Eco-Friendly Treatment of Oily Domestic Wastewater by Using Effective Microorganism Technology

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ABSTRACT

The management of domestic waste water, particularly the oil containments generated during daily domestic water uses processing, it poses significant environmental challenges. The presence of high oil content in wastewater breaks water quality, damaging aquatic ecosystems and complicating waste treatment processes. This study investigates the effectiveness of an Effective Microorganism (EM) solution in enhancing the degradation of oil content in domestic waste. EM, a integrated mixture of beneficial microbes such as lactic acid bacteria, yeasts, and photosynthetic bacteria, was applied to domestic wastewater under controlled conditions. It is observed that from result that the EM solution significantly reduced the oil contamination in the effluent, with a degradation efficiency of over 65 -70% within a four week period. The microbial containments contributed to the breakdown of oil into simpler, non-toxic compounds, while also improving overall wastewater quality by reducing the presence of other organic pollutants. The findings indicate that EM treatment offers a sustainable and eco-friendly alternative for the remediation of oil-polluted domestic waste water , providing an effective solution for improving water quality in domestic waste water processing environments. Further research is recommended to optimize the application parameters and assess the long-term effects of EM use on domestic waste water management.

Keywords:- Effective Microorganism (EM) solution, oil contamination, domestic waste water management.

1.INTRODUCTION

Domestic wastewater, especially from kitchens, contains oil, fats, and grease, which are challenging to treat and degrade using conventional methods. Oil contamination in domestic wastewater is a significant environmental concern as it leads to the deterioration of water quality, clogging of sewage systems, and harm to aquatic life. This project explores the potential of using Effective Microorganism (EM) technology to degrade oil present in domestic wastewater.

Effective Microorganisms (EM) technology is a microbial solution that uses a mixture of beneficial microorganisms to break down organic materials, including oils, in wastewater. The approach is sustainable, eco-friendly, and has shown promise in treating various types of organic waste.

The kitchen waste is one of the typical household's waste shows a major impact on municipalities for the treatment of the same, but most of them are not possible to use at local level.

2. METHODOLOGY

A flowchart showing the methodology for Treatment of oily waste water by using EM Technology.

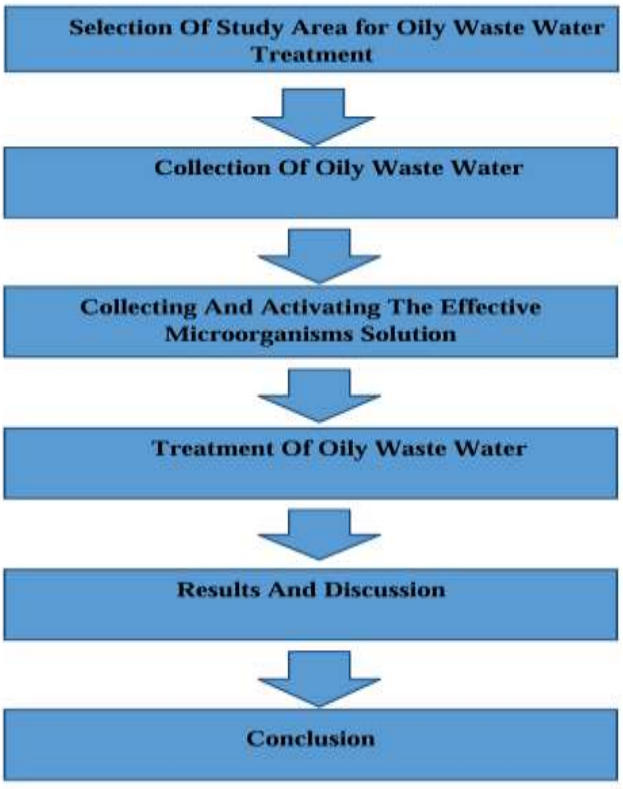


Fig. 2.1. Flow Chart Of Methodology

2.1 Selection Of Study Area for Oily Waste Water Treatment

Study area is first important parameter in my project. First I select the study area for treating domestic waste water containing oil. So I select the domestic waste water collection study area from house hold daily kitchen waste water containing oil. There is lots of daily waste water generates and from that we are trying to treat such water and reduce oil contaminates from waste water and then will be used in gardening purpose, washing and cleaning purpose for village.

