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# Sorption and Extraction of Anionic Surfactants from Domestic waste water using Acidified Sawdust

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**Abstract:** Surfactants are the compounds which reduce the surface tension between two liquids or between solid and liquid such as detergents, emulsions, wetting agents etc.There are different types of surfactants such as anionic, cationic, zwitterionic, non-ionic. Aionic Surfactants such as sulfate, phosphate, sulfonate and carboxylates. Alkyl sulfates includes Sodium Dodecyl Sulfate(SDS), Sodium Lauryl Sufate(SLS) etc.Anionic surfactants are potentially dangerous environmental pollutants due to their high-volume use in laundry and cleaning products ,they are omnipresent water contaminants . The aim of the research work is to investigate the optimized conditions for removal of anionic surfactants from domestic waste water using acidified saw dust. The initial concentration of anionic surfactants in domestic waste water is 20 ppm. After the sample is treated with acidified sawdust the anionic surfactants concentration is estimated by solvent extraction by using as solvent and Acridine orange as indicator and at 467 nm in UVSpectrophotometr.The optimum conditions for removal of anionic surfactants were Time of 90min, Adsorbent dosage of 5%(W/V), pH-7 and at 25◦C temperature obtained. From the obtained optimal conditions, the removal efficiency was 70% and it was improved to 90% using chemically Acidified sawdust.Column Chromatography and their kinetics were also studied. In Column,Chromatographic studies the sample is feed to column in batch process. For every 10 min the sample is collected and concentration of Anionic Surfactants is estimated by solvent extraction method the maximum % Removal of Anionic Surfactants is obtained at 45min of 90%, and their kinetics were estimated pseudo second order is best for the process the correlation coefficient is 0.99.

**Keywords**: Surfactants, Optimization, Acidified sawdust, Column Chromatography, Kinetics.

## I. INTRODUCTION

Pollution of Water Bodies The presence or introduction of unwanted materials in the environment which have harmful or poisonous effects is called Pollution. It is the introduction of contaminants in the surroundings which have adverse effects.The different constituents of pollution which are called pollutants may be either contaminants which are already in nature or those which have been come onto existence due to human activities. Pollutions might be present in the form of any organic or inorganic materials or sometimes some kind of energy like sound, light etc. Water pollution has become one of the most dangerous threats to environment in today's world. It is the impurification of water resources- rivers, oceans, groundwater etc. because of human beings and their activities. There are various ways of polluting water, most important being the discharge of industrial wastewater through spillage from water bodies. The sewage discharge from homes is not treated before being discharged to environment which is also a main cause of pollution [1]. Other causes include chemicals which are flowing on the surface due to various activities and fertilizers and pesticides release from the agricultural activities. Surfactants are generally deposited in numerous ways on land and into water systems, whether as part of an intended process or as industrial , household waste. Some of them are known to be toxic to animals, ecosystems, and humans, and they can increase the diffusion of other environmental contaminants[8][9][10].In the year 2000 there were two major surfactants used namely Linear Alkylbenzene Sulfonates (LAS) and the Alkyl Phenol Ethoxylates (APE). They break down in the aerobic conditions found in sewage treatment plants and in soil to the metabolite nonylphenol, which is thought to be an endocrine disruptor.

**Saw dust :**

Sawdust or wood dust is a by-product of cutting, grinding, drilling, sanding, or otherwise pulverizing wood or any other material with a saw or other tool; it is composed of fine particles of wood. It is also the byproduct of certain animals, birds and insects which live in wood, such as the woodpecker and carpenter ant. It can present a hazard in manufacturing industries, especially in terms of its flammability. Sawdust is the main component of particleboard.

**Surfactant:**

In the following the word surface will be used to designate the limit between a condensed phase and a gas phase, whereas the term interface will be used for the boundary between two condensed phases. This distinction is handy though not necessary, and the two words are often used indifferently particularly in American terminology.

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**Classification of Surfactants** From the commercial point of view surfactants are often classified according to their use. However, this is not very useful because many surfactants have several uses, and confusions may arise from that. The most acepted and scientifically sound classification of surfactants is based on their dissociation in water. The figures in page 4 show a few typical examples of each class.

