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Research Article

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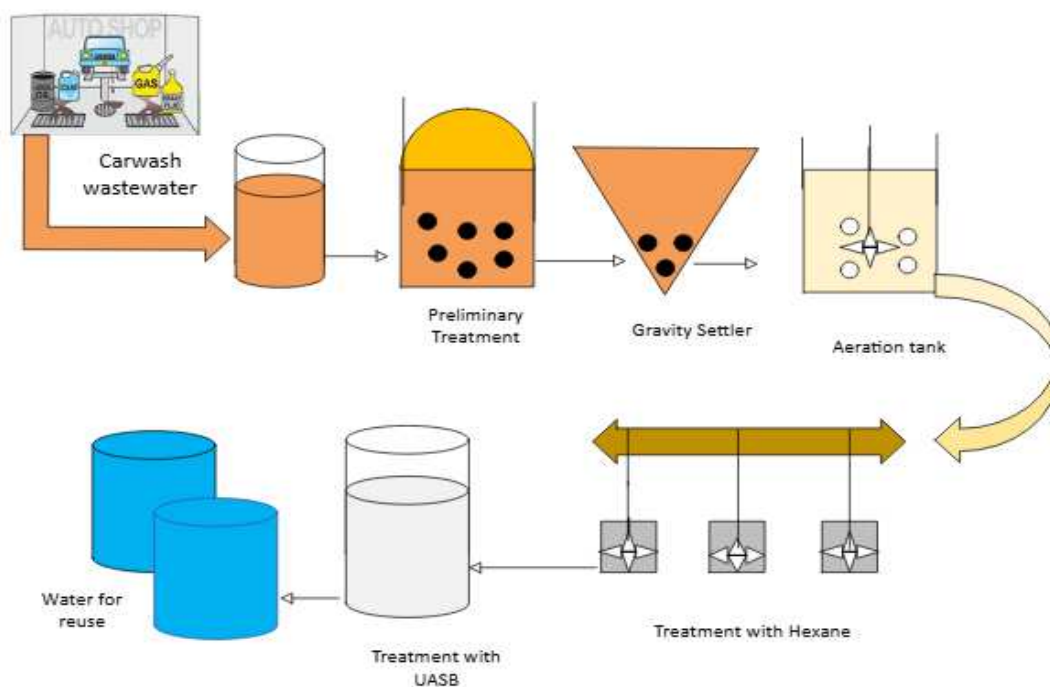
Integrated treatment system and removal of oil contents for carwash industry wastewater using hexane and UASB reactor

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Graphical Abstract



ABSTRACT

Car wash industry wastewater contains many obnoxious pollutants which need to be removed to achieve EPA standard. Almost 100 liters of water consumed to clean a car which goes to sewage after washing. Major components are oil, grease, detergents and solid particles which need to be removed before discharging into sewage lines. This waste water is treated, both chemically and biologically for a comparison. An up flow anaerobic sludge blanket (UASB) treatment option was proposed for biological treatment. The reactor was fed with trace element and glucose as carbon source for two weeks. Later on it was shifted to treat carwash industry wastewater. Chemically a simple treatment option was proposed as, n-hexane treatment and sand filtration. Before both treatments Natural sedimentation (NS) was allowed for 3 hours where 80% solids were removed followed by aeration. To oxidize the oil contents n-hexane was used and 90% oil contents, 95% COD and BOD was reduced. By feeding to UASB, It was observed 98% COD, 97% BOD and 85 % turbidity was removed. Proposed treatment system of NS, aeration and UASB reactor was successful to removed COD up to EPA acceptable standard.

Keywords: Car wash wastewater, n-hexane, chemical oxygen demand, biological oxygen demand, turbidity, UASB.

