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Pollution effects of brewery wastes: Ruaraka river

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ABSTRACT

This paper reports the results of a two-year study on the pollutional effects of brewery wastewater on the Ruaraka River. As a preliminary investigation to an extensive river pollution study, samples were taken twice weekly between August 1988 and June 1990 from two sampling points immediately upstream and downstream of the point of discharge of the Tusker Brewery wastewater into the river. The samples were analysed for BOD and COD as well as other parameters.

The results of this preliminary investigation showed that whilst the average BOD of the river water was about 6.9 mg/l at the section just above the wastewater outfall, the average BOD of the river water at the sampling point immediately below the outfall was about 115.6 mg/l. Similarly, the average COD concentrations for the upstream and downstream sections were 34.7 mg/l and 240.4 mg/l respectively. If the brewery wastewater was treated in an anaerobic pond having only 45 per cent BOD reduction efficiency before discharge, it is estimated that the average BOD concentration of the river water at the downstream section would only be about 65mg/l. Treatability studies carried out on the wastewater showed that it would be possible to achieve a BOD reduction of 45 per cent or more in laboratory scale anaerobic pond units.

INTRODUCTION

Dilution in receiving waters is by far the most commonly used method for the ultimate disposal of wastewater effluents. The fundamental principle governing effluent disposal is to make treatment plants do part of the work and let nature complete it. Serious pollutional problems often arise when nature is called upon to do far more than its share of the work. This is presently the case with respect to the disposal of the wastewater effluent from the Tusker Brewery plant at Ruaraka, Kenya into the Ruaraka River.

Wastes from the brewery industries are known to have the advantage of containing materials with very high re-use values.

Herzka and Booth (ref. 1) listed the main by-products from brewing as; spent grains, surplus yeast, carbon dioxide, spent hops and broken glass from bottling operations. Broken glass is usually recycled to the bottle manufacturer whilst a limited amount of spoilt beer is used in vinegar manufacturing. Spent grains are sold wet to farmers for direct feeding to livestock while surplus yeast is reported to be useful to specialist manufacturers in manufacturing products such as: Marmite, Vitamin B tablets and savoury biscuits (ref. 1). Carbon dioxide, produced in large quantities from beer fermentation, is purified and liquefied for internal brewery use, beer dispensing, and carbonation of soft drinks. After all necessary measures have been taken to minimise the quantity and strength of the effluent through good housekeeping practise and recovery of by-products, there still exists a substantial volume of very strong effluent requiring disposal. Literature reports show that although the brewery industry produces large volumes of strong effluents, they are readily biodegradable (ref. 2).

The Tusker Brewery at Ruaraka

The Tusker Brewery located at Ruaraka (about 6 km from Nairobi City Centre) is the largest brewery plant in Kenya, producing about 2.25 million litres of beer per day. The raw materials used in the plant include malt, barley syrup, sugar cane, hops, water and yeast. The various unit operations in the brewing process are shown in the flow diagram (Fig. 1) below.

The malting plant is situated separately in Nairobi's industrial area and therefore its waste is not included in this investigation. The major wastewater generation activities at the Ruaraka plant are brewing, fermentation, bottling and washing. The only by-product recovery exercise currently undertaken at the plant is the recovery of broken glass, and wastewater is presently discharged into the Ruaraka River without any form of pretreatment.