Anionic Surfactants, Nonionic Surfactants, Cationic Surfactants

## II. MATERIALS AND METHODOLOGY

MATERIALS REQUIRED FOR THE TREATEMENT OF WASTEWATER

**Collection of domestic wastewater**: Domestic Wastewater was collected in Visakhapatnam in Andhra Pradesh.

**Chemicals required:** Saw dust, H2SO4, NaoH, Toluene, Glacial Acetic acid, Acridine Orange, Distilled water.

**Equipment required:** Magnetic stirrer, pH meter, UV-Visible spectrophotometer, Orbital shaker

**Determination of Anionic Surfactants Apparatus:** UV- spectrophotometer ranging 200- 1000 nm with 1 cm matching quartz cells

**Reagents:** Acridine orange, toluene, glacial acetic acid

**Preparation of acridine orange solution:** Acridine orange is normally available in powder form so, 10gm of acridine orange is dissolved in 10ml of distilled water.

**Procedure:** The anionic surfactants are determined by spectrophotometric method using acridine orange. A 10ml sample of domestic waste water is taken and adds 100µL of glacial acetic acid and acridine orange each and to it also add 5ml of toluene and kept in separation funnel(Fig 1) and it is shaken for one minute and allowed to settle for 5min and separation takes place. Take 2.5 ml of toluene layer whish in the top and the absorbance is directly measured in UV Spectrophotometer at 467nm.

Fig. 1: Separating Column

**Adsorbent collection**

Saw dust(Fig 2) was collected from the local saw mill of large quantity

Fig.2: Saw Dust


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**Preparation of Adsorbent:**

**Acidification of saw dust**

**Preparation of 1N $H_2SO_4$:**19ml of H2SO4 is taken in volumetric flask (1000ml) and it is dissolved in 500ml of distilled water.

**Procedure:**

A raw saw dust of 175gm were collected from the local saw mill and it is dried and the saw dust is kept in a tray and add 1N $H_2SO_4$ of 500ml to it and allowed for 24hr for acidification process and it is dried in an hot air oven at 100$^oC$ temperature for 2hr, and the dried powder is sieved using 150 mesh size for uniformity of the size of the adsorbent.

## III. RESULTS AND DISCUSSION

**Optimization of Adsorbent:**

The removal of anionic surfactants concentration was studied by using different types of adsorbents like saw dust, acidified saw dust and basified saw dust to optimize the adsorbent source. Then the experiments were conducted for all the three adsorbents with respect to time. One gram of each adsorbent were added to the 10ml of domestic waste water that is sample and kept in a shaker and for every 30 min the sample were taken and tested under UV spectrophotometer. And readings were noted for all three samples for which different adsorbents were added. For the saw dust which was acidified shows the high percentage removal of anionic surfactants are observed. So we have taken the acidified saw dust as an adsorbent for conducting the experiments for removal of anionic surfactants concentration in domestic waste water for various parameters. The results for all the three adsorbents were given in the Fig-3. Hence the optimized source for the removal of anionic surfactants concentration is acidified saw dust.

