1 Introduction

1.1 Background

Rapid industrialization and Urbanization has increased the generation of liquid wastes in high quantities. Discharge of domestic wastewaters, as well as industrial wastewaters having high concentrations of biodegradable organic compounds to the environment has given rise to environmental pollution in various aspects. The major aspects of this problem are water quality degradation of surface water bodies exceeding the natural assimilation capacity, ground water pollution and land pollution.

Therefore to overcome this problem it has become necessary to select and apply proper treatment technologies for this type of wastewaters. Although conventional wastewater treatment methods could be successfully used to treat domestic wastewaters having lower concentration of organic constituents and rich in macro nutrients (N, P), practically industrial wastewaters are difficult to treat using those methods due to the fact that industrial wastewaters have high organic loadings with low levels of nutrients. However, anaerobic wastewater treatment technologies are highly applicable to wastewaters in this nature, with lower nutrient requirement and ability to withstand high organic loading rates and high concentrations. In addition to the degradation of organic matter into simpler compounds, thus reducing the oxygen demand, the biogas produced could be used as an energy source.

1.1.1 High strength industrial wastewater

Industrial wastewaters are complex in nature, containing soluble, insoluble and/or potentially insoluble pollutants and compounds which may give rise to inhibition or toxicity, foaming or scaling. They can be categorized into different groups such as food processing, textile industry, chemicals and pharmaceutical production etc. The typical characteristics of industrial wastewaters are strong or high strength i.e. may be having very high BOD and COD levels or having high COD levels but low in BOD

depending on the type of wastewater. In addition, wastewater streams vary in terms of temperatures, acidity/alkalinity, inorganic chemical constituents and also exhibit diurnal and seasonal variations of ingredients. High SS content, irregular flow patterns; variations in wastewater quality; presence of toxic substances such as heavy metals are some limitations to treat them.

The definition of high strength wastewaters varies in literature. In general the wastewaters with COD higher than 1500 mg/l are regarded as high strength industrial wastewaters.

Type of Wastewater	pH	COD (mg/l)	TSS (mg/l)	Nitrogen	Phosphorus
Slaughterhouses	6.8-7.8	5400-11400	570-1690	0.019-0.074	0.007-0.0283
Dairy effluent	5.6-8	1120 -3360	28-1900		
Sugarcane	8.1	27600			
Distillery	3.8 - 4.4	70000-98000	2000-14000		

Table 1-1: Characteristics of some industrial wastewaters
Source: Rajeshwari et al., 1999

1.1.2 Treatment of wastewater

Generally a complete wastewater treatment system consists of a series of steps. This includes preliminary treatment designed to remove large and heavy solids, primary treatment designed to remove 45-70% of settle able solids but little or no removal of colloidal and dissolved organic matter, secondary treatment designed to remove about 85% of suspended solids and BOD_5 / COD, and advanced treatment designed to remove up to 99 percent of residual suspended solids and nutrients. (Journey and McNiven, 1996)

Most conventional wastewater treatment technologies are biological in nature and removal in such systems is carried out under aerobic conditions; for example activated sludge systems. In this system mechanical energy is used to mix the oxygen with bulk liquid (mixed liquor). The necessity of mechanical energy for mixing and aeration,

production of high proportion of sludge, application of lower volumetric organic loading rates are some of the major constraints to practically use this technology for treating high strength industrial wastewater.