1. INTRODUCTION

Wastewater from car washing stations contains a number of impurities such as sand and dust, free oil, grease, oil/water emulsion, carbon, asphalt, salts, surfactants and organic matter, which is discharged directly into municipal sewage treatment plant [1]. Due to the amount of the water and complexity of the water quality, from a viewpoint of environmental protection, reuse of carwash water is an important subject. Therefore effective and cheap UASB technology was tested to treat the car wash waste water. UASB reactor is anaerobic reactor and used just because of those advantages that it has low energy requirement, less sludge production, and less operation cost. This technology is used effectively in different food, pulp and dairy industries [2]. Anaerobic system is effectively used for the effluents from meat processing industry because they yield high rate of organic load removal with significantly lower costs when compared to aerobic processes [3]. The UASB wastewater treatment systems represent proven sustainable technology for a wide range of very different industrial effluents. [4].

For removal of oil and grease effectively, hexane was used. Hexane is a hydrocarbon which is significant constituents of gasoline. It is colorless liquid. They are widely used as cheap, safe and easily evaporated. It is used to extract oil and grease from water and soil. Acute toxicity of hexane is low and long term toxicity ranging from > 400 ppm. In this study Hexane was used to treat carwash wastewater after primary treatment.

The objective of this study was to see the effect of hexane on TOC and COD removal. It is well known that hexane dissolved the fat for separation. And UASB reactor is used in different food and textile industries for treating WW so it may be possible to use for treating the carwash WW. UASB reactor effectively treats the carwash WW because microbes can degrade the organic matter. It is for the first time that Car wash waste water is treated by using UASB reactor and hexane for its reuse.

2. MATERIALS AND METHODS

2.1 Start up of UASB reactor

The UASB reactor was operated with Sludge, synthetic food for microbes in storage tank, and collection tank at the end for the treated effluent. The reactor starts up with glucose and synthetic

food given in table 1 for 3 weeks at HRT of 24 hrs. Glucose was used as carbon source for enhancing the activity of microbes.

Table 1. Composition of Synthetic influent

Synthetic influent	Concentration
NaHCO ₃	1g L ⁻¹
Trace element solution	1 ml L ⁻¹
MgCl ₂	1g L ⁻¹
KH ₂ PO ₄	1g L ⁻¹
(NH ₄) ₂ SO ₄	0.24g L ⁻¹

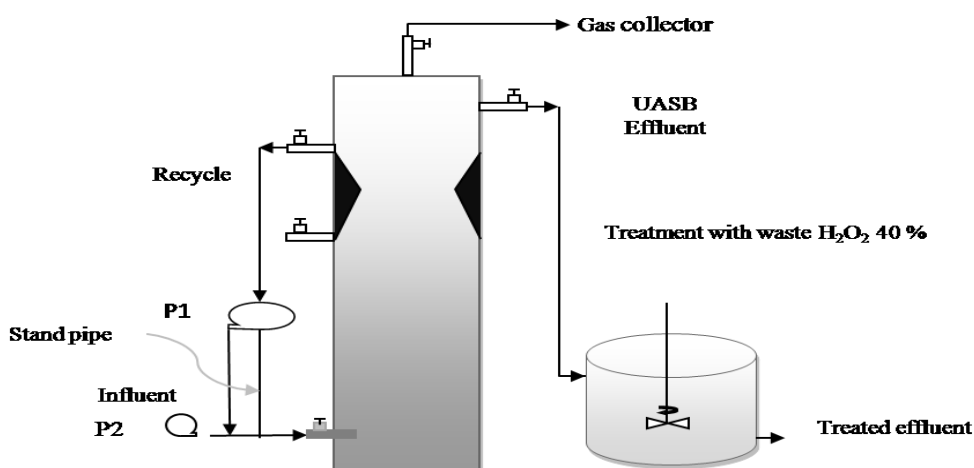


Figure 1. UASB reactor

2.2 Treatment with Hexane

In order to evaluate the optimum amount of used hexane for BOD, COD, TOC removal and oil contents reduction, a series of experiments were conducted with various hexane concentrations i.e., 0.3, 0.4 and 0.5. In these experiments, parameters were measured throughout the reaction period of 0, 30, 60, 90, and 120 min. A mixer with variable rotational speed of 0-500 rotations per minute (rpm) was used to mix the sample thoroughly. One-liter of raw CWW was treated in batch reactor at mixing speed of 500 rpm. All the experiments were conducted at ambient temperature of 25 ± 2 °C.

