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Removal of Oil and Grease from Industrial Wastewater- A Review of New Utility Approach

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Abstract
This study reviews Oil and Grease removal from Industrial wastewater by using new utility approach. This is an attempt to explore oil and grease pollution which may pollute fresh water and impact on aquatic environment. Then removal of oil and grease from manufacturing wastewater becomes very necessary but common techniques not adequate. So, to assess humiliation prospective of oil and grease and also to analyze and maintain water quality, enzymes and adsorption unit were developed which consider as a new approach for the removal of oil and grease from industrial wastewater. To evaluate oil and grease removal performance, number of environmental variables and components such as flow rate, bacteriology measure, dissolved oxygen and amount of adsorption material are required. Organic reduction can be increased by using natural material like zeolite under optimal conditions such as high length of adsorption unit and closer spacing which increase adsorbent and oil and grease contact period because of that overall removal performance of system increased.
Keywords: *Zeolite, Lipase Enzyme, Oil and Grease, Membrane Treatment*

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I. INTRODUCTION

Oil and Grease (O & G) ae the main element of organic toxic waste which causes ecology damages for aquatic organisms [1],animal, plant, and equally, carcinogenic, and mutagenic for human being [2]. They releases from various sources and form a layer on water surface due to which dissolved oxygen level in water decreases. O&G layer form oil film around microbes in suspended matter and water which decreases biological activity of treatment process. Then oxygen molecules are difficulty to be oxidative for microbial on hydrocarbon molecules and cause ecology damages to water bodies [3, 4].

Skimming tanks is the conventional technique to remove oil and grease but its low removal efficiency is the main disadvantage to use it.

In treatment plant there may be clogging of pipes due to remaining oil which needs regular cleaning and sometimes replacement of pipes also. This lead to increase inspection and maintenance cost [5].Now a days alternative uses of biochemical route (enzymes and lipases) have likely gained more attention because of their clean and friendly application which overcome its limitation [6]. Microbial activity plays important role in performance, strength purification process, and elimination of pre - treatment process in wastewater treatment plant which depends on enzyme costs [7]. Environmental studies by Oasis explained prevention of filming or fat blockage in waste systems before releasing wastewater into sewage system. He investigated new approach to degrade organic matter with commercial mixture (lipase enzymes) which cleans grease traps, holding tanks, septic tanks, and other systems [8].

R. Bussamara, A. M. Fuentefria, E. S. D. Oliveira et al. studied that Lipases constitute a large category of water soluble ubiquitous enzymes. These enzymes hydrolyze ester bonds of water in soluble substrates and act as the interface between a substrate phase and an aqueous phase [9]. E. Rigo, proved that enzymes play ecological significance in oxidation reduction, have low production cost and can reflect organic matter circulation for wastewater treatment [10]. Y. Zhang, B. Cui, S. Wang et al explain that enzyme activity serve as biological indicator for sediment to reflect eutrophication level of water resources and also they do not require purification [11]. H. Horchani, and I. Aissa, describe characteristics which led to increase enzyme production technology and find out microorganisms which have a diverse ability to produce enzymes. They finds that Lipases used in detergent formulation, bio-diesel, paper industries, textile, and pre-treatment of lipid-rich wastewaters. He describes biotechnological processes as microbial lipases are the most attractive due to their properties such as flexibility and ease of mass production can apply [12].

H. K. Shon and P. N. Ibegbulam-Njoku find out the application of Pseudomonas spp. strains' which increases the hydrolysis of O&G waste by acting as a catalyst. It can be treated as pre-treatment for decreasing concentration of organic matter, suspended solids, and color [13, 14].

In view W. Yeoung-Sheng water pollutants becoming more complex and multi pollutants simultaneous removal is required more and more attention to be removed. Recent composite materials such as amorphous zeolite, aluminum oxide, Nano particles, and laterite adsorbents are used to treat complex wastewater as have high adsorption capacities [15].

