

Treatment of Petroleum Refinery Wastewater by using UASB Reactors

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Abstract—Petroleum refineries discharged large amount of wastewater -during the refining process- that contains hazardous constituents that is hard to degrade. Anaerobic treatment process is well known as an efficient method to degrade high strength wastewaters. Up-flow Anaerobic Sludge Blanket (UASB) is a common process used for various wastewater treatments. Two UASB reactors were set up and operated in parallel to evaluate the treatment efficiency of petroleum refinery wastewater. In this study four organic volumetric loading rates were applied (i.e. 0.58, 0.89, 1.21 and 2.34 kg/m³·d), two loads to each reactor. Each load was applied for a period of 60 days for the reactor to acclimatize and reach steady state, and then the second load applied. The chemical oxygen demand (COD) removals were satisfactory with the removal efficiencies at the loadings applied were 78, 82, 83 and 81 % respectively.

Keywords—Petroleum refinery wastewater, anaerobic treatment, UASB, organic volumetric loading rate

I. INTRODUCTION

PETROLEUM refineries now more than ever are motivated by cheaper, cleaner and safer treatment processes and are choosing wastewater treatment methods that are simple, reliable, time effective and cost saving to ensure that they meet the regulatory discharge limit of effluent. Petroleum refineries wastewater contains high level of pollutants and are characterized by the presence of large quantities of oil products and chemicals [1] (e.g. BTEX and phenol). Biological treatment processes are economical and efficient methods and being used to treat the wastewater from oil industry [2].

Petroleum refinery wastewater treatment attracted researchers to provide reliable biological treatment process. Petroleum refinery wastewater and its major components such as phenols and BTEX has been studied to investigate the treatment efficiency by using aerobic, anaerobic and anoxic or a combinations of two or more biological conditions [3, 4, 5, 6].

Many toxic and recalcitrant organic compounds found in petroleum wastewater are degraded under anaerobic conditions, with the compound serving as a growth substrate [7]. The up-flow anaerobic sludge blanket (UASB) reactor is a proven process and its advantages are high organic loadings and relatively low detention time possible for anaerobic treatment, and the elimination of the cost of packing material.

The UASB process has proven highly effective for the treatment of medium- and high-strength wastewaters within a wide range of hydraulic retention time (HRT) (3–48 h), and steady state conditions are generally able to predict the parameters that have been considered in mass balance relations [8].

UASB reactors have been successfully used to treat two types of wastewater, wastewater containing non-inhibitory substrates such as sucrose, and wastewater containing inhibitory substrates such as phenol which is one of the recalcitrant compounds that present in petroleum refinery wastewater [9].

II. BACKGROUND

Synthetic wastewater containing phenol was treated under anaerobic thermophilic condition (55°C), the results showed that removal was 99 % at 40 h HRT for a wastewater containing 630 mg/L of phenol, corresponding to 1500 mg/L of chemical oxygen demand (COD) and a loading rate of 0.9 g COD/L·d. [4].

Four UASB reactors were operated successfully with petroleum refinery wastewater at low organic loading rate (0.05-0.1 kg COD/m³·d). The organic loading rates were then gradually increased to about 2, 1.5, 0.5 and 1.5 kg COD/m³·d for the reactors, at an influent COD of about 220 mg/L and hydraulic retention times of 2.5, 4.5, 8.5 and 4.5 hours respectively [10].

A UASB reactor operated with petroleum refinery wastewater at a high HRT (48 h) and influent COD (500 mg/L) at a constant organic loading rate (OLR) of 0.4 kg/m³·d, COD removal was 81 %. The rate of biogas production increased when HRT increased; the biogas production rate was 559 mL/h at HRT of 40 h and an influent COD of 1000 mg/L [8].

In an experimental study investigating the influence of organic loading rate (OLR) on the efficiency of a UASB bioreactor treating a canning factory effluent, the chemical oxygen demand (COD) was increased stepwise from 2300 to 4000 mg/L. The hydraulic retention time was kept constant at 24 h and the OLR increased from 2.28 to 3.95 kg COD/m³·d. The highest COD removal (92 %) was reported at OLR 2.5 kg COD/m³·d [11].

The biodegradability of a local petroleum refinery wastewater was studied previously [12]. The wastewater was ultimately biodegradable in a mixture with mineral nutrients and sludge in a single batch run for 28 days. Anaerobic

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