ANAEROBIC-AEROBIC TREATMENT OF DISTILLERY WASTES

S. SHRIHARI and VINOD TARE*

Environmental Engineering Division, Department of Civil Engineering, Indian Institute of Technology, Kanpur-208016, India

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Abstract. In this study an attempt has been made to find a solution to the problem of disposal of distillery effluents through anaerobic followed by aerobic treatment. Accordingly, experimental studies were planned and carried out in two phases. The first phase experimentation was conducted to study the performance of Semicontinuous Fixed Film Anaerobic Reactors (SCFFAR) which simulate Downflow Stationary Fixed Film anaerobic reactors (DSFF) for partial treatment of distillery waste. Second phase experimentation included studies on degradation of anaerobically treated effluent employing semicontinuous aerobic reactors with sludge recycle. The results indicated that the distillery waste should be diluted to bring down the COD to about 50000 mg L⁻¹ before the same is treated by stationery fixed film anaerobic reactors and this dilution can be achieved by circulating the treated effluent. Further the reduction of COD beyond 9000 to 10000 mg L⁻¹ by anaerobic treatment appears to be uneconomical. Results of second phase of the study show that the aerobic degradation of anaerobically treated effluent can achieve significant COD reduction (approx. 67%). However, reduction of COD of final effluent below 500 mg L⁻¹ appears to be very difficult. The settling characteristics of the sludge produced in aerobic study depended on the BSRT value and improved with increase in BSRT.

1. Introduction

Distillery industries are among the major pollutors of the aquatic environment. Waste generated from distilleries is highly organic in nature. The basic question is no longer whether this waste can be anaerobically degraded to CH₄, since most organics are amenable to anaerobic treatment, but at what rate it is degradable, to what degree it is degradable, how the maximum yield of CH₄ can be obtained and also how the overall process can be made cost effective. The literature has been expounding the advantages of anaerobic treatment over other treatment methods particularly with the advent of the fixed film reactors. Voluminous literature is available on the application of fixed film anaerobic reactors for the treatment of high organic wastes and several reviews are available (Jewel, 1982; Henz and Harremoes, 1983; Seth, 1986).

India is a major sugar producing country in the world, having more than 330 sugar mills of which about 150 are integrated sugar-cum-distillery units. There are about 150 distilleries in India with an installed capacity of about 900 × 10⁶ L of alcohol resulting approximately in 10000 × 10⁶ L of spent wash per annum. It is estimated that the spent wash generated by these distilleries is equivalent to the pollution generated by 5 × 10⁵ persons.

Recent advances in solving the problem of disposal of liquid effluent generated by distilleries have led to the application of anaerobic retained biomass reactors. Several reactor configurations which promote biomass retention have been suggested. These

* Author for all correspondence.
include stationery fixed film, expanded or fluidized bed and upflow sludge blanket reactors. From an operational point of view, particularly under the present day Indian conditions, stationery fixed film reactors appear to be more suitable for the treatment of distillery wastes.

A review of the literature (Shrihari, 1987) indicates that most of the investigations were carried out employing USFF (Upflow Stationery Fixed Film) reactors while it is suggested that DSFF (Downflow Stationery Fixed Film) reactor may prove to be better for the treatment of distillery wastes. Therefore, one of the major objectives of the present research has been to employ a DSFF reactor for reducing the pollution potential of the distillery waste. Specifically, the studies were conducted to find answers to the following questions in an attempt to attain this objective:

(1) Is it viable to treat raw distillery waste (without any dilution) using DSFF anaerobic reactors?
(2) Is it advantageous to dilute the distillery waste before it is fed to the DSFF anaerobic reactors?
(3) If the answer to the above question is yes, then what should be the extent of dilution?
(4) To what extent can the reduction in organic strength (BOD/COD) of distillery wastes be achieved by application of DSFF anaerobic reactors?
(5) How much energy (CH$_4$) can be recovered in the process of reducing the pollution due to distillery effluents?

The main problem regarding safe disposal of distillery effluents is to treat large quantities of highly organic wastes to very low organic concentrations to satisfy the standards. The anaerobic treatment alone cannot solve this problem. Hence, it is essential that further treatment of anaerobically treated distillery effluents be considered. The literature available on this aspect of the problem is very scanty. There are very few studies (Lele, 1985; Lutskaya and Cherkashina, 1986; Tambe, 1986) reported which suggest aerobic degradation as polishing treatment. Thus the second objective of the present investigation has been to evaluate the treatability of anaerobically treated distillery effluents by aerobic degradation. Again, to achieve this objective the studies were directed to answer the following questions:

(1) Is it possible to significantly reduce the organic strength of anaerobically treated distillery effluents?
(2) How is the process efficiency influenced by varying biological solids retention time?
(3) What are the values of kinetic constants which are required for rational process design?
(4) How the settling characteristics of the mixed liquor change with change in biological solids retention time?