2.2 Collection Of Oily Waste Water

The waste water containing oil were collected in a sterilized plastic container from household kitchen. After collection, the waste water was brought to the laboratory for further analysis The collected waste water sample was subjected to physicochemical and microbiological analysis.

Fig. 2.2. Sample of Chlorine Free Water ,EM solution and jaggery water

2.3 Collecting And Activating The Effective Microorganisms Solution

EM is available in a dormant state and requires activation before application. Activation involves the addition of 6000 ml of chlorine free water and 300ml of jaggery water to 300ml of dormant EM one week prior to application. These ingredients were mixed together in either a 7 L or 10 L container and stored in area with minimal temperature fluctuations. A major influence on the survival of microorganisms is the temperature of their environment, with significant temperature fluctuations impacting upon their survival. The pH is also a determining factor. It was indicated that the pH of the EM should be approximately 4.5. And sweet sour smell was developed then activated EM was ready for use.

2.4 Treatment Of Oily Waste Water

The samples were kept in a closed container at a minimum room temperature for a period of 5 to 7 days with periodic mixing to ensure uniform treatment. After that, the treatment of oily wastewater was done after activating the EM solution, and various tests were conducted to perform the various physical properties and chemical properties are studying. The set up consists of three 1liter Erlenmeyer flasks with 1 litre of waste water each. 100 ml of activated EM culture was added into the waste water sample. The setup was operated continuously for 21 days. The effect of EM was assessed by changes in the oil and grease content , pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total Dissolved Solids (TDS), Dissolved Oxygen (DO), after the incubation period.

3.TREATMENT OF OILY WASTE WATER BY USING EM TECHNOLOGY

Various test to be carried out by studying various parameters in Oily waste water.

3.1 Measurement Of Parameter On Waste Water

The characteristics of oily waste water can be classified under following three heads:

- Physical Characteristics
- Chemical Characteristics
- Biological Characteristics

3.1.1 Physical Characteristics

The Physical Characteristics of oily waste water are determined using the physical method of analysis:

3.1.1.1 Colour

Waste water with oil often appears milky ,grey, brownish-yellow or even black depending on concentration and emulsification. For colour checking use glass beaker or bottle.

3.1.1.2 Turbidity

Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles that are generally invisible to the naked eye, similar to smoke in air. The measurement of turbidity is a key test of water quality.

3.1.1.3 Total Dissolved solids

Total dissolved solids (TDS) is a measure of the dissolved combined content of all inorganic and organic substances present in a liquid in molecular, ionized, or micro-granular (colloidal sol) suspended form. TDS is sometimes referred to as parts per million (ppm).Water quality levels can be tested using a digital TDS PPM meter.

3.1.2 Chemical Characteristic

3.1.2.1 pH

The pH value of water indicates the logarithm of reciprocal of hydrogen ion concentration present in the water. It is thus an indicator of the acidity or the alkalinity of domestic waste water. If the pH value is less than 7, the water is acidic and if the pH vale is more than 7, the water is alkaline.

The waste water is alkaline, with passed of time pH tends to fall due to production of acid by bacterial action in anaerobic or nitrification processes. However with treatment of waste water the pH tends to rise. Determination of pH is important because efficiency of certain treatment methods depends on it. Especially the biological treatment, for better result the pH of waste water should be around 7.0 in biological treatment as microorganisms can flourish in that pH range. pH can be determined using pH meter.

