Chapter I

INTRODUCTION

Energy is indispensable and it is one of the prerequisites for the growth in the domestic, agricultural and industrial sector. Commercial sources like oil, coal and natural gas are the basic means with which the energy requirements are being met and utilized. In the recent years, natural gas prices have increased nearly by 150% as reported by Greenspan, 2003. Owing to the sharp increase in prices of commercial energy, there is a gradual but continual depletion in these scarce sources making it necessary to develop and exploit alternate sources of energy. Methane is accepted and is considered as one of the promising sources of alternate energy and this energy has been promoted by the National Biogas Programme, launched in 1980-81 to meet the existing as well as future needs of the rural areas.

Tannery waste disposal problem leads to environmental disharmony and contributes to be one of the major industrial pollution facing the country (Sarkar, 1941). According to Chandramouli (1998), there are close to 3000 tanneries in India, Of which 812 industries are situated in Tamil Nadu and there are 63 tanneries in Dindigul alone (Arora et al, 1975). Solid wastes from leather processing industry are posing eternal challenges and threat to their very existence. Fleshing and sludge are the two solid wastes emanating from tanneries. It is estimated that 30 to 40 percent of the weight of the raw skin comes out as solid waste- trimmings, shavings and fleshings. As per the data collected, the tanneries in the country generate 89,000 tonnes of fleshings per year and of this, about 140 tonnes of fleshing are generated in the tannery cluster of Vellore district everyday. Currently about 13 % of the world’s total output of leather comes from India and tanning
is the fifth largest industry in the country, fetching appreciable foreign exchange (Anuradha, 2000).

Twenty-five percentage of the weight of raw hides results in the finished leather whereas the remaining 75% becomes solid waste, of this, about 50% is utilized by manufacturers of poultry feed, gelatin, glue, fishmeal and soap and the remaining 50% is dumped indiscriminately.

The imprudent disposal of solid waste is a burning problem in lieu of the increasing demand of leather. India’s leather industry plays a pivotal role both as an earner of foreign exchange and provider of employment opportunities. Nevertheless, most of the tanneries do lack technical and financial resources to embrace modern technology especially in pollution abatement. As a result, the leather industry is compelled to compromise with obsolete and an inefficient technology, which in no way, contributes to environmental sustainability. It is neither advisable to store solid wastes too long on site due to the nuisance of smell and runoff of leachate during rains. The predicaments of disposal of sludge will further aggravate in the near future when the environmental quality standards for the solid waste disposal come into force. Presently there is no proper sludge disposal system in the tanneries. The dried sludge is removed from the sludge drying beds and disposed off in the tannery surroundings unwisely without any environmental consideration. Tannery industry pollutes the soil due to addition of various chemicals during the processing of the hides (Apparao and Karthikeyan, 1990; Jogdand, 1995).

The rapid depletion of vital natural resources and global warming are the two major burning issues that the world is facing. Leaving them unchecked would bring havoc and disaster to the human race. The atmospheric concentration of methane is increasing at the
rate of 1% per year and has more than doubled over the past two centuries (Safley et al, 1992). By digesting the organic matter in biodigesters, the methane can be tapped and used for generating energy. Anaerobic digestion of waste matter results in the production of biogas, which contains a high percentage of methane. Anaerobic digestion proves to be more advantageous in terms of efficiency of treatment as well as potential to produce energy. It is relatively odour free and the biosolids residue after anaerobic digestion is rich in nutrients and finds application as an organic fertilizer in agriculture (Pratapchandran et al, 2003). In addition, anaerobic digestion of industrial, agricultural and municipal wastes does prove to offer positive environmental value and this technology would be used enormously in the near future.

Currently there is extensive use of chemical fertilizers to strengthen the crop yield; however, this can cause serious environmental soil pollution. The sludge from the anaerobic digester is dried and sold as nutrient-rich manure (Down to Earth, 2002). Biodigested slurry is good manure, which is richer in all the three major nutrients, namely nitrogen (N), phosphorus (P2O5) and potassium (K2O). The economical aspects of tannery sludge as a fertilizer has been highlighted by Thortensen and Madhushah, 1979.

Biomethanation is the process of conversion of organic matter in the waste (liquid or solid) to biogas and manure by microbial action in the absence of air. Its calorific value is approximately 20 MJ per cubic meter or 4700 Kcal/m³ (Mathur and Rathore 1992). The prime advantage of such a technology is to recover energy, reduce the sludge volume, pollution load and remove odour. Biomethanation of biodegradable waste results in both energy generation and reduction of green house gas emissions (Arun Kansal, Rajeshwari and Kishore, 1998). The technology for biogas conversion to substitute natural gas is a
relatively simple one, and research on the utilization of biogas for thermal, electrical, and mechanical power generation is well established. Moreover, both industry and society are positioned to gain considerable economic and environmental benefits from implementation of this technology.

