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Analysis and Treatment Wash off Water from Vehicular Service Station in Hyderabad

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Abstract: The number of vehicular service stations is increasing significantly all around the world as the number of vehicles is increasing. These service stations are a major organic source of water pollution. There are total 48 service stations in Hyderabad, Sindh. These service stations discharge 380,880 liters of waste water each day, mainly into canals carrying water for irrigation and drinking purposes. Considering the serious water shortage issues, it is necessary to treat this wastewater for reuse purpose. This research focuses upon developing the wastewater treatment method to make the water reusable for washing purpose. The wastewater is treated with Dissolved Air Floatation (DAF) method followed by wool fiber filtration to reduce turbidity, oil and grease particles and settleable solids. The proposed method successfully removed the turbidity of wastewater by 97%; oil and grease particles 98.75% and an improvement of 68% was observed in the number of settleable solids.

Keywords: wastewater, vehicular service station, oil and grease, DAF, wool fiber

1. INTRODUCTION

The untreated disposal of contaminated water increases the water pollution levels in receiving water reservoirs. Due to continuous increase in pollution level, buffering capacity of natural water bodies is significantly reducing and causing nuisance to human and natural eco-system. Retrospectively the Environmental regulatory authorities are taking measures to reduce the pollutional strength of wastewater before disposal into sewerage or any other direct disposal. Several studies have already been conducted to treat the wastewater of vehicular service stations, mining industries and petroleum industries specifically to reduce main contents i.e. oil and grease, turbidity, and suspended solids.

The vehicle service is preferred to increase the comfort level and vehicle life. Population growth and increased purchasing power have increased the number of vehicles hence a dramatic increase in the number of vehicular service stations. According to survey, roughly 48 service stations are located in Hyderabad city each serving 25 to 30 vehicles per day. These 48 service stations are discharging 380,880 liters of wastewater each day there polluting canals carrying water for agricultural and domestic purposes (Bhatti *et al*. 2016). This issue is of keen importance, as the service stations require fresh water to wash each vehicle. And no any water cleaning technique is applied which could make this water reusable. The reported issue gets more severe in such regions which are facing fresh water shortage. According to a joint report of WHO and UNICEF about 663 million people are facing serious water shortage issues around the world (WHO and UNICEF, 2015). Simultaneously 80% of the wastewater in developing countries is discharged untreated in to river water and other water sources and becomes a chief reason for diseases. Approximately 3.575 million people die of various diseases caused by polluted water around the world (Dahal, 2012). The waste water of vehicular service station is contaminated with high turbidity values, oil and grease particles, high number of settle able solids and many other impurities. Yasin *et al*. (2014) reported high levels of BOD, COD, suspended solids and oil & grease contents in the wash off water of service stations in Pakistan and were significantly above the National Environmental Quality Standards (NEQs) (Yasin *et al*. 2012).

Several wastewater treatment methods are being explored by scientists around the world. The researchers have been working to develop water cleaning methods to reuse wastewater after removing the organic contaminants. DAF is found to be efficient for removal of micro-pollutants from solution and illuminating minor level of turbidity; it is also applicable to treat wash off water to separate oil, chemically treated waste water, and refinery wastewater (Gregory**,** 1990). DAF enhances the buoyancy of oily water by attaching small air bubbles to the oils and grease mixed in the water thereby raising them to the surface (Zouboulis and Avranas, 2000). Typically during the DAF process the air bubbles are formed by dissolving the air in water at high pressure (nearly 5 bar) and releasing that water at lower air pressure. The size of the air bubbles is set to be 10-100 µm. The bubble size is a significant factor; it

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affects the collision capability of bubbles with oil & grease particles. However, 40 to 80 µm is an ideal bubble size (Edzwald**,** 2010). The efficiency of DAF process is affected by efficiency of saturator, reuse ratio, air to oil percentage, pressure and the design of DAF tank (Karhu, 2015). After DAF, wastewater is filtered to remove sediments and hanging particles. Vinod Kumar *et al*. (Appe *et al*. 2016), describe that filtration process comprises of two stages, i.e. primary filtration and secondary process. In primary filtration, metallic gauze is used to separate large particles from wastewater. This is applied at the first phase of filtration. In secondary process gravity separation is found to be most efficient. In gravity separation method, the undissolved particles are retained to settle down in the bottom of the container. However, this method is not applicable to separate micro sized particles as, a particle of size 1 micro meter will require 8 days to settle down to 1 meter in a container. Water filtration methods are being applied since ancient times. Several water filtration media are being applied nowadays, of them sand filter, cotton or cloth filters, paper, membrane filters are common.