In view of these points, H. S. Abd El-Gawad carried out a research studies and give new approach to degrade toxic waste (oil and grease) from industrial wastewater. He invented lipase hydrolysis stage using Pseudomonas strains as a producer of lipase and determine their degradation capabilities. He carried out adsorption process by using zeolite (laterite and amorphous materials) due to very much easy and cheap availability as an adsorbent. He coupled enzymes unit with adsorbent material for the complete and efficient removal of toxic waste (oil and grease) from industrial wastewater. [21]

II. MATERIALS AND METHODS

2.1. Environmental Sampling Program

2.1.1. Study Area

H. S. Abd El-Gawad collected water samples for chemical analysis from industrial area of Kafr El-Zayat and sludge were is collected from El-Rahway drain along Rosetta branch

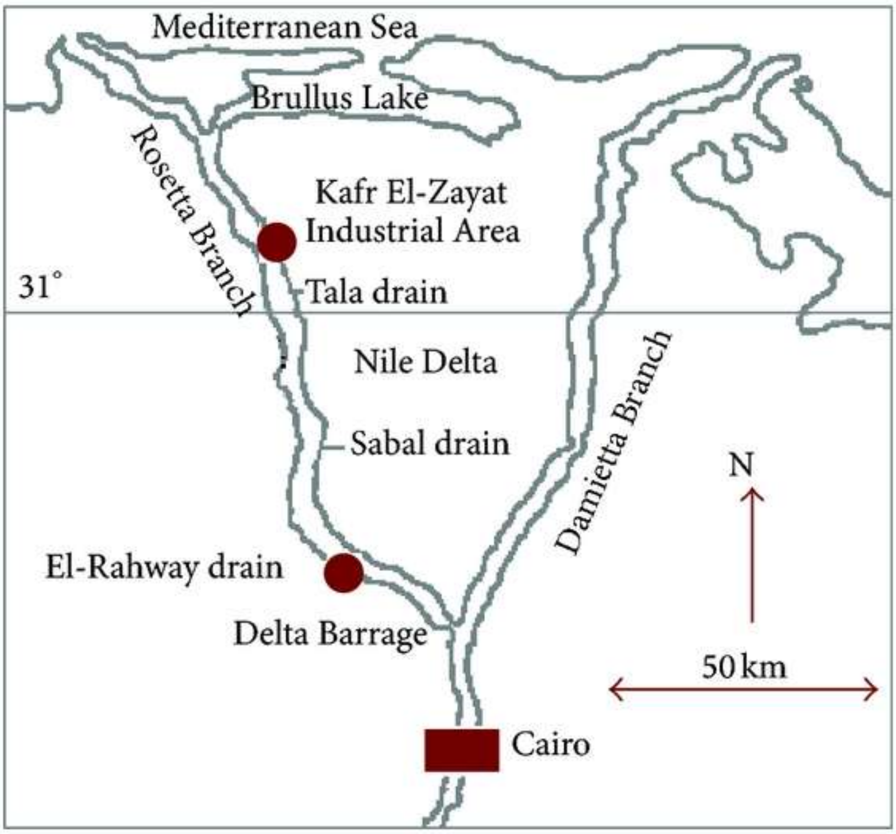

FIGURE 1

Sample of waste water were collected from detergent and oil industry which produced food oil producs.They include fat replacement and cooking oil. These industries also manufactured oil products which have application is coloring and dairy products and can be used as a food

2.1.2. Collection of Water Sample

Water samples were collected in 1 litre plastic bottles from 60 cm depth of investigated sites for the measurements of physicochemical properties. According to APHA water sample stored in refrigerator at 4°C prior to analysis of chemical oxygen demand (COD), total organic carbon (TOC), and biological oxygen demand (BOD) parameters [16].and oxygen demanding variables included total organic carbon (TOC), chemical oxygen demand (COD) and biological oxygen demand (BOD) parameters that stored in refrigerator at 4°C prior to analysis [16]. H. S. Abd El-Gawad used one litre glass bottles which is filled with oil and grease water sample measurement in (1 m × 1 m) area. For minimum fluctuations of physical and chemical parameters which caused due to temperature differences measurements were carried out on the same day of sampling.[21]

2.1.3. Field Measurement

On line field measurements including pH, D.O., T.D.S, temperature, and electrical conductivity (E.C) were measured using multi-probe system by model Hydrolab-Surveyor.