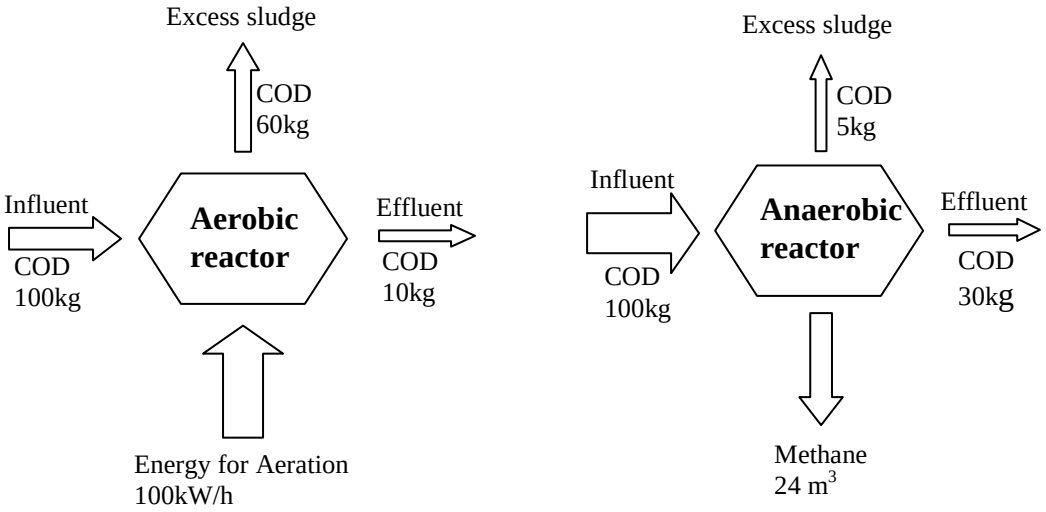

Figure 1-1: COD transformation and energy comparison between aerobic and anaerobic treatment processes
Source: Journey and McNiven, 1996

The use of anaerobic reactors to remove the most of the biodegradable organic constituents from the wastewaters results in relatively low production of more stable sludge than aerobic processes. However the effluent would contain biodegradable COD in certain amounts, which therefore would not comply with the discharge standards. In principle anaerobic treatment results an effluent quality between primary and secondary treatment. In spite of each system's own advantages and disadvantages, the anaerobic treatment systems are ideal to treat high strength industrial wastewaters since high strength wastewaters can be reduced to a level which can be handled by aerobic treatment with low costs.

1.2 Objectives

The present study attempts to develop design criteria for Upflow Anaerobic Sludge Blanket (UASB) reactor for the treatment of high Strength Industrial wastewater at the ambient temperature.

The specific objectives of the study were

- To investigate operational parameters providing successful operational conditions,
- To study the process performance and
- To study the problems encountered in the process

1.3 Scope of the study

Various kinds of anaerobic wastewater treatment technologies are available to treat high strength wastewaters. Anaerobic digesters, anaerobic ponds etc. have been successfully used in Sri Lanka to treat domestic wastewaters and even treating food industry wastewaters. UASB reactors are high rate anaerobic reactors, which have been successfully used in treating various types of wastewaters. However, in Sri Lanka only a few UASBs are in operation and even these are not operating at optimum conditions and maximum efficiency. Therefore, it was decided to select UASB since it is one of the least adopted technologies with very high potential in the local context.

Often anaerobic reactors are heated using heat exchangers and heat insulations to prevent heat losses. However, recent research has shown that UASBs could be successfully operated at ambient temperature while achieving higher efficiencies. Therefore the performance was studied at ambient temperature since it is less costly in applying at an industrial scale.

In this study, a synthetic food processing industry wastewater was tested considering the fact that the food processing industry is one of the Sri Lanka's leading industries Furthermore, UASBs have been utilized to treat food processing wastewaters in other countries such as the USA, Netherlands, South Africa and India.

1.4 Significance of the study

As explained earlier high strength industrial wastewaters are wastewaters containing high concentrations of COD. Although conventional treatment is economical and

efficient in treating municipal wastewater streams having low to fairly high COD concentration, in industrial wastewaters it is not so. In spite of that, most industries view wastewater treatment as an additional cost only. Nevertheless, the use of anaerobic wastewater treatment serves as an additional energy source.

It should be noted that food industry wastewaters are rich in BOD and COD, varying in the range of 5400 and 70000 mg/l, respectively as shown in Table 1-1. (Rajeshwari et al, 1999) In Sri Lanka upflow anaerobic filters are essentially used as anaerobic treatment techniques to remove BOD and COD from food processing wastewaters. However, in Sri Lanka development and application of anaerobic techniques that could withstand high flow rates and achieve higher BOD and COD removal efficiencies within shorter hydraulic retention times (HRT) are still in its infancy.