COMPLETE SYSTEM FOR TREATING OIL- and FAT-RICH WASTEWATER

Thai Union Mfg. Wastewater Treatment Plant

Biological treatment of oil- and fat-rich wastewater (such as those coming from a fish canning plant) suffer a major set-back in the process due to coating of biological flocs sufficient to interfere with oxygen transfer from the liquid to the interior of the living cells. Thus, oil and fat tend to "smother" the cells[1]. Also, oil particles tend to make the active sludge float and render them ineffective in removing the organic wastes.

Thai Union Manufacturing Ltd. (Samut Sakhorn, Thailand), manufacturer of canned fish for both human and animal consumption, generates 3,500 m^3 of wastewater for 300 metric ton of fish processed per day.

Previous treatment systems have failed to meet Thai Government effluent standards.

TREATMENT PLANT

To meet their requirement, Thai Union commissioned Enviroasia Ltd. to design a treatment plant consisting of a combination of pre-treatment, anaerobic, aerobic and sludge treatment systems. This complete system greatly reduce the oil, suspended solids and BOD load of their discharge to the adjacent stream and meet the government standards

DESIGN SPECIFICATIONS		
Parameters	*Design*	
	Influent	*Effluent*
Flowrate (m^3/d)	6,000	
COD_t (mg/l)	6,000	< 120
BOD_5 (mg/l)	4,000	< 20
TSS (mg/l)	2,000	< 30
TKN (mg/l)	300	< 100
FOG (mg/l)	800	< 5

Pre-Treatment

A longitudinal static fat trap was installed after screening to reduce the fat content of the wastewater before biological treatment by providing a quiescent condition for oil flotation. A chain-driven scraper assembly (bottom and surface) provides removal of coagulated oil.

To enhance the biological treatment of the wastewater, an equalization basin is provided to homogenize/buffer the fluid for quality and quantity. The organic molecules are solubilized, hydrolyzed and converted to organic acids, mostly acetic, which is a direct substrate for the main bacterial community (i.e. methane-forming group) in anaerobic digestion.

Anaerobic Treatment

In the anaerobic digestion process, organics are converted biologically in the absence of oxygen into simpler end products principally methane and carbon dioxide[2]

Anaerobic digestion of this kind of wastewater serves a dual function of greatly reducing the oil and grease content of the liquid to be treated as well as protecting the active biomass (activated sludge) of a subsequent aerobic system.

This type of wastewater is best treated in an Upflow Anaerobic Contact (UAC) reactor, which is a hybrid of an Upflow Anaerobic Sludge Blanket (UASB) and a classic Anaerobic Contact (AC). This type of reactor with low loading rate can digest moderate amounts of fats and oil as well as suspended solids.

In the UAC process, the wastewater is introduced at the bottom of the reactor and flows upward through a sludge blanket composed of biologically formed flocs whereby treatment occurs as the wastewater comes in contact with the sludge. Treated effluent is collected in a holding tank for degasification, then passes through a specially designed external plate separator where treated effluent and bacterial sludge are separated. A provision for effluent recycle is provided to ensure a minimum upflow velocity inside the reactor required to maintain a sludge blanket. Also, solid retention time is maximized with this set-up.

For this particular project, Enviroasia provided two (2) 4,650 m^3 capacity cylindrical UAC reactors provided with a common holding tank and three anaerobic sludge separators.

The biogas produced is conveyed via a pipeline to the plant's steam boiler to supply a portion of their energy requirements.

Aerobic Treatment

TUM wastewater is also high in total nitrogen, owing to its high protein content. To cope with government requirements for nitrogen discharge, the wastewater undergoes a further nitrification-denitrification stage using the activated sludge process.

The effluent of the anaerobic reactors is subjected to extended aeration using a combination of surface and fine bubble aerators to ensure complete nitrification of the ammonia produced naturally during the earlier stages of treatment. A small by-pass of wastewater from the equalization basin is brought to the denitrification tanks is provided in order to maintain the minimum BOD to TKN ratio required for

[1] Sawyer et.al Chemistry for Environmental Engineering 4th Ed. McGraw-Hill p 603

[2] Metcalf & Eddy. Wastewater Engineering. 3rd Ed.,McGraw-Hill p436.

nitrification. Further BOD removal is also taking place in this stage.