3. ANALYTICAL PROCEDURES

Raw and treated samples by both processes (chemically and biologically) were analyzed for their COD, BOD, pH, and TOC, DO, and Oil contents according to the standard methods. All the analytical procedures used were the standard methods for water and wastewater analysis (APHA, 2005). The BOD₅ was measured by using standard method (APHA, 2005), COD was determined by closed reflux colorimetric method using digester (HACH - LTG 082.99.40001) (APHA, 2005). (LOVIBOND tintometer GMBH, 44287 DORTMUND). The pH meter (HANNA, HI – 991003) was used for pH determination. For TOC determination TOC-Vcsh (total organic carbon analyzer). For oil contents determination Liquid-Liquid partition Gravimetric procedure was used.

4. RESULTS AND DISCUSSION

4.1 Effect of treatments on COD removal

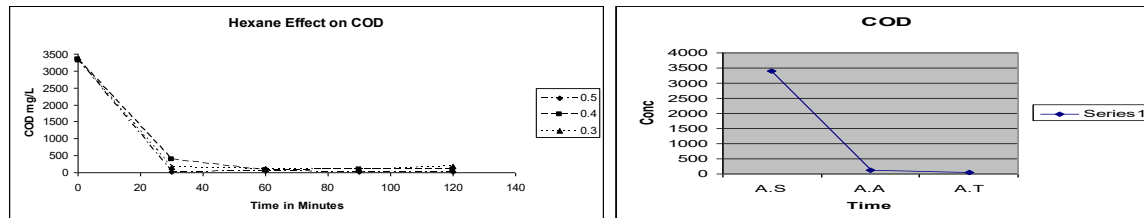


Figure 2.

Effect of Hexane

Effect of UASB

The COD was reduced up to acceptable level after both treatments from initial COD. In all experiment where different concentration of hexane was added in CWW showed that in 30 minutes COD reduced below 500 mg/L from initial COD of 3400 mg/L. And 99% COD removed after UASB treatment.

4.2 Effect of treatments on BOD removal

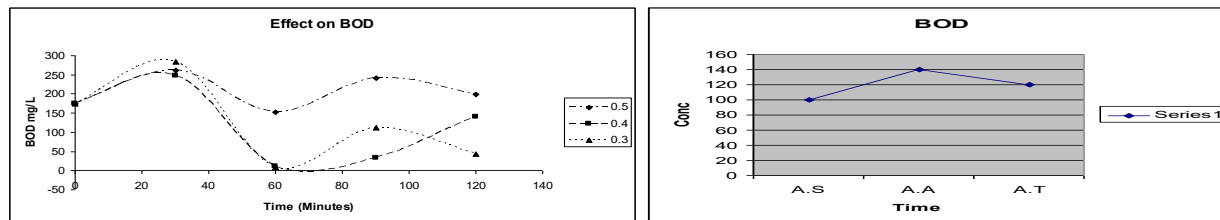


Figure 3.

Effect of Hexane

Effect of UASB

As CWW contains high concentration of oil such as diesel, petrol and lubricant which are not ideal organics for all types of microorganisms to decompose them therefore by UASB, BOD removal rate was less. May this is the reason, in this study BOD value found very low as compare to COD. BOD/COD ratio 0.051 which is very low. This indicates that BOD can be effectively reduced by chemical treatment.

4.3 Effect of treatments on TOC

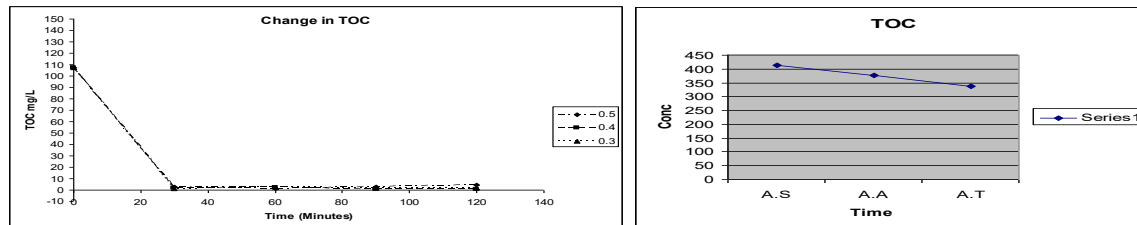


Figure 4.