3.1.2.2 Chemical Oxygen Demand

The BOD test takes minimum 5 days time and due to this it is very useful in control of treatment processes. An alternative test is COD test. It is widely used as a means of measuring the amount of organic matter in the waste. It can be used to measure both biodegradable and non biodegradable organic matter. COD test, takes 3 hours in comparison to 5 days for BOD test, In COD test, a strong chemical oxidizing agent like potassium dichromate is used in acidic medium to oxidize the organic matter present in the waste. Almost all type of organic matter with a few exceptions can be oxidized by the action of strong oxidizing agents under acidic conditions. COD can be defined as amount of oxygen required to chemically oxidize organic matter using a strong oxidizing agent like potassium dichromate under acidic condition.

3.1.3 Biological Characteristics

3.1.3.1 Dissolved Oxygen

Dissolved oxygen is the amount of oxygen in the dissolved state in the wastewater. Through the wastewater generally does not have DO, its presence in untreated wastewater indicates that the waste water is fresh. Similarly, its presence in treated wastewater effluent indicates that the considerable oxidation has been accomplished during the treatment stages. While discharging the treated wastewater into receiving waters, it is essential to ensure that at least 4 mg/l of DO is present in it. If DO is less, the aquatic animals like fish etc. are likely to be killed near the vicinity of disposal. The presence of DO in wastewater is desirable because it prevents the formation of obnoxious odour. DO determination also helps to find the efficiency of biological treatment.

3.1.3.2.Biochemical Oxygen Demand

Biochemical Oxygen Demand (BOD) is defined as the amount of oxygen required by the microorganisms (mostly bacteria) to carry out decomposition of biodegradable organic matter under aerobic conditions. The BOD test is widely used to determine the pollution strength of domestic and industrial wastes in terms of the oxygen that they will require if discharged into natural watercourses. It is the one of the most important test in stream pollution control activities

3.2 Test To Be Performed

Various test to be carried out to doing domestic oily waste water treatment.

3.2.1 Oil And Grease Content Determination Test:-

Determining the oil and grease content in wastewater is important for evaluating water quality, especially in household kitchen waste water where oils are used. The presence of oil and grease in wastewater can harm aquatic ecosystems and interfere with wastewater treatment processes. There are several methods for measuring the oil and grease content in wastewater, but I use gravimetric method (also called the solvent extraction method) for oil and grease content determination in waste water.

3.2.1.1 Apparatus:-

Sample of wastewater (representative sample),Solvent (e.g., petroleum ether or hexane),Evaporating dish or beaker, Balance (for weighing),Drying oven (to remove excess solvent),Filter paper (if necessary),Sodium sulfate (for drying),Glassware (e.g., separatory funnel, flasks)

3.2.1.2 Procedure for Determining Oil and Grease in Wastewater (Gravimetric Method):

1. First collect a sample of wastewater containing oil.

2. Take and weight an empty evaporating dish. This will be used to collect the oil and grease extract.

3. For the Gravimetric Method, use a solvent like petroleum ether or hexane, which effectively dissolves oils and greases. The solvent should be added to the sample in sufficient quantity. Allow the extraction process to continue for a set period (usually 1–2 hours).

4. After extraction, filter the solvent-oil mixture through a filter paper to remove any solid particles or suspended material.

5. Transfer the solvent-oil mixture into an evaporating dish. Evaporate the solvent using gentle heating (e.g., in an oven) under controlled conditions. It's crucial to remove all solvent to ensure you are left with only the oil and grease.

6. After evaporation, allow the dish to cool to room temperature. Weigh the dish with the oil and grease residue. The difference in weight before and after the extraction represents the amount of oil and grease in the sample.

7. After that calculate the oil and grease content.

3.2.1.3 Observations

Table no 3.1 Observations of Oil and Grease Content in Wastewater

Sr. No.	Sample	Initial Weight Of Beaker In gm (W1)	Final Weight Of Beaker With Oil In gm (W2)	Volume Of The Sample Taken For The Extraction In ml (V)
1	Before Treatment	54.00	132.4	100
2	0 Days	54.00	132.4	100
3	07 Days	54.00	104	100
4	14 Days	54.00	71.8	100
5	21 Days	54.00	59.6	100