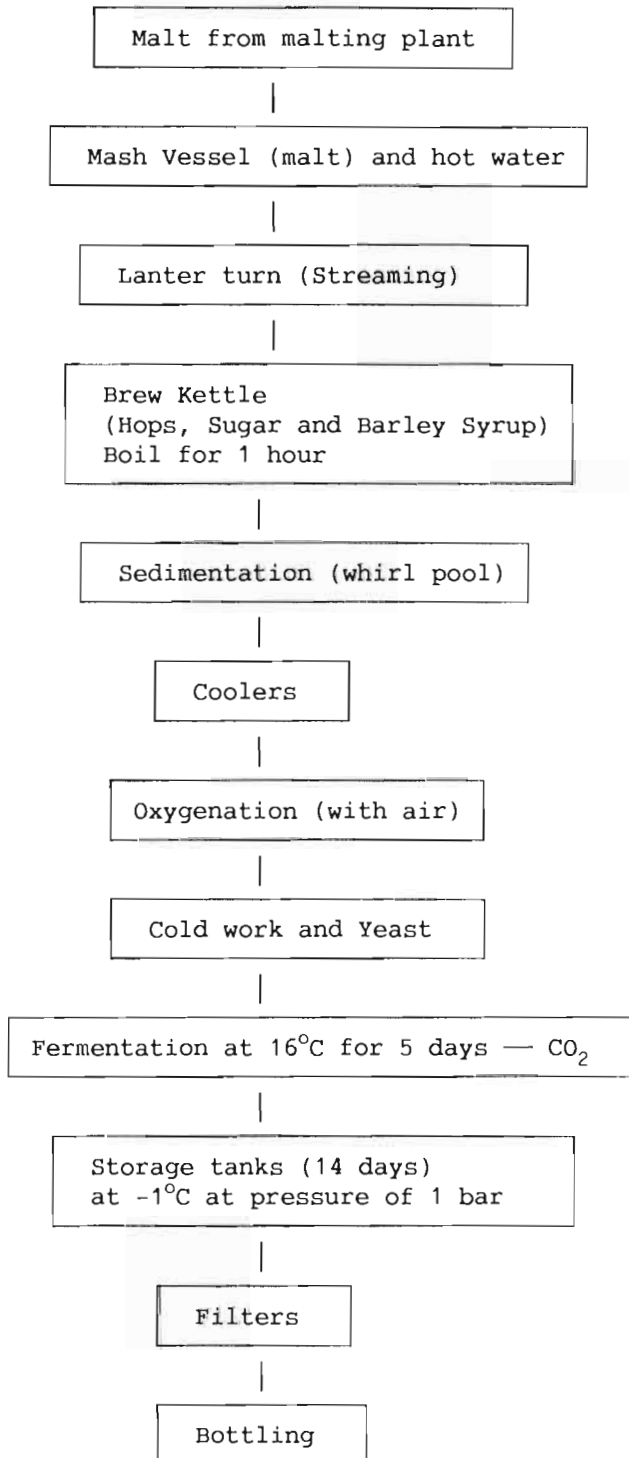


Fig 1. Flow diagram of the production process at the Tusker Brewery.

EXPERIMENTAL INVESTIGATIONS

The various investigations that were carried out concurrently include: routine monitoring of the river water quality immediately before and after the point of discharge of the brewery effluents;

monitoring the characteristics of the brewery wastewater; and treatment studies of the wastewater in laboratory-scale anaerobic ponds.

River quality monitoring

Samples were taken from the river at points immediately upstream and downstream of the point of brewery wastewater discharge and analysed for BOD, COD, SS and DS. This was carried out twice a week, from August 1988 to June 1990 and the results obtained form the basis of discussion presented in this paper.

Brewery wastewater sampling and analysis

Between October 1988 and May 1989, samples were collected from the Tusker Brewery plant twice a week and analysed for Biochemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Suspended Solids (SS), Dissolved Solids (DS), pH, alkalinity, nitrate and Nitrate nitrogen, albuminoid ammonia, and chloride contents.

Treatment studies

A laboratory model anaerobic pond (dimensions 0.2 m x 0.4 m x 0.6 m deep) was used for the treatment of the brewery wastewater. During start-up the pond was initially half filled with raw sewage from Kariobangi sewage treatment works and topped up with the brewery waste. The pond was then completely covered with black polythene sheets and left for about two weeks before continuous feeding with the brewery waste commenced. Sampling of the influent and effluent of the pond commenced a week after continuous feeding began. The samples were analysed for BOD, COD, SS, pH, and alkalinity in accordance with the Standard Methods for the Examination of Water and Wastewater.

RESULTS AND DISCUSSION

Detailed discussion on the results of the investigation covering the characteristics and treatability of the brewery waste has been presented in earlier publications (ref. 3 and 4). The results showed that the average BOD concentration for the brewery wastewater was 6800 mg/l while the average BOD concentration of the effluent from the laboratory model anaerobic pond, operating at an average 5-day detention time, was 3700 mg/l.

Discharging the untreated wastewater into the river gives the river water characteristics shown in Figures 2,3, and 4 for the upstream and downstream sections.

