



Are centralized MBRs coping with the current transition of large petrochemical areas? A pilot study in Porto-Marghera (Venice)

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H I G H L I G H T S

- ▶ Wastewater from large petrochemical areas are becoming very variable in EU and USA.
- ▶ MBR can safeguard effluent quality under sudden and drastic transient conditions.
- ▶ Ammonification of recalcitrant organic compounds affected total nitrogen removal.
- ▶ Underloaded MBRs promptly improved nitrification rate due to NLR increase.
- ▶ Spent caustic soda and refinery effluents played major nitrification inhibition roles.

A R T I C L E I N F O

Article history:

Received 31 July 2012

Received in revised form 11 October 2012

Accepted 19 October 2012

Available online 26 October 2012

Keywords:

Membrane bioreactor

Configuration

Petrochemical wastewater

Inhibition

Nitrification–denitrification

A B S T R A C T

The operation of a pilot scale membrane bioreactor (MBR) provided feedback for the world's largest centralized MBR plant treating petrochemical wastewater, located in the industrial area of Porto-Marghera, Venice. The main objective was to study the robustness of MBR technology under variable operating conditions of the petrochemical industry. We aimed to reduce the idle volumes of biological reactors and to enhance biomass activity. Five runs were conducted, initially aiming to represent the operating conditions of the full scale MBR and then alternations were introduced, including the addition of more external carbon source, the reduction of the anoxic compartment volume, changes in configuration and an increase of influent load. Ammonification was not effective in the pre-denitrification configurations, since the average organic nitrogen removal ranged from 29% to 60%. Nitrification was very satisfactory since ammonium concentration was usually lower than $0.5 \text{ mg NH}_4\text{-N L}^{-1}$. Increased acetic acid addition was effective, as it enhanced oxidation activity and denitrification rate. The reduction of the anoxic reactor volume and the abolition of internal recycling resulted in a decrease of denitrification rate. Petrochemical wastewater composition affected the biological processes of ammonification and denitrification. The low denitrification during the nitrification, post-denitrification configuration was attributed to the low organic carbon to total nitrogen ratio of influent wastewater. The doubling of inflow rate did not significantly compromise permeate quality. The MBR demonstrated to safeguard the effluent quality even under sudden and drastic transient conditions. Caustic soda caused inhibition of nitrifiers by 56% and refinery wastewater up to 60%.

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1. Introduction

Petrochemical refinery industries produce large amount of wastewater resulting from several processes including vacuum distillation, desalting, catalytic cracking, hydrocracking, catalytic reforming, alkylation, isomerisation, hydroskimming [1–3]. When

refineries are associated with chemical manufacturing, several chemical components can be present in effluents apart from hydrocarbons and other compounds of oil processing. Spent caustic soda and other hazardous wastes can be generated in significant quantities [4]. Thus, a variety of contaminants are present that must be adequately removed [5,6]. Petrochemical wastewater is usually characterized by significant concentrations of suspended solids, chemical and biochemical oxygen demand (COD, BOD), oil and grease, sulfide, ammonia, phenols, hydrocarbons, benzene, toluene, ethylbenzene, xylene, polycyclic aromatic hydrocarbons (PAHs)

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