2.2. Treatment

The experiment involves two parts as laboratory scale column (LSC) and laboratory experimental unit (LEU). The LEU experiment basically use stock (*Pseudomonas* strains lipases) in microbial process which obtained from Sigma whereas adsorbent zeolite column (laterite and amorphous material) is use by laboratory scale column use as shown in Figures 2 and 3. LEU includes mixed

Culture of Pseudomonas strains lipases and wastewater combine under aerobic condition. With rich cultural of microbial enzyme incoming waste water is recycles.

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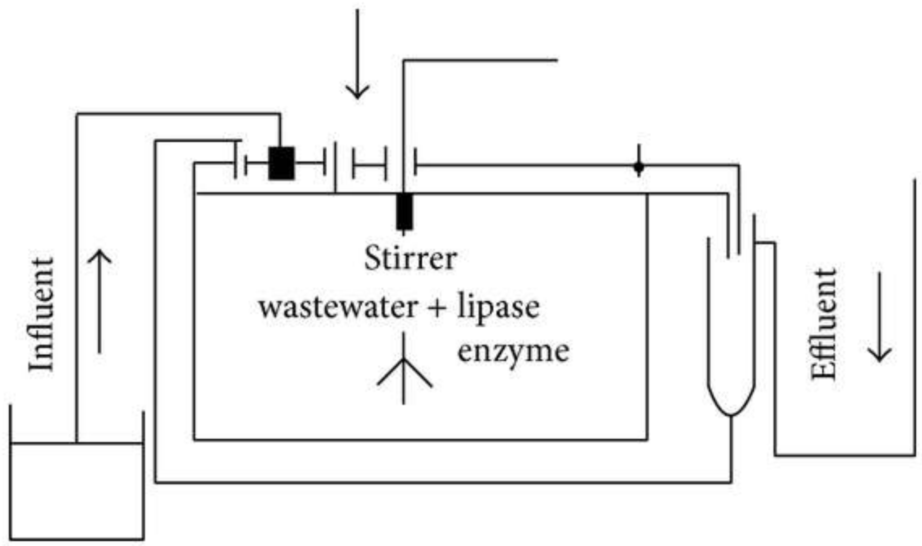

