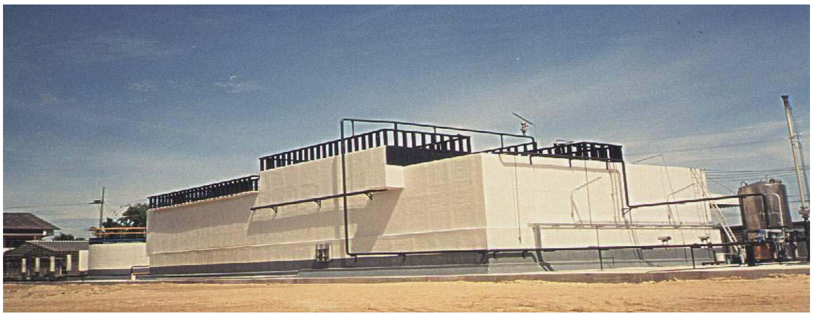
ANAEROBIC TREATMENT: SUSTAINABLE AND ECONOMICAL ENVIRONMENTAL SOLUTION FOR HIGH STRENGTH WASTEWATER



Thai Glucose Co. Ltd. Wastewater Treatment Plant

Industrial waste produced from the manufacture of starch, from the processing of carbohydrate foods, and from the industrial uses of starch is among the most difficult ones environmental engineers have had to treat[1]. Some industrial wastes that are high in BOD, COD and TSS can be stabilized very efficiently by anaerobic treatment[2]. Since waste from starch and other related industries fall into high strength category, several plants are now turning into anaerobic treatment as an alternative way of biodegrading their wastewater.

Thai Glucose Co. Ltd. in Nakornpathom, Thailand is among the plants that have adapted the anaerobic treatment system. A manufacturer of glucose syrup and dextrose monohydrate powder from tapioca starch, the plant generates approximately 3.7 m^3 wastewater per ton of raw material. Given the high concentrations of BOD and COD of the wastewater, the anaerobic system is the most appropriate technology that could handle such high loading efficiently.

naerobic Treatment Plant Design	
Parameter	Design Value
laximum Flow	)0 m^3/day
lydraulic Retention Time	)-24 hours
'OD Influent	,000-12,000 g/L
;OD Influent	,000-8,000 g/l
'OD Effluent	)0-1,200 mg/l
;OD Effluent	)0-800 mg/l
iogas Production	,160 m^3/day

ource: Enviroasia, Thai Glucose Co. Ltd.

The key advantage of anaerobic treatment is the ability to breakdown complex organic compounds at high concentrations.

1 Sawyer, Clair N. et. al. Chemistry for Environmental Engineering. Mc-Graw Hill Inc.Singapore, 1994.

2 Tchobanoglous, George and Franklin Burton. Wastewater Engineering: Treatment, Disposal and Reuse. Mc-Graw Hill Inc. Singapore, 1991.

Aside from handling high organic loading, benefits of an anaerobic system are low energy consumption, moderate investment cost, less space and production of a reusable energy - methane gas. The solid generation is minimal and easier to dispose unlike aerobic sludge. It also provides a steady performance under varying load and is suitable for seasonal operation.[3]

PLANT DESCRIPTION

In 2001, Enviroasia started a combined anaerobic and aerobic treatment plants at Thai Glucose Co. Ltd. The plant is processing 150 tons tapioca starch per day which corresponds to finished product in form of 20 tons dextrose powder and 120 tons glucose syrup.

The effluent from the factory passes a screen extractor to remove coarse solids, then flows into a gravity type oil/fat/scum separator. From there, the screened wastewater flows into a pump sump from where it is transferred to an equalization basin. This basin handles the occasional peaks of incoming wastewater and at the same time buffers the quality. The incoming COD is partially acidified in preparation to anaerobic digestion.

3 Olthof, M. and J. Oleszkiewics. “Anaerobic Treatment of Industrial Wastewaters”. Chemical Engineering, Nov. 1982 (121-126).

The pre-acidified wastewater is then pumped into the methane reactor. Correction of the pH of the incoming wastewater with sodium hydroxide is provided in order to maintain the optimal pH inside the reactor (6.5 - 7.5). Addition of urea and DAP (diammonium phosphate) was done since these compounds are deficient in the wastewater, particularly during the start-up period.

The methane reactor is a 4th generation Enviroasia - UASB (Upflow Anaerobic Sludge Blanket) reactor, proven reliable in practice (over 100 plants in Asia and the Pacific Region) and allows high loading rates.