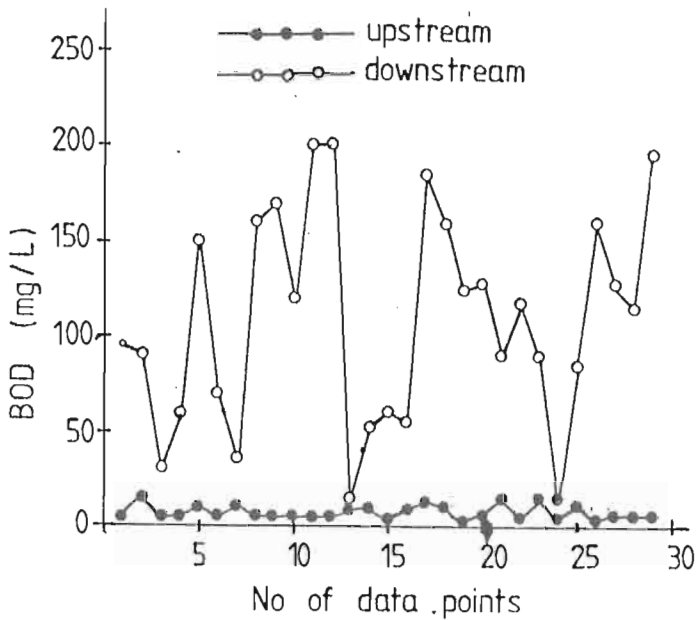


Fig 2 - Variations in BOD at the upstream and downstream sections of the discharge point

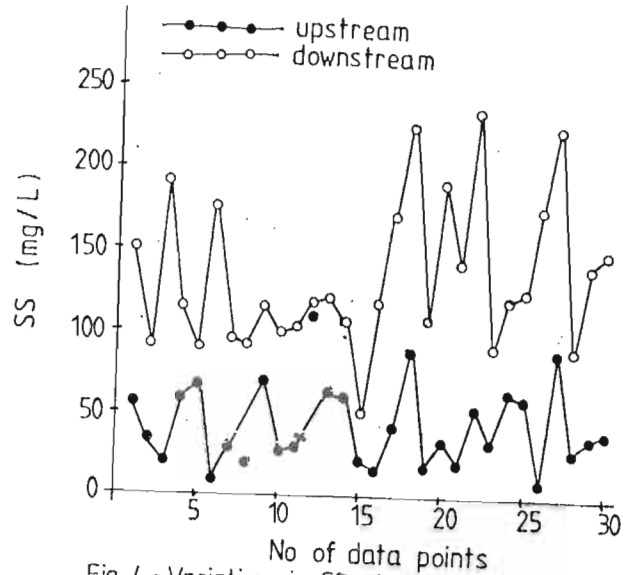


Fig 4 - Variations in SS at the upstream and downstream sections of the discharge point

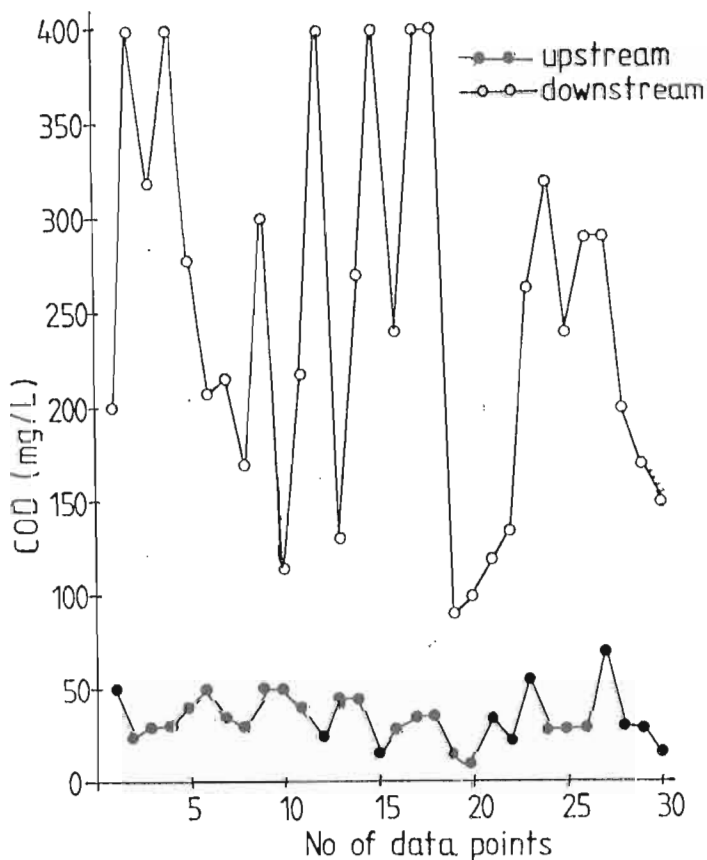


Fig 3 - Variations in COD at the upstream and downstream sections of the discharge point

The average BOD concentration of the river water at the sampling point immediately downstream of the point of discharge was 115.6 mg/l as compared to an average upstream value of 6.9 mg/l. Analysis showed that if wastewater was to be treated in an anaerobic pond prior to discharge, the expected average BOD of the river water at the downstream section would be about 65 mg/l. Following through the analysis down the river channel produced the BOD profiles shown in Figure 5. It is clear from the analysis that with the current practice of discharging the effluent untreated, the river would only attain a BOD level of 65mg/l at a distance of more than 7 km from the point of discharge, assuming that its assimilative capacity is not already exceeded by the heavy organic load.