FIGURE 2

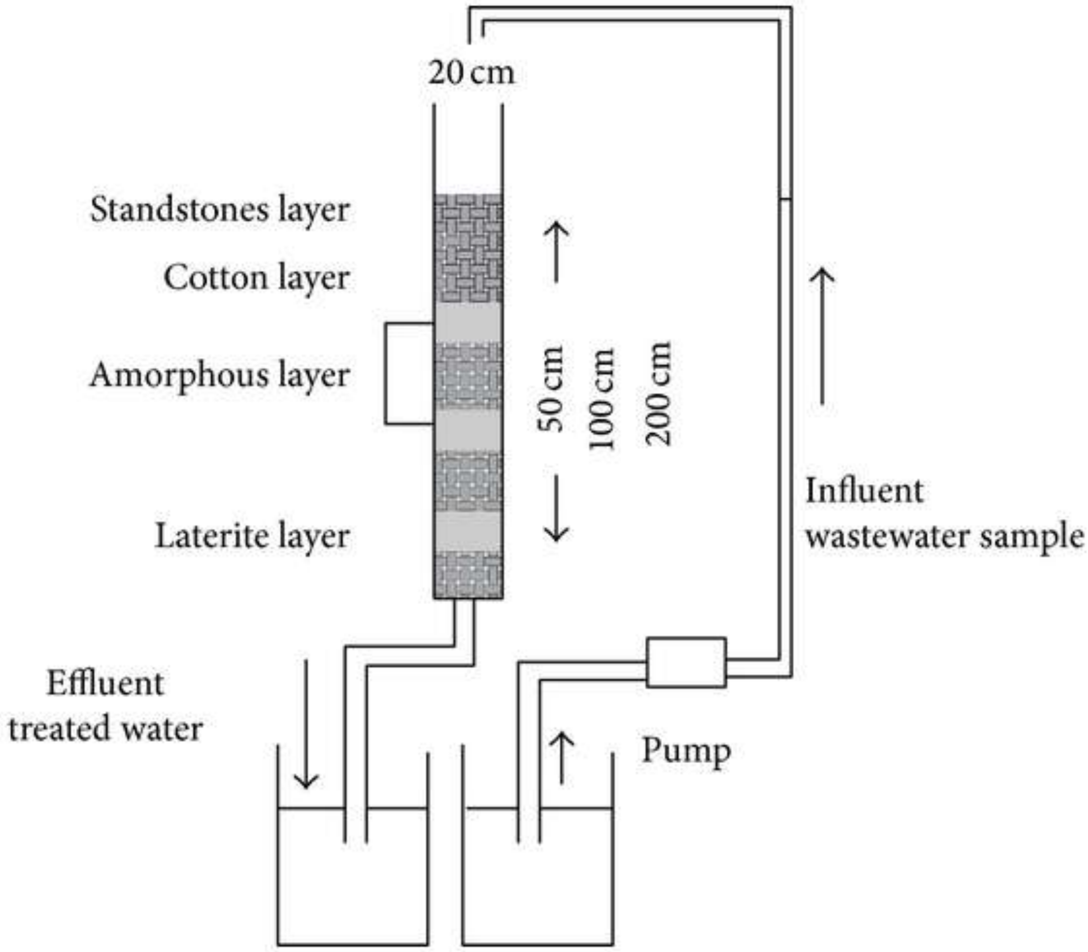

FIGURE 3

2.2.1. Experimental Setup

Wastewater and sludge characteristics are shown in Table. Acclimatization is a process in which an individual microorganisms in the sludge adjust to change to renew wastewater environment allowing to a change in its performance of different environmental conditions. Lipases application needs lipase activity, their stability at alkaline pH, effect of temperatures above 40 ± 1°C and compatibility with different pollutants to remove Oil & Grease from waste water.

Parameter	Unit	Industrial Waste water	Sludge
Temp	^{0}C	18.9	20.1
pH	--	8.4	8.81
EC	Mmhos/cm	2.34	3.14
TSS	mg/L	132	345
TDS	mg/L	1503	2041
D.O	mg/L	3.2	1.35
COD	mg/L	572	3100
BOD	mg/L	388	400
TOC	mg/L	60.1	300
Oil and Grease	mg/L	292.4	0.005
Total Coliform	CFU/100ml	$645 X 10^3$	$245 X 10^7$

TABLE

Acclimatization of a mixture of activated sludge and wastewater with a proportion of (3 : 1 v/v) is carried for five days in a three – litre stirred tank having a 6-blade up-pumping 450-pitched blade impeller with a speed of about 200 rpm. To provide different rates of air supply for aeration an air pump was used.

2.2.2. Lipase Enzyme

For the study of aeration and sludge concentrations effect H. S. Abd El-Gawad carried out lipase enzyme (LE) treatment process. He took all runs in a three –liter stirred tank having a 4-blade up-pumping 600-pitched blade impeller with a speed of about 400 rpm.[21]

Number of experiments at the room temperature were performed within fixed time (6 hours) by using laboratory experimental unit (LEU) to analyzed the influence of aeration and sludge volume to remove organic pollution (oil and grease and COD) from collected sample of waste water (Figure 2). By using a Master flex peristaltic pump, 100 mL water sample was pumped in the up flow mode of LEU from the vessel. To check the performance of treatment for analyzing organic matter treated water sample were collected within fixed time—6 hours.

2.2.3. Zeolite Adsorbent

To study the time and the flow rate effects zeolite adsorbent (ZA) treatment process used. For this study an experiment is performed by H. S. Abd El-Gawad at different length (50, 100, and 200 cm × 20 cm) of plastic pipe having fixed width. Number of experiments at the room temperature were performed by using laboratory scale column (LSC) (Figure 3) to analyze the effect of dosage and time to remove organic pollution from wastewater sample [21].

