sludge is dewatered and disposed off. Clarified wash water is taken to Buffer tank, where lime is added, as per need,

Fig-1
Effluent Treatment Plant



to maintain pH. Recycled water from anaerobic digester also goes to buffer tank. Wash water is pumped from buffer tank to anaerobic digester's bottom through well distributed feed system. Wash water moves upward through anaerobic micro organism bed maintained in the UASB digester, where organic pollutants are converted into bio gas (CH_4+CO_2). The bio gas is separated from waste water at the top of digester. The bio gas is collected into a gas storage tank from where it is pumped to either boiler as a fuel or flare when there is no demand of fuel in boiler.

Anaerobically treated waste water overflows from the top of the digester and is taken to aerobic treatment plant through tube settler. In tube settler the sludge carryover with treated waste water is separated and sent to ETP sludge handling system.

Aerobic treatment plant consists of Equalization tank, Reaction tank, Bar Screen Feed Sump, Primary Clarifier, Aeration tank-I, Secondary Clarifier-I, Aeration tank-II, Secondary Clarifier-II and Sludge handling system.(Fig.1)

Parameters achieved in anaerobic treatment plant is given in Table-II

It can be seen that COD and BOD reduction during anaerobic treatment is about 68 and 92 % respectively. There is no change in Chloride and Colour by anaerobic treatment. Anaerobically treated waste water matches well with combined mill's effluent going for aerobic Treatment.

Before installation of UASB system wheat straw waste water was treated by anaerobic lagooning which takes a long retention time and bio-gas formed during lagooing was going to environment causing Green House Gas (GHG) effect. By adopting UASB system not only GHG release to environment is controlled but the gas is being utilized for generating energy by burning it in boiler. Equivalent quantity of fuel is saved.

Economics:

Taking Bio gas production
= 2000 Nm^3/day
Working days
=345
Methane content` in bio gas
= 67- 68%
Carbon dioxide in bio gas
= 31-32%
Hydrogen sulfide
= 1-2%
and water vapour etc in bio gas
Rice husk saving
=2.2 kg/Nm3 of bio gas
Cost of rice husk
= Rs.3500/T
Rice husk saving comes to
= Rs.53.13 lacs
Investment
= Rs.235 lacs
Return on investment
= 4.42 years

Bio methanation project is eligible for: Subsidy by Ministry of New and Renewable Energy, Government of India and Carbon trading under CDM scheme.

Benefits of anaerobic treatment of Wheat straw waste water is:

- Saves Environment
- Saves fuel
- Produces renewable energy
- Treats effluent on low cost
- Low maintenance
- Works as a profit centre

Points to be taken care of:

Wheat straw wash water contains carryover wheat straw which may choke the feed distribution system so it must be removed.

Wheat straw wash water contains sand, silts etc which are dead loads and must be removed. Also, it increases ineffective sludge in UASB digester.

System is very sensitive to temperature. Ideal temperature is 37-39 ^{o}C,which should be maintained.

System is sensitive to pH. pH in the vicinity of 7.0 should be maintained.

New Development:-

For Anaerobic treatment of effluent having COD 3000-5000 mg/l UASB is designed on Hydraulic Retention Time (HRT) basis. Normally for such effluents HRT varies from 24 to 36 hours.Higher digester volume is needed for providing 24 to 36 hrs. HRT. To reduce the volume of digester a pilot scale experiment was carried out at Shreyans Industries Limited in association with United Envirotech Private Limited (UEPL) ,Pune, taking wheat straw wash water as feed . Experiment was carried out to reduce the retention time in the digester and get result similar to that obtained in existing UASB. Specifications of Pilot scale Low Retention Digester (LRD) is given in Table-3.

It can be seen from the Table -3 that gas generation rate in LRD and UASB is same but retention time is quite low in LRD in comparison to UASB i.e. 37.5% of UASB.

Diameter being low LRD takes less area than UASB.

After having a successful pilot scale experimentation, Shreyans is going for a commercial scale low retention digester of 6 M diameter and 24 meter height.

Conclusion

Shreyans Industries Ltd. has gone for the first time to treat wheat straw wash water by UASB system. It was a technically successful and economically viable project.

Bio gas production varies in the range of 300-500 Nm3/T of COD reduced during digestion.

The UASB system reduces GHG emission when compared to open lagoon treatment. It reduces water pollution thus saves environment. It produces energy from waste and improves economy by saving fuel and Trading Carbon.

LRD takes less retention time as compared to UASB system to get similar results.

Table-3
Specifications of Pilot and Existing anaerobic digesters

Specifications	Pilot (LRD)	Existing (UASB)
Diameter of Digester(Mtr)	2.0	20.0
Height of digester(Mtr)	20.0	8.2
Volume of Digester (m3)	62.86	2577
Feed to Digester (m3/hr)	7.0	100.0
Retention time (Hrs)	8.98	25.77
Gas Generation(Nm3/day)	138	2000
Gas Generation(Nm3/hr)	5.75	83.3
Gas generation per cubic meter of feed(Nm3)	0.821	0.833