The solid wastes emerging from tannery industry does damage to the soil and groundwater in an inexplicable manner, when dumped in the open contaminates both surface water and ground water. The toxic metals emanating from the tannery industries were contaminating groundwater and soil (Tariq et al., 2006). To understand the environmental impact of leather tanneries it is necessary to understand the composition of animal hides, which consists of water (71.5%), proteins (7.2%), non-nitrogenous protein (1.5%), fat (11%), sodium chloride (3%), calcium carbonate (4%), sodium sulphide (3.0%) and other components, such as pigments. A hide can be divided into three structurally different parts, the epidermis, the dermis and the hypodermis. The epidermis contains hair mainly consisting of keratin and the dermis is the part that is normally considered to be skin, which is later transformed into leather; the main fraction of the dermis is collagen. The structure of the hypodermis is formed by horizontal fibers linked with blood vessels, muscles, fat, nerves, etc; the dominating fraction is flesh. For the transformation of a hide into leather, the epidermis, hair and flesh have to be eliminated. Total annual skins processed in India is 58.31 million and the waste both solids and liquid are discharged into the environment, inducing hazards to human and other aquatic organisms, making the land and soil unusable, the ground. The abnormal concentrations of total solids, hardness, chromium and chlorides in the discharged waste water renders the groundwater unfit for drinking, washing and irrigation (Kamini et al, 1999). Attention is paid
in particular to the effects of tannery waste on the region’s ground water in the context of the drinking water shortage, health hazards and the effects on agriculture and livestock (Muthu, 1992).

There are 63 tanneries situated in and around Dindigul town, all within five-kilometer distance from the heart of the town. All of these are connected to the Common Effluent Treatment Plant (CETP) situated near Senkulam Lake, Dindigul. Tamil Nadu is the front-runner in India in establishing Common Effluent Treatment Plants (CETPs) according to Environment and Forests Department, Policy note (2005-2006). Till now, proposals for 50 Common Effluent Treatment Plant schemes have been formulated. Of these 33 are under operation and 17 are under various stages of implementation. Government of Tamil Nadu has formed a joint sector company with Tamil Nadu Leather Development Corporation (TALCO) and Dindigul Tanner’s Association as partners in order to see that the functioning of the CETP, and run as Dindigul Tannery Environmental Control Systems (Pvt.) Ltd. The effluent treatment plant, which has been constructed near the Senkulam tank, can treat only the effluents from about 63 tanneries found as a cluster. Around 25,000 to 30,000 tonnes of hides are processed in Dindigul and it accounts to 6 to 7% of the total quality processed in India.

Prior to Common Effluent Treatment Plant the effluents were discharged to nearby lands affecting a radius of six kms and agricultural land were being affected by tannery pollutants every year is increasing by ten to twenty acres (Paul Baskar, 1992). Sludge volume form CETP (1095 tonnes per annum) is being land filled however, this option is only for a limited period of 10 years and its envisaged that before the end of the period a
cost-effective technical solution has to be found for using the sludge (TALCO Report, 1997).

This study explores in detail the treatment of biodegradable biosludge arising from tanneries to generate methane and study the nutrient value of the waste after biomethanation. Based on facts and available work done the present study has been attempted with the following objectives

- To evaluate the physico-chemical characteristics of tannery biosludge and fleshing viz., ash, moisture content, TS, VS, pH, EC, Total N, P, K, Organic Carbon, C:N and COD.
- To isolate, evaluate and select efficient bacterial strains having proteolytic and lipolytic activity.
- To identify the selected efficient strains using morphological, cultural and biochemical tests.
- To test the biological liquefaction of tannery fleshing using the selected proteolytic and lipolytic bacterial strains.
- To test the growth of the efficient isolates as influenced by pH and temperature.
- To test the effect of pH, temperature and incubation periods on proteolytic and lipolytic activity.
- To biologically liquefy the tannery fleshing using selected proteolytic and lipolytic bacteria to facilitate higher rate of biomethanation.
- To carry out anaerobic biodigestion of tannery fleshing and biological sludge for methane production and study various parameters.
- To test the digested slurry for its NPK and micro nutrient content.