3.2.1.4 Sample Calculations

$$\text{Oil And Greese Content} = \frac{(W2-W1)}{V} \text{ X } 1000$$

$$\text{Oil And Greese Content} = \frac{(132.4-54.00)}{100} \text{ X } 1000$$

$$= 784 \text{ mg/l}$$

3.2.1.5 Results

Table No 3.2 Result of Oil and Grease Content in Wastewater

Sr No	Samples	Oil and Grease in Wastewater in mg/l
1	Before Treatment	784
2	0 Days	784
3	07 Days	500
4	14 Days	178
5	21 Days	56

3.2.2 pH Test

The pH is one of the basic water and wastewater characteristics. It expresses the intensity of acid or alkaline conditions by indicating the hydrogen ion activity. Some of the processes in water quality engineering that require pH monitoring and control are the following: disinfection, coagulation, softening, biological treatment etc. Natural waters usually have pH values close to neutral.

3.2.3. Dissolved Oxygen (mg/l) Test

Dissolved Oxygen (D.O.) levels in natural and wastewaters are dependent on the physical, chemical and biochemical activities prevailing in the water body. The analysis of D.O. is a key test in water pollution control activities and waste treatment process control.

The presence of oxygen is essential for the survival of aquatic life in water. This oxygen is especially required by aerobic bacteria and other micro-organisms for degradation and stabilization of organic constituents in waste water. A rapid fall in DO level in river water is one of the first indications of organic pollution. Thus it is one of the important parameters for accessing the quality of water, water bodies and plays a key role in water pollution control activities. The major inputs of DO to natural water are from atmosphere and photosynthetic reaction. The solubility to oxygen in water depends on pressure, temperature, altitude and chloride concentration etc.

3.2.4 BOD (Biochemical Oxygen Demand) test (mg/l)

The Biochemical Oxygen Demand (B.O.D.) of sewage or of polluted water is the amount of oxygen required for the biological decomposition of dissolved organic matter to occur under aerobic condition and at the standardized time and temperature. Usually, the time is taken as 5 days and the temperature 20°C as per the global standard. The B.O.D. test is among the most important method in sanitary analysis to determine the polluting power, or strength of sewage, industrial wastes or polluted water. It serves as a measure of the amount of clean diluting water required for the successful disposal of sewage by dilution. The test has its widest application in measuring waste loading to treatment plants and in evaluating the efficiency of such treatment systems.

3.2.5 Determination Chemical Oxygen Demand (COD) (mg/l)

COD is the oxygen required for the oxidation (chemical) of organic matter by strong chemical oxidant (K2Cr2O7) under acidic condition. In COD test the main disadvantage is that along with the organic matter, some inorganic substance like Nitrates, Chlorides, Sulphides also get oxidized (However some organic substances like Amino Acids, Benzene, Ketone, etc., do not get oxidized). Hence, this test does not give the exact measure of the strength of organic wastes. The main limitation of the test lies in its inability to differentiate between biologically oxidizable and biologically inert material. COD determination has the advantage over BOD determination, in that, the result can be obtained within 3 hours, where as it takes 5 days in BOD test.

3.2.6 Total Dissolved Solids (mg/l)

Normally the sewage water sample contains 99.9 % water and 0.1% solids. The term solids in water and waste water for a sanitary engineer refers to as the matter which remains as a residue after evaporation and subsequent drying at specified

temperature of 100^0 to 105^0 C. the total solids is considered as the sum of dissolved solids and suspended solids.