Mazumder and Mukherjee (2011) treated the vehicular service station wastewater with coagulation and activated sludge method using $CaCl_2$ and $FeSO_4$ as alums. They reported that using the coagulation and activated sludge methods the oil contents were reduced to permissible limits. Similarly, Muller *et al.* (2003) used the adsorption technique to remove the oil and grease particles from the wastewater of vehicular service stations. The authors compared the efficiency of five different adsorbents: powdered activated carbon (PAC), anthracite and three other modified clay adsorbents. The results depicted that PAC was found to be most optimum thereby reducing the oil/grease particles to 30 mg/L and efficiency of anthracite was found to be lowest. Similarly Altaher *et al*. (2011), conducted a comparative study on various coagulants in order to determine the most optimum coagulant. It was found that ferric chloride was found to be most optimum in the provided conditions as it decreased the turbidity values to 1.8 NTU, which is significantly less than maximum allowable limits (15 NTU). The results of aluminum sulfate were comparable to that of ferric chloride and lime was found to be least efficient among all. In another study on wastewater treatment of vehicular service stations, Gheethi *et al*.(2016), applied coagulation and flocculation followed by natural filtration at the end. The authors used Moringa-oleifera leaf as flocculants and Ferrous-Sulphhate ($FeSO_4.7H_2O$) as coagulant. The proposed method found to be effective in reusing the wastewater after suggested treatment.

In this research, the wastewater sample was collected from various vehicular service stations and treated with DAF followed by wool fiber filtration technique. Four different service stations wastewater is treated for turbidity, oil and grease contaminations and settleable solids using the Dissolved Air Floatation (DAF) method followed by wool fiber filtration technique.

2. METHODOLOGY

Site Selection and Sampling

The vehicular station waste water was collected from four different service stations within the premises of city of Hyderabad, Pakistan. The samples were collected randomly in a polythene container, each sample comprised sixty litres water. All the samples collected, were later tested, and analysed at the laboratory, located in Environmental Engineering and Management department at Mehran University of Engineering and Technology. Each water sample was examined for oil and grease contents, turbidity and settle able solids. **(Fig. 1).**

Fig. 1. Location of sampling collection points

Experimental Work

Each water sample was treated with DAF followed by wool fiber filtration.

Dissolved air flotation treatment design

The wastewater sample was first filled in the mixing tank, where it was stirred with an agitator. The wastewater sample was stirred to avoid the settling of impurities and evenly distribute various polluting agents throughout the wastewater sample. After the wastewater sample was properly stirred, it was let to flow into the skimming tank. The bubbles were formed using an air pump, and injected in the skimming tank from bottom, such that they rose to the top of the skimming tank. During their rise, they interacted with oil and grease particles present in the wastewater. In last the air bubbles comprising of oil and grease particles were found to be floating on the surface of the water. The oil and grease particles in the form of the thick sludge were then removed manually. The DAF arrangement is shown in **(Fig. 2).**

Fig. 1: DAF Apparatus

Filtration

After the DAF technique, the wastewater was filtered using wool fiber. The wastewater sample recovered from the skimming tank was filled in a hard-plastic container as shown in **(Fig. 3).**

The water from the plastic container was let to flow into the filtration column, which contained wool in the bottom. The length and diameter of column were 11.4 inches, 2.5 inches respectively. The wool counted 4.5 inches from the bottom of the filtration column. The wool fiber specimen was replaced with the new one after each 60 liters of waste water were treated. The water was filled in the filtration column at a rate of 7 liters/minute.

Fig. 2: Filtration Apparatus

3. RESULTS AND DISCUSSIONS

Various types of pollutant parameters affect the quality of wastewater generated from automobile service stations. Those parameters are analysed in laboratories in order to determine the level of concentrations as well as the possible reduction of concentrations to improve the quality and to control the harmful effects on the sewer system and the treatment processes of wastewater treatment plants. The selected main parameters in this study are: oil and grease contents, turbidity and settleable solids respectively. After treating the wastewater samples for all four selected service station with the proposed method of DAF followed by the wool fiber filtration is discussed below:

Oil and Grease

The performance of DAF for observed wastewater samples with initial, final oil and grease level along with the removal efficiencies are shown in Table 1 and Fig.4. It is evident from Table 1 that the designed DAF method successfully removed oil and grease levels. The efficiency of the designed DAF managed to trap more than 80% of the Oil and Grease levels in all the wastewater samples of automobile service station. The highest removal efficiency of 98.7% was observed for Sample 3 and lowest efficiency 82.7% was observed for Sample 4. The removal efficiencies were comparable with 18 – 68% removal efficiency reported by Mazumder and Mukherjee, 2011; 90% reported by Asha *et al*. 2016 and 90% reported Bharati *et al*. (2014).