Effect of Hexane

Effect of UASB

TOC measures the total present organic components. In present study, it observed that TOC is reduced up to acceptable level after both treatments. After hexane treatment TOC found to be observed less than 10 mg/L from 110 mg/L.

4.4 Effect of treatments on Oil contents

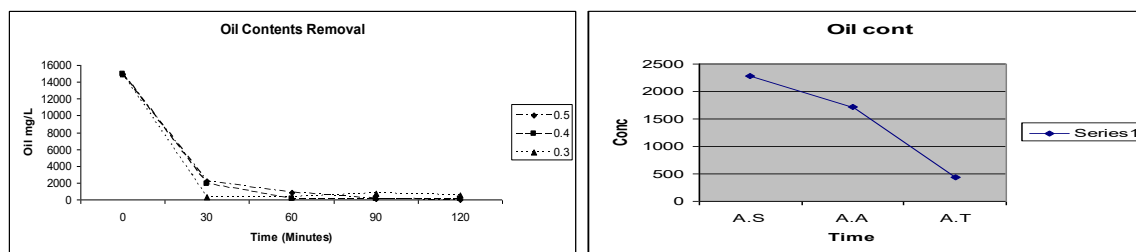


Figure 5.

Effect of Hexane

As oil content is higher in car wash wastewater by which it become turbid. By treatment with hexane, oil contents can become lower from 15000 to 320 at 0.5 ml of hexane mixing it become lower almost near to 40mg/l. By treatment with UASB reactor, oil contents reduce up to 400 mg/L. These limits are acceptable for wastewater.

Effect of UASB

4.5 Effect of treatments on pH

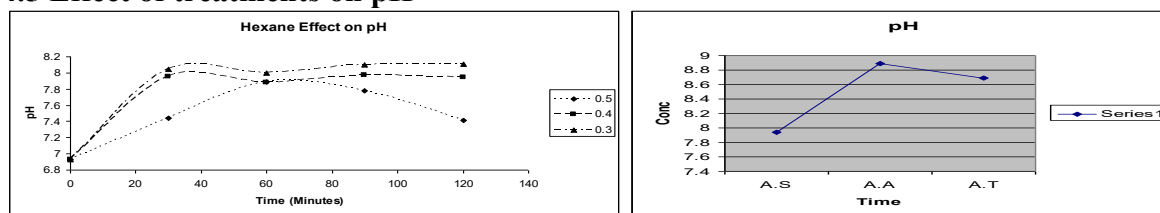


Figure 6.

Effect of Hexane

pH is found hydrogen concentration in wastewater which become effected by both treatments. At first treatment of hexane pH become 7-7.5 but it become increases as concentration of hexane is decreases, and after treatment of UASB.

Effect of UASB

4.6 Effect of treatments on DO

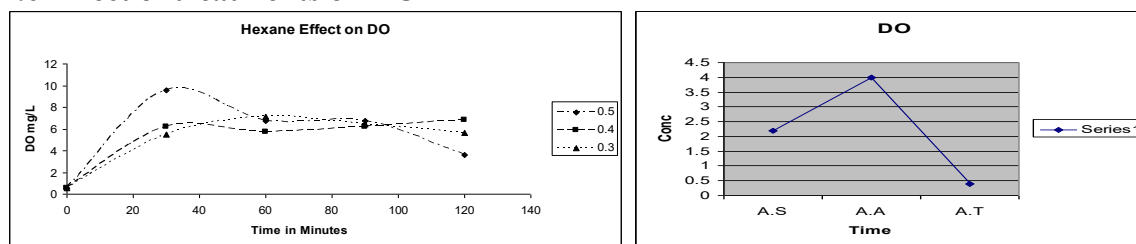


Figure 7.

