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# Distillery Effluent Treatment Using Membrane Bioreactor Technology Utilising Pseudomonas Fluorescens

**M. M. Manyuchi[1], E. Ketiwa[2]**

[1]Department of Chemical and Process Systems Engineering, Harare Institute of Technology, Belvedere, Harare, Zimbabwe

[2]Department of Chemical and Process Systems Engineering, Harare Institute of Technology, Belvedere, Harare, Zimbabwe

[1]mmanyuchi@hit.ac.zw

***Abstract*— Distilleries produce vast amounts of contaminated effluents which if disposed to the water bodies will pose environmental problems hence need to treat this effluent. A membrane bioreactor with Pseudomonas fluorescens as a decolorizing micro-organism was employed for treatment of distillery effluent over 10 days. The effluent pH changed from being acidic (4.2-5.0) to neutral (7.3-8.0). The effluent BOD, COD, TDS and TSS was significantly reduced by more than 90%. The membrane bioreactor sufficiently improved the effluent water quality parameters due to the degradation of the organics and removal of the suspended matter through microfiltration. Membrane bioreactor technology can be used for treatment of distillery effluents.***

**Keywords— Distillery effluent, membrane bioreactor, *Pseudomonas fluorescens*, water treatment**

## I. INTRODUCTION

Membrane bioreactor technology is increasingly becoming popular as a wastewater treatment method [1]-[2]. Membrane bioreactor technology degrades organic microorganisms in the wastewater using various microorganisms in the bioreactor [1]. The micro-organisms and suspended matter are then removed from the treated water by filtration on the membrane part [1]. Membrane bioreactor technologies have higher performance, lower space requirements and sludge production [3]. Membrane bioreactors have been reported to reduce the wastewater biological oxygen demand (BOD), chemical oxygen demand (COD), total dissolved solids (TDS) and total suspended solids (TSS) [4]-[5]. BOD is the amount of dissolved oxygen needed by aerobic biological organisms in a body of water to break down organic material present in a given water sample at certain temperature over a specific time period [5]-[7]. COD describes the amount of oxidisable matter in effluent i.e. organic/inorganic compounds that deplete/use up dissolved oxygen in water [5]-[8]. TDS is a measure of the amount of material dissolved in water which may include carbonate, bicarbonate, chloride, sulfate, phosphate, nitrate, calcium, magnesium, sodium, organic ions, and other ions [5]-[6]. TSS refers to all particulate matter suspended in water [5]-[8].

This study therefore applied the membrane bioreactor technology in the treatment of distillery effluents from Afdis, a wine distillery company as a measure to control the effluent characteristics before disposal. The BOD, COD, TDSS and TSS were out of the set range such that the disposal of this distillery effluent will pose environmental problems when disposed into other water bodies (see Table 1) [9].

TABLE 1: DISTILLERY EFFLUENT AND WATER QUALITY CHARACTERISTICS

| Quality parameter | Distillery effluent | Limit value |
|---|---|---|
| pH | 4.2-5.0 | 6.0-9.0 |
| BOD (mg/L) | 43510-44090 | 30 max |
| COD (mg/L) | 38970-41090 | 200 |
| TDS (mg/L) | 76450-79430 | 30 max |
| TSS (mg/L) | 30100-34320 | 30 |

## II. MATERIALS AND METHODS

### *A. Materials*

A membrane bioreactor with an externally configured membrane was used. The membrane bioreactor had a working volume of 50L, hydraulic retention time of 10 days, solid retention time of 50 days and an average temperature of 23◦C. A MD020TP2N organic propylene membrane with a pore size of 0.2µm was used. Organic membranes have high pH tolerance. The membrane had an inner diameter of 6mm, outer diameter of 10 mm and length of 600 mm. The trans-membrane pressure was 0.6 bars [10]. Oxygen was supplied by air at 0.8 vvm (volume of air per volume of reactor per minute). The experimental set up is indicated in Fig 1 [11].