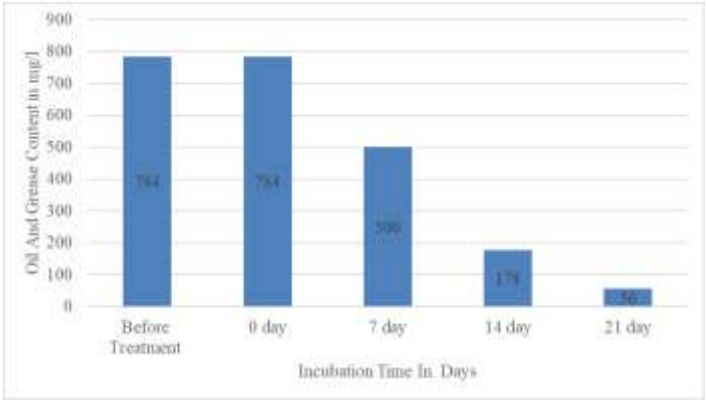
The measurement of solids is by means of the gravimetric procedure. The various forms of solids are determined by weighing after the appropriate handling procedures. The total solids concentration of a sample can be found directly by weighing the sample before and after drying at 103°C. However, the remaining forms, TDS and TSS require filtration of the sample. For liquid samples, all these solids levels are reported in mg/L.

4. RESULTS AND DISCUSSION

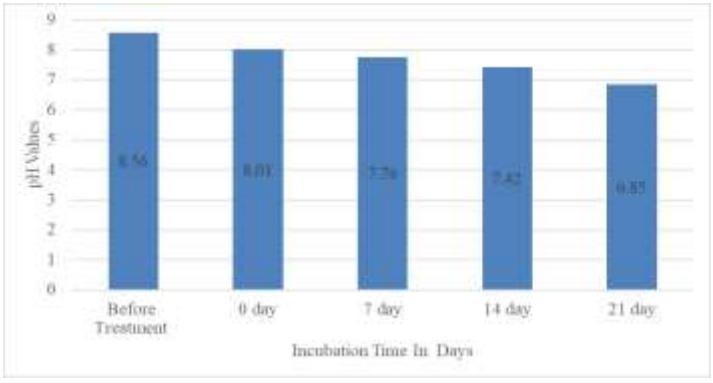
The results were found and according to contaminants present in the waste water the various techniques to be used for the treatment is to be known. Studies have suggested that EM treated oily domestic waste water showed distinct reduction in all the tested parameters under all the tested incubation period. Oil and grease content was reduced to 784,784,500,178 and 56.pH was also reduced from 8.56 to 8.01,7.76,7.42 and 6.85. No reduction was observed in DO content. The BOD was reduced from 5.6 to 5.5, 4.7,3.9 and 3.5. The COD was decreased from 203 to 199, 175,146 and 129 mg/litre. Total dissolve solid was found to be reduced from 1400 mg/lit to 1200, 900,800 and 750 mg/litre at the respective incubation time. The analyses were carried out according to recommended ISO methods.

Table 4.1 Changes In Parameters Of Oily Domestic Waste Water Treated With EM

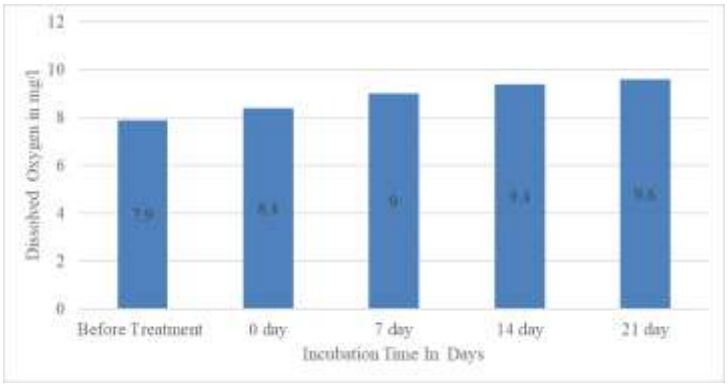
Sr. No.	Parameters	Incubation Time In Days				
		Before Treatment	0	7	14	21
1	Oil And Grease Content (mg/l)	784	784	500	178	56
2	pH	8.56	8.01	7.76	7.42	6.85
3	Dissolved Oxygen (mg/l)	7.9	8.4	9.0	9.4	9.6
4	BOD (mg/l)	5.6	5.5	4.7	3.9	3.5
5	COD (mg/l)	203	199	175	146	129
6	Total Dissolved Solid (mg/l)	1400	1200	900	800	750