Effect of Hexane

As dissolved oxygen is almost 2-2.5 in wastewater before treatment. By treating with hexane DO become higher in Wastewater. At 0.4 ml of hexane mixing it become 6-6.3 mg/l. And at 0.5 ml of hexane it becomes higher. By treating with UASB reactor DO becomes almost 0-0.4 because WW was treated in anaerobic environment in absence of oxygen.

Effect of UASB

4.7 Effect of treatment on organic compounds of CWW (GC-MS)

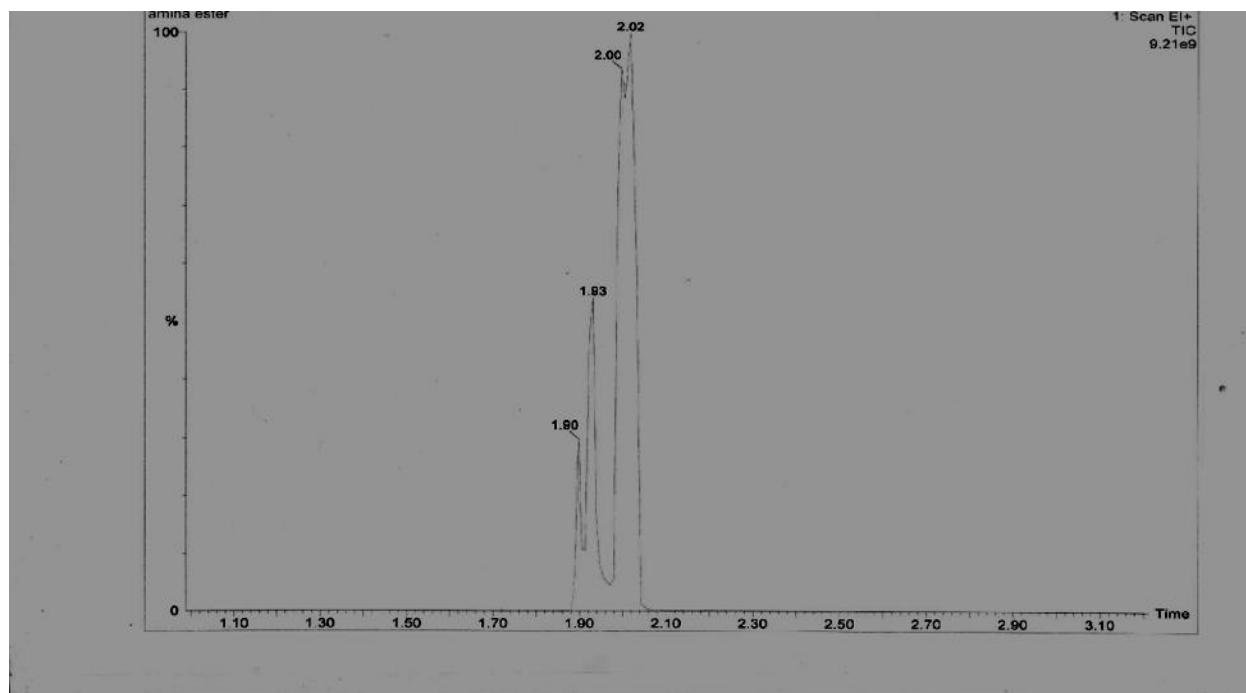


Figure 8. GC-MS results

Oil content of Treated effluent of car wash WW was taken and extracts its amines by esterification process and run on GC-MS to determine which fatty acids were remained and not digested by microbes during treatment of WW. GC-MS results shown following peaks which are mention in graph. These peaks are of Undecane, Isooctane, Isooctane, 4-Methylthiane, Toluene, 2, Beta-dinitrostyrene, Undecane, Cyclohexane, Ethyl, Ethyl benzene, O-xylene respectively.

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