The aerobic effluent is then recycled back to the denitrification basin at the start of the aerobic system where anoxic conditions are maintained. Nitrogen gas is produced there, which goes to atmosphere.

The activated sludge is separated from the mixed liquor in 2 circular sedimentation tanks called final clarifiers. The activated sludge is allowed to settle and is collected at the bottom, which is then pumped back to the denitrification basin.

Discharge characteristics (after clarification) can be found in table below.

FINAL EFFLUENT CHARACTERISTICS			
Para- meters	Effluent Guarantee	Government Standards	Actual Results
COD_t (mg/l)	120	120	117
BOD_5 (mg/l)	20	20	12.7
TSS (mg/l)	30	50	11.8
TKN (mg/l)	100	100	23.7
FOG (mg/l)	5	5	nil
pH (So)	6.5 - 9.0	5.5 - 9.0	6.55

Note: Based on a 2-week GUARANTEE TEST RUN Results

SLUDGE TREATMENT

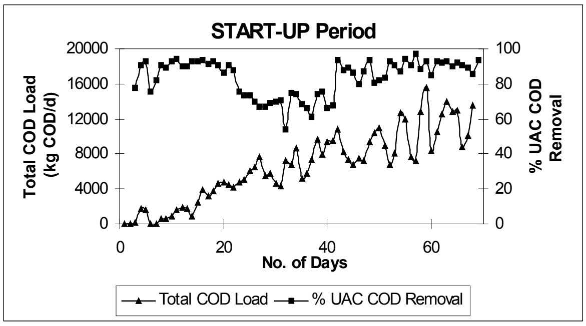
Fats removed by the fat trap, as well as excess aerobic (and occasionally anaerobic) sludge, is treated anaerobically in a Sludge Digester to decrease the volatile solids content of the sludge and to degrade fats to allow easy dewatering.

Two (2) existing belt presses were incorporated into the design for sludge dewatering purposes.

START-UP

The wastewater treatment plant started operation in January 2001.

The pre-treatment facility was operated so as to remove the solids and fat components, and to allow homogenization and acidification of the wastewater in the equalization basin. Before the wastewater enters the reactor, caustic soda or NaOH was dosed in order to keep the pH in the reactor near neutral (7.0-7.2).



The 2 UAC reactors were seeded with a total of about 1000 m^3 anaerobic sludge from an Enviroasia UASB reactor of a local brewery. During the first few weeks, organic loading to the reactors was progressively increased until 100% of the actual wastewater output of the factory was treated.

Shown in the chart above is the trend in COD loading for the first 3 months operation of the system and the corresponding COD removal efficiency. Note that in the first stages, the starting load was low. Gradual increase in loading was made possible by the increasing bacterial population and improving quality of sludge. Five weeks after the initial feeding all the wastewater was being treated in the system, load then varies depending on the organic concentration of the influent and the volume of wastewater output of the factory. Highest organic load reached during the start-up (based on the actual volume of wastewater generated in the factory) was about 75% of design load or about 16,000 kg COD/d.

Simultaneously, the aeration system was seeded by activated aerobic sludge from the past aerobic system used by Thai Union. All the wastewater not treated by the UAC reactors was directed to the aeration system until such time when loading in the UAC reaches its actual load. In order to sustain a minimum BOD/TKN ratio needed for the nitrification / denitrification process, a small by-pass of pretreated wastewater to the denitrification / aeration system is being maintained. With this set-up, growth and stabilization of aerobic sludge was hastened and shortly thereafter, the effluent already met the design parameters and the Thai government standards for discharge.

Eighty to ninety five percent of the organic pollutants in the wastewater, expressed in COD and BOD, are removed in the anaerobic treatment system. Meanwhile, about 90% of the fats and oil are also removed and digested in the UAC reactor, resulting to a nil FOG concentration after the aeration system.

Meanwhile, the Sludge Digester was started up without seed sludge, and it performs as much as 64% dry solids (DS) removal at 71% of the design load, and produces 0.5 m^3 biogas per kilogram DS removed.

Anaerobic wastewater treatment plants, coupled with aerobic treatment system (sludge treatment included), reduce pollution by as much as 80-99% with moderate investment costs. The biogas produced is a valuable by-product which when utilized, pays for the wastewater treatment plant's (and even partly of the factory's) operating costs.

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