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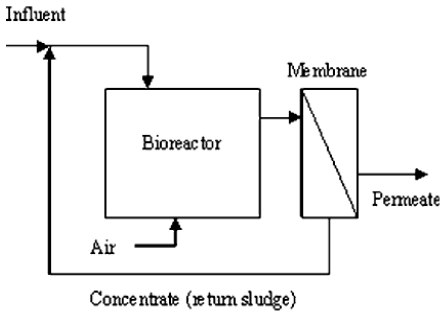


Fig 1: Distillery treatment experimental set up [11]

*B. Methods*

The raw distillery effluent which was dark brown in color was analyzed for pH, $BOD_5$, COD, TDS and TSS. At day 10 of treating in the membrane bioreactor the same water quality parameters were tested. The pH was measured by an AND Hanna Instrument. The $BOD_5$ was determined by the standard oxidation procedure after 5 days at 20◦C whilst the COD and turbidity were also determined by a Shimadzu *uv-vis* spectrophotometer according to procedures clearly explained in detail by Manyuchi *et al*., [6]-[8] The TDS and TSS were determined by filtration through a 0.45µm filter and the amount of solids removed was determined by drying at 100°C. *Pseudomonas fluorescens* was used as the decolorizing micro-organism as it has potential to lower the turbidity by more than 90% [5].

## III. RESULTS AND DISCUSSION

A colourless treated distillery effluent was obtained at the end of the 10 days. The change in the effluent colour was attributed to the *Pseudomonas fluorescens* bacteria employed as a decolorizing agent.

*A. Changes in pH*

The pH in the treated distillery effluent increased by 99.2% from being acidic to almost neutral upon passing through a microfiltration membrane bioreactor (see Fig 2). The pH of the treated effluent was in the required range for allowed water guidelines of pH range 6.0-9.0 [9]. This was probably due to the reduction in ions in the solution after the membrane bioreactor treatment.

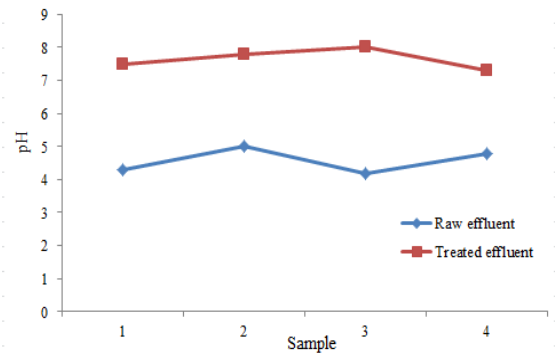


Fig 2: pH changes in the raw and treated distillery effluent

*B. Changes in BOD*

The $BOD_5$ in the treated distillery effluent significantly decreased by 96% upon passing through a microfiltration membrane bioreactor (see Fig 3). Although the remaining $BOD_5$ was still on the high side for disposal in the water bodies, the membrane bioreactor was efficient in reduction of the $BOD_5$. High $BOD_5$ levels reduces the oxygen quantity in receiving water bodies affecting aquatic life [12].

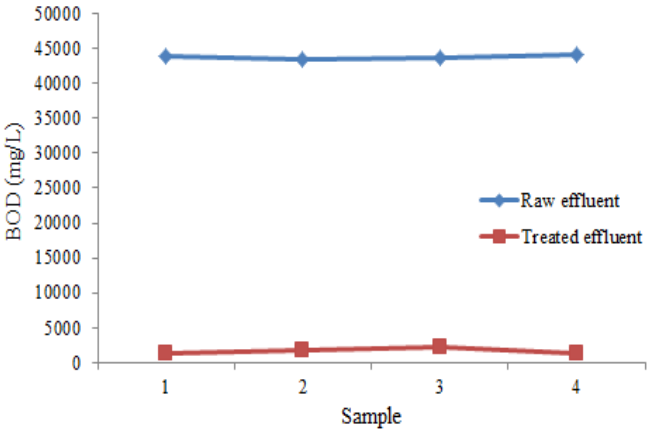


Fig 3: BOD changes in the raw and treated distillery effluent

*C. Changes in COD*

The COD in the treated distillery effluent decreased by 98% upon passing through a microfiltration membrane bioreactor (see Fig 4). The set up managed to remove non-biodegradable contaminants without the use of chemicals.