CONCLUSION

It was generally observed that the management of Tusker Brewery plant had little or no knowledge of the characteristics of the wastewater being generated from the industry. This study has shown that the brewery wastewater is biodegradable and a simple treatment in an anaerobic pond with only 45 per cent BOD reduction efficiency is sufficient to avert the serious pollutional problems currently caused to the Ruaraka River by the wastewater.

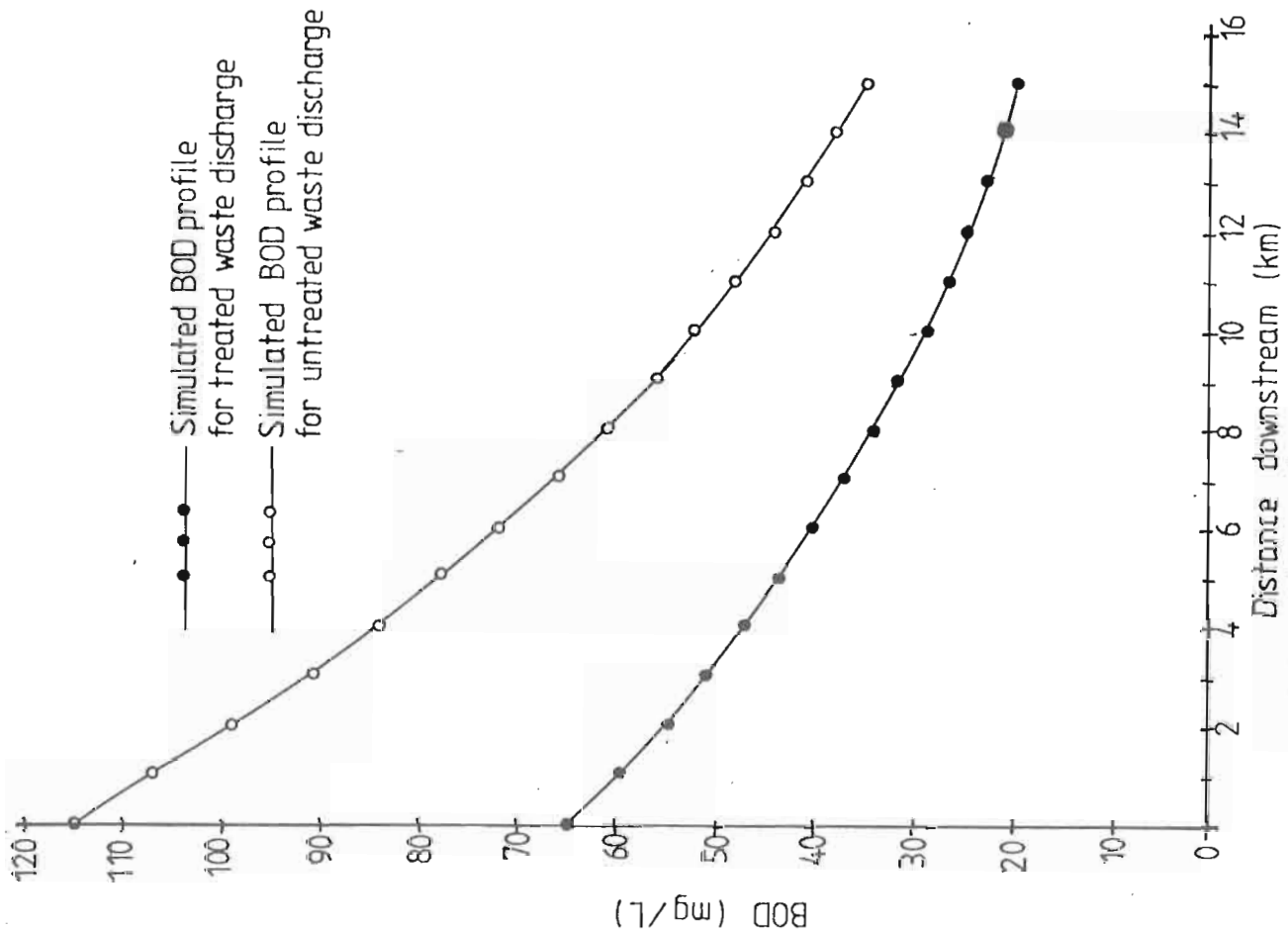


Fig 5 Simulated BOD profiles for Ruaraka River

It is appropriate to point out that sampling of the river water at different sections downstream is continuing and the results will be useful in developing mathematical models for the pollutional profile of the river.

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