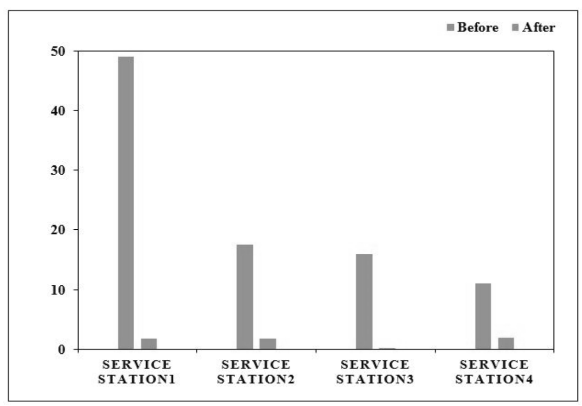
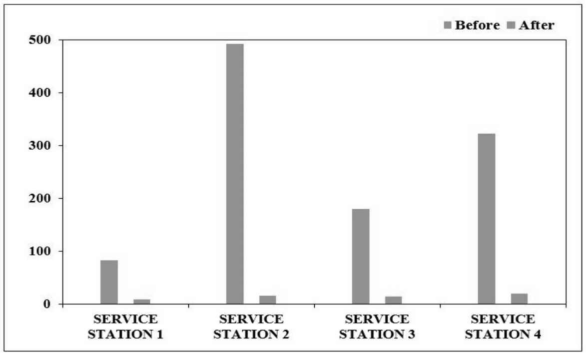


Fig. 3: Oil and Grease Contents in the Washoff Water Before and After Treatment.

Service Station No.	Concentration of Oil and Grease (mg/L)		Removal Efficiency (%)	Concentration of Oil and Grease (mg/L)
	Initial	Final		
1	49	1.8	96.32	
2	17.7	1.85	89.4	
3	16	1.25	98.75	
4	11	1.95	82.7	

Turbidity

The wastewater samples possessed high turbidity values, due to presence of oil and grease particles, dust particles and other hanging solids. From Fig. 5, it is depicted the turbidity values of the wastewater samples obtained from various service stations, before and after treatment.



A significant level of removal efficiency in concentration of turbidity was observed in collected wash off water of all four service stations. The initial turbidity concentration of the wash off water of service station one was 82.4 NTU, which upon the application of proposed method was reduced to 8.87 NTU thereby removing 90% of the initial turbidity. Similarly, the initial turbidity values of wash off water of service station 2 was 493 NTU which was reduced to 15.26 NTU upon the application of proposed cleaning method. This gave an improvement of 97%. However, the proposed method resulted to 92% and 94% improvement in the turbidity values of wash off water of service stations 3 and 4 respectively. An average of 94.7% improvement was observed in the turbidity values of all the four service stations.

Settleable Solids

The Wash-off water comprised of significant concentration of settleable solids. These settleable solids are mainly the dust particles and other solid material. Fig. 6 shows the values of settleable solids in the Wash-off water before and after treatment.

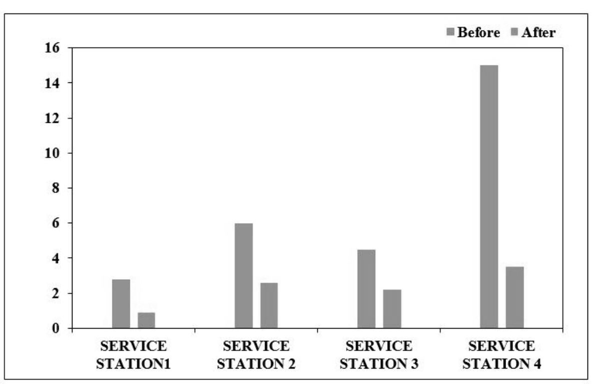


Fig. 4: Settle-able Solids Values Before and After Treatment

The proposed method was applied to decrease the number of settleable solids in the wash off water of all the four service stations. The drain water of service station one had 2.8 **units** of settleable solids which was reduced to 0.9 after the proposed method of cleaning was applied. This improvement is equal to 67.86%. Whereas the wash off water of service station two had 6 **units** settleable solids, which were reduced to 2.6, which is equal to 43% of initial value of settle able solids. The waste water of service station three had 4.5 units of settleable solids, which were reduced to 2.2. Significant reduction in the number of settleable solids was observed in the wash off water of service station four, which were reduced to 3.5 from 15. However, mean reduction in the number of settleable solids was found to be 67.5%.

4. <u>CONCLUSION</u>

This research focuses upon the development of waste water treatment method to make the Wash-off water of vehicular service stations reusable. The study was conducted on the Wash-off water of four different vehicular service stations in Hyderabad. The Wash-off water of these service stations was found to be carrying different pollutants, including oil and grease particles, dust particles and other polluting agents. The Wash-off water was treated using DAF followed by wool fiber filtration for oil and grease particles, turbidity, and settleable solids. The proposed method efficiently removed the oil and grease particles by 98%. Whereas, the turbidity of the Wash-off water was reduced by 94.7%. The proposed method was also found to be efficient to remove the settleable solids, as they were reduced up to 67.5%. The limitation of this method is routine washing of wool fiber, after treating 60 liters of Wash-off water.

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