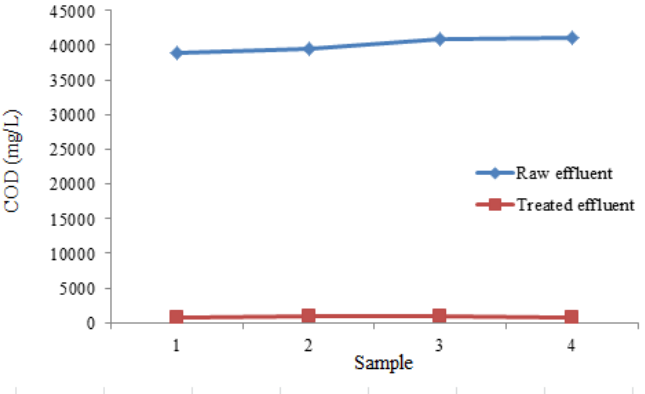


Fig 4: COD changes in the raw and treated distillery effluent

*D. Changes in TDS*

The TDS in the treated distillery effluent significantly decreased by 97% upon passing through a microfiltration membrane bioreactor (see Fig 5). The TDS reduced as these were converted to sludge in the bioreactor and the minute particles did not pass through the membrane. High TDS values upon disposal into receiving water bodies results in discoloration of water increasing its turbidity [12].

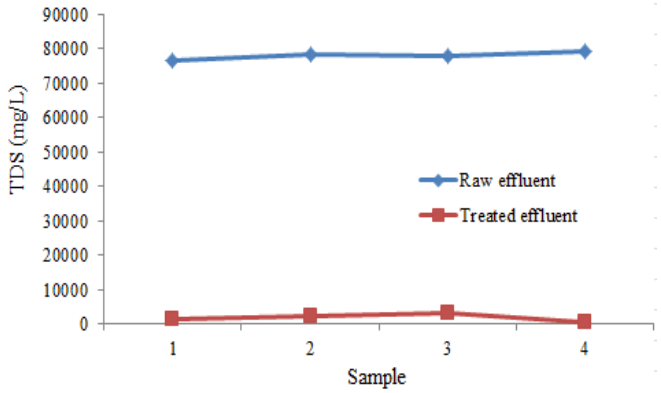


Fig 5: TDS changes in the raw and treated distillery effluent

*E. Changes in TSS*

The TSS in the distillery effluent decreased by 99.8% upon passing through a microfiltration membrane bioreactor (see Fig 6). The TSS reduced as these were converted to sludge in the bioreactor and the minute particles did not pass through the membrane. High TSS values upon disposal into receiving water bodies results in discoloration of water increasing its turbidity [12].

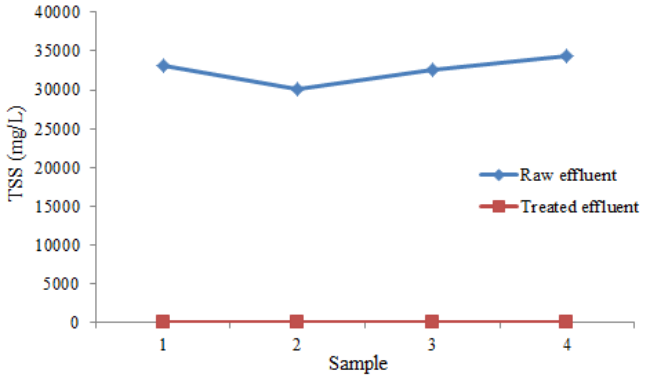


Fig 6: TSS changes in the raw and treated distillery effluent

## IV. CONCLUSION

The membrane bioreactor technology can be successfully used for reducing unwanted water pollutants from distillery effluent. The TDS, TSS, BOD and COD composition was significantly lowered by more than 95%. In addition, the distillery effluent's pH was changed from being acidic to neutral.

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