Master flex peristaltic pump was used to pumped 100volume of water sample (influent) to the up flow mode of laboratory scale column (LSC) from vessel. To check the treatment performance for analyzing COD and Oil and Grease treated sample were collected at different time intervals.

2.2.4. Purification of Oil and Grease Waste

To determine optimum treatment process, procedure for disposal management and avoid industrial risk of oil and grease waste experiment was performed. To ensure the efficiency of removal organic waste laboratory experimental unit (LEU) is designed as biotechnology to minimize organic load combine with a laboratory zeolite column (LZC) (Figure 4).

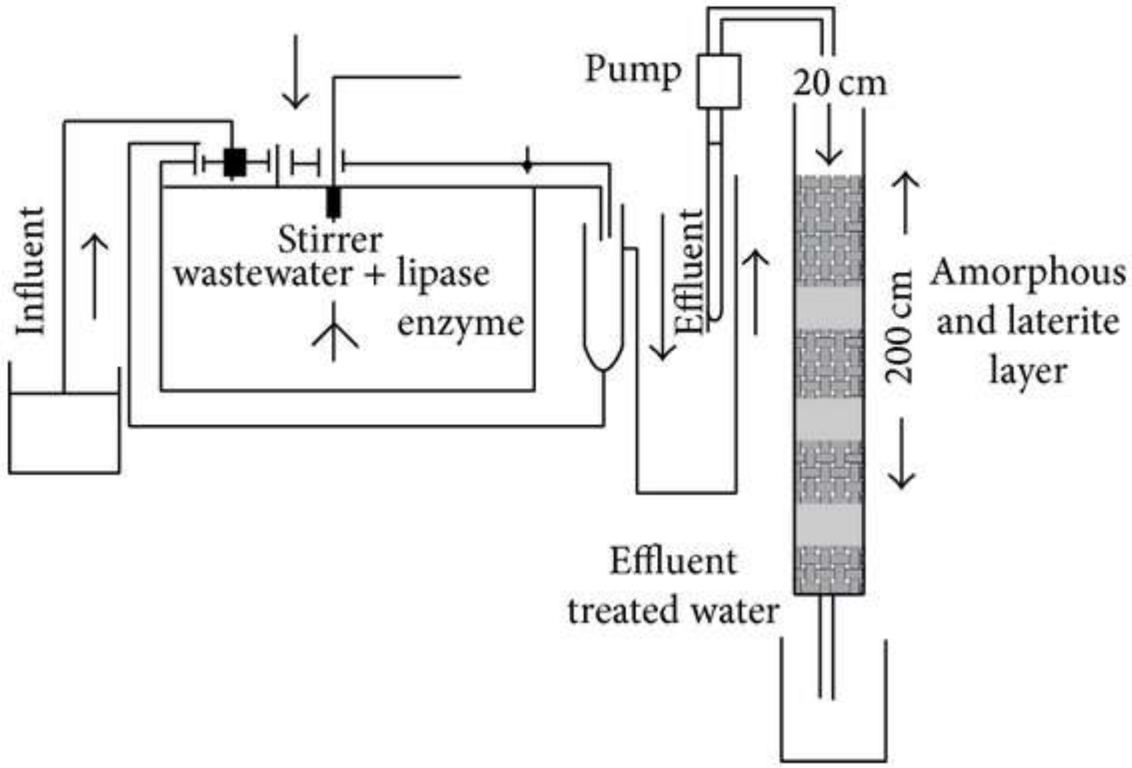

FIGURE 4

III. RESULTS AND DISCUSSION

To show the activity during removal of organic pollutants R. Gupta, and P. Rathi conducted an experiment in which sludge and wastewaters in LEU was covered with large quantity of enzymatic stock. They found that common bacteria and lipases are very much essential as thousands of lipase units are produced from culture medium. They also focused on Bacterial lipases are strongly influenced by nutritional and physicochemical factors, such as pH, nitrogen, inorganic salts, presence of lipids, temperature, and dissolved oxygen concentration [17].