In the methane reactor, the actual anaerobic purification takes place. The organic compounds present in the wastewater (sugars, etc.) are largely degraded by the anaerobic bacteria (sludge) and converted into biogas which is a mixture of methane and carbon dioxide. The wastewater enters the reactor at the bottom through a special distribution system, and leaves the reactor through a built-in performing three-phase separator, which allows separation of the treated wastewater, sludge and biogas. Absence of any mechanical agitation in the UASB reactor allows the natural selection towards heavy, granular sludge flocs of active methanogenic sludge.

The treated wastewater leaves the reactor via the overflow channel, part of which is being recycled back into the reactor to ensure sufficient mixing and the rest going to the aerobic treatment system for further polishing.

The biogas generated is deflected and collected into gas domes. During the start-up, the biogas was burnt in the emergency flare. Recently however, the biogas has since been used as fuel for the plant's steam boiler.

Effluent of the anaerobic treatment is further treated in an aerobic system, which consist of a low loaded activated sludge treatment, followed by a sedimentation step wherein the mixed liquor is separated into water and sludge. After final clarification, the treated effluent is discharged into a sewer.

The excess aerobic sludge and some of the generated anaerobic sludge is eventually dried in the sludge drying bed.

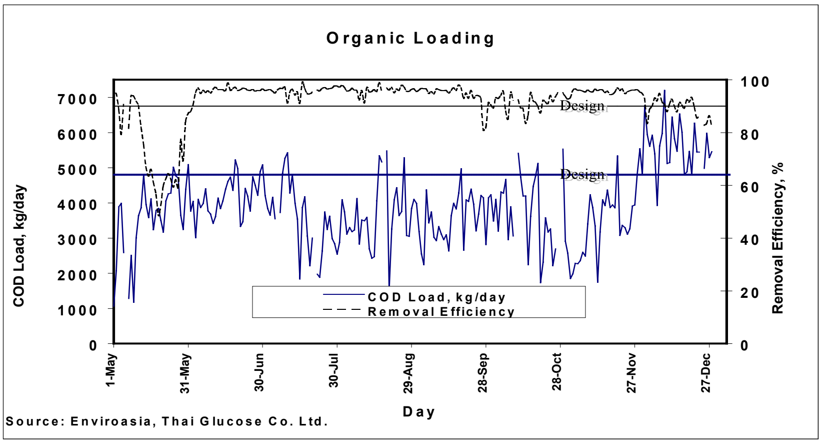
PLANT START-UP AND OPERATION

Operation of the wastewater treatment plant started in April 2001. The daily performance of the plant was monitored and evaluated for the first eight months.

Approximately 300 m^3 of a combination of sludge from an existing anaerobic reactor and the factory's existing aerobic lagoon was seeded onto the methane reactor.

Partial conversion of the organic compound into volatile fatty acids occur spontaneously in the equalization basin. This acidification in turn generates a pH between 4 - 5 in the basin. In order to maintain a neutral pH of the methane reactor influent, automatic dosing of sodium hydroxide solution is necessary in the start-up phase. During normal operation the biological conversion of the organic waste into biogas increases the pH naturally, so that NaOH consumption is minimized or eliminated altogether.

Loading to the UASB reactor was gradually increased during the first month of operation until the reactor was able to take all the



Performance Trend of the Wastewater Treatment Plant

wastewater coming from the factory. During the start-up, the COD and BOD concentrations of the incoming wastewater were frequently above the maximum design values (12,000 mg/l and 8,000 mg/l, respectively).

The performance of the reactor progressed, as it was able to acclimatize to the type of wastewater. The figure above shows the performance trend of the treatment system. The COD removal efficiency of the MUR in the first month yielded 74% then after a month of acclimatization it increased to 96% and above. Though the organic load is fluctuating the removal efficiency remains high thus indicating that the bacterial activity is already stable. The reactor was able to handle even as high as 147% design organic loading with good results.

The anaerobic effluent is further treated in the aerobic system prior to discharge into the sewers. This polishing brings down the COD concentration to as low as 64 mg/l and BOD concentration to about 10 mg/l. The corresponding overall organic removal efficiency of the wastewater treatment system is 99%.

ECONOMICS

The anaerobic system, which reduces the organic water pollution by 90-98%, allows moderate investment and very low to negative operating cost.

The monthly chemical cost of the wastewater treatment plant is approximately US $2,100. Manpower cost on the other hand, is approximately US $270 per month and energy consumption is roughly 10,500 kWh per month.

Whether an anaerobic system is economical depends on the amount of biogas the system produces. Biogas, particularly its methane content is a reusable energy and can be utilized to produce steam in the manufacturing plant. The operating cost for the wastewater treatment plant is compensated by the reuse of the biogas. The biogas generation of the wastewater treatment plant reaches as high as 3,216 m^3/day (at 147% load). With methane content of the biogas produced roughly 70%, the equivalent fuel oil is 2,026 liters/day. This corresponds to a fuel cost savings for the factory of approximately 30-40%.

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