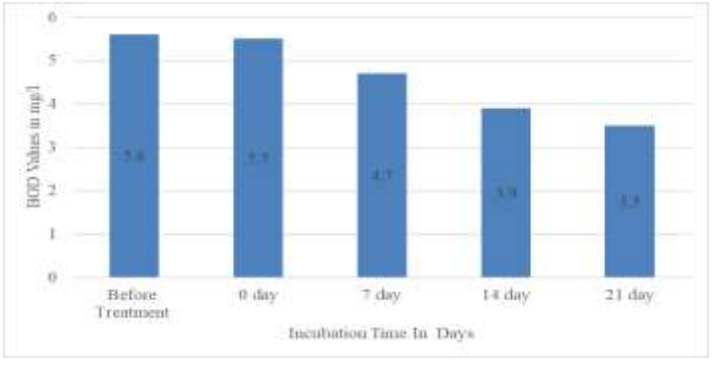
Graph No 4.1. Changes in Oil & Grease Content among samples within 21 days.



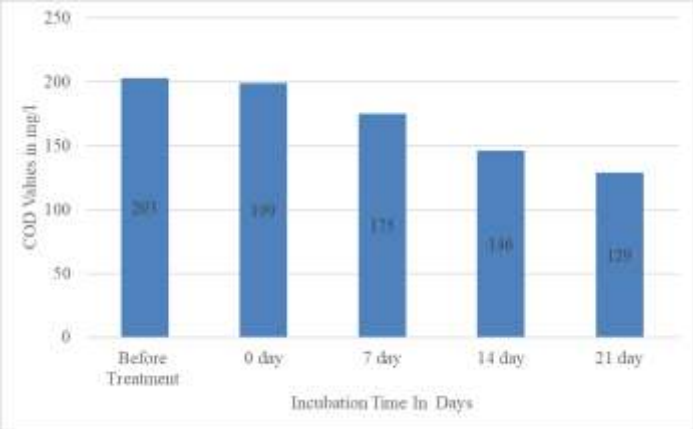
Graph No 4.2. Changes in pH Values among samples within 21 days.



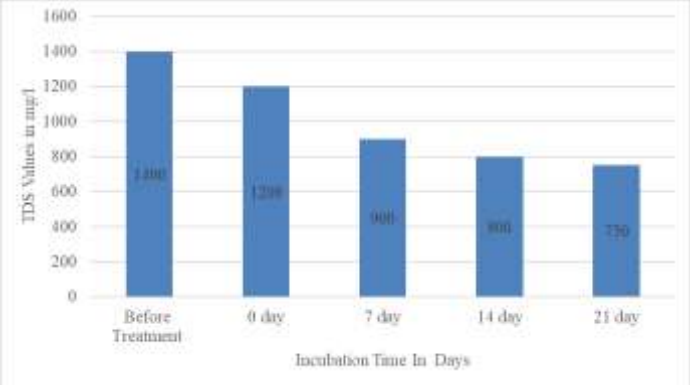
Graph No 4.3. Changes in Dissolved Oxygen Values among samples within 21 days.



Graph No 4.4. Changes in BOD Values among samples within 21 days.



Graph No 4.5. Changes in COD Values among samples within 21 days



Graph No 4.6. Changes in TDS Values among samples within 21 days

5. CONCLUSION

The study demonstrates that Effective Microorganisms technology is a promising, sustainable, and eco-friendly solution for degrading oil in domestic wastewater. The results suggest that EM technology can effectively reduce oil contamination, providing a viable alternative to traditional wastewater treatment methods. Moreover, the use of EM technology aligns with global trends in seeking sustainable and green solutions to environmental problems.

The study reveals that EM technology in wastewater treatment significantly reduces environmental impact by decreasing oil and grease concentrations. It also effectively controls pH, TDS, and BOD, improving water quality. EM technology significantly reduces the content of contaminants in water, including phosphorus compounds, E. coli, coliform bacteria, and the total plate count of bacteria, up to 21 days after application.

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