3.1. Enzymatic Profile for Organic Waste Degradation

L. Bora and M. C. Kalita described thermal resistance of lipases from *Bacillus* .They invented that *Bacillus* genus showed optimal activity and thermal stability is up to 50°C only, at high temperature *Bacillus* genus are less active[18]. S. Facchin proved that normally at neutral or alkaline pH ,bacterial lipases have optimal activity[4] while S. Bradoo, and R. K. Saxena stated that lipases from *Bacillus* species are active upto pH range (pH 3–12) [19]. From above experiments H. S. Abd El-Gawad found that lipase extracts produced by *Bacillus* species usually showed more than that one of optimal pH values.[22]

To determine the optimum aeration and sludge volume Y. Zhang, B. Cui, S. Wang et al. performed experiments in which all steps were conducted at fixed time period of 6 hours, at room temperature And pH of wastewater sample as shown in (Figure 2).To verify potential activity of enzyme lipase Rich lipase (cell suspension) was conducted at normal sludge, 1 : 5 and 1 : 10 diluted sludge so that it was used to degrade organic waste by different ways [11]

S. S. Dash, R. Subramani, and D. S. Kompala explained O&G and COD concentrations at various sludge volume according them the optimum normal sludge volume was (O&G-50% and COD-60%). For diluted sludge it reached to volume 1: 5 (COD-50% and O&G-40%) was very useful to organic degradation than diluted sludge reached to volume than 1: 10 (COD-40% and O&G-30%)at same parameters which required for pre-treatment units of industrial wastewater [20].

3.2. Zeolite Evaluation for Oil and Grease Removal

H. S. Abd El-Gawad conducted an experiment by varying flow rates at different times.They evaluated collected sample to determine concentration of oil and grease and also access oil removal efficiency in the laboratory.

They noticed that, efficiency of oil removal is increased with the increased length of column and concentration of oil was decreased. So, removal efficiency of oil can be increased with more time of contact and with more time of movement.

3.3. Advanced Purification for Oil and Grease Waste

Laboratory zeolite column (LZC) combined with Laboratory experimental unit (LEU) as shown in (Figure 3). They paired for the reduction of organic load and to achieve maximum waste removal efficiency. This procedure used as disposal management procedure to minimize industrial risk of oil and grease waste. The experiment was performed at ideal treatment process condition: high aeration at LZC: 200 cm length, mixture of amorphous and laterite zeolite at high flow rate, normal sludge, and various zeolite dosage (50, 100, 150, and 200 g). Figure 4 showed different efficiencies of oil removal in various experiments. It was cleared that organic load removal increased as the length of column increased and concentration of O&G decreased. So, more time of movement give rise to more time of contact as a result, efficiency of organic waste removal was increased .

H. S. Abd El-Gawad explained that variation in oil concentration and reduction of O&G in high LZC length unit at different intervals of zeolite dosage. Moreover it was found that as length of LZC unit's increased, efficiency increased in all four stages. W. Yeoung-Sheng They also focused on and H. Shu-Huei explained that at slower flow rates and for closer spacing, efficiency increased as the contact period with adsorbent increased. They also focused on efficiency increased with the increased length of LZC unit. So, ideal result may be obtained for higher LZC unit length, with slower flow rates, and closer spacing. Compared to other systems as laterite is easily available and very cheap its overall cost of system is very low [15].

IV. CONCLUSION

Characteristics of wastewater are depends on source of waste water which may increase. In recent days it becomes more toxic due to the tremendous growth in oil and grease use, expansion of oil mills and refineries worldwide, high-demanded oil processed foods, as well as arbitrarily discharge of oil and grease into the water streams. Increase in the concentrations of oil and grease in wastewater streams which ultimately increase adverse effects on the ecology.

This paper comprises the efficiencies, applications, and challenges of oil and grease wastewater treatment from industrial wastewater. Effective development for desired removal of oil and grease is discussed as emerging pollutants. Lipase and adsorbent material zeolite can be effectively used to eliminate O&G concentration from industrial wastewater.

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