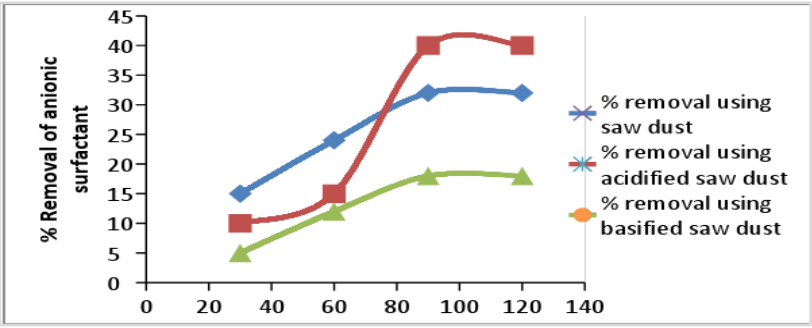


Fig3: Effect of modified saw dust for % removal of anionic surfactants

## IV. STUDY OF EFFECT OF VARIOUS PARAMETERS

**a) Effect of Acidified saw dust on Contact time:**

Time is important parameter in every process. The time required for removal of anionic surfactant concentration is estimated by taking a 250ml conical flask into which 10ml of the sample is added and add 1gm of acidified saw dust to the sample and kept in an orbital shaker. The removal of anionic surfactants from domestic waste water was studied as an function of contact time in the range of 30-180 min, at 6.52 pH and at room temperature. The anionic surfactants concentration is observed at every 30 min. The anionic surfactant is observed until it reaches stable state. The anionic surfactants concentration is decreased with respect to time and it is stable at 90 min and the process is continued further but there is no change in the anionic surfactants concentration. It says that the increase in time of treatment with acidified saw dust does not have any effect on the anionic surfactants. The mechanism involved in this process is the solute transfer to the solid includes diffusion through the pores to the active sites. At the early stages the diffusion between the film and the available pore sites are large and the rate of adsorption is fast. At the later stages the rate of adsorption decreases due to slow pore diffusion of the solute ion into the bulk adsorbent.

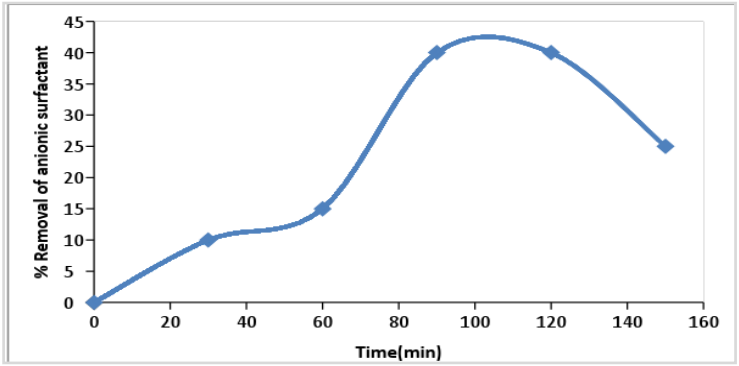


Fig.4: Effect of contact time on % Removal of Anionic Surfactants

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The % removal of anionic surfactants at 90min is 40%. In this process the removal percentage of anionic surfactants with respect to time is shown below Fig-4. Hence the optimum time for removal of anionic surfactants is observed at 90 min.

**b)Effect of acidified saw dust on dosage :**

Adsorbent dosage plays a important role in the process. The amount of acidified saw dust used for removal of anionic surfactant is determined by taking 10 ml of sample in 5 conical flask of 250 ml and the conical flasks are kept in a shaker. The anionic surfactants concentration estimated by treating the samples with acidified sawdust for 90min from0.5gm to 1.5gm the concentration the anionic surfactants concentration is decreased gradually and it is stable at 2.5 and 3gm. The obtained data shows that the adsorbent dosage increases the percentage adsorption also increases. By increasing the adsorbent dosage there will be increase in the adsorption sites. The % removal of anionic surfactants at 2.5gm is 80%. In this process the removal of anionic surfactants with respect to acidified saw dust is shown in the below Fig-5. Hence the optimum adsorbent dosage for removal of anionic surfactants is 2.5gm.

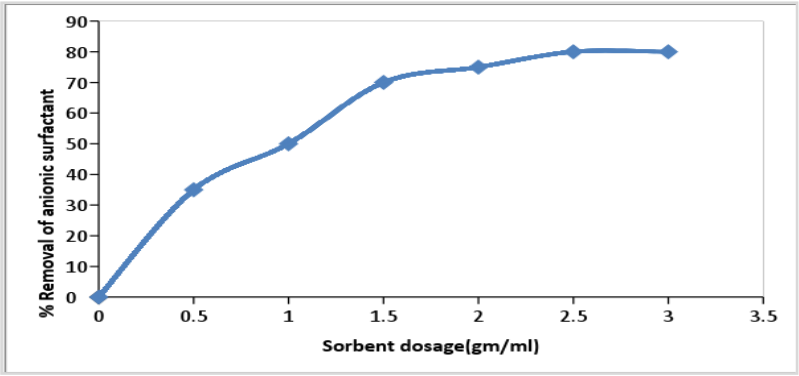


Fig 5: Effect of Sorbent dosage on % Removal of Anionic Surfactants

**c)Effect of acidified saw dust on pH:**

pH is the important factor for reducing the concentration of anionic surfactants from domestic waste water is estimated by 10ml of sample in a conical flask and add 2.5gm of acidified saw dust to the samples in conical flask and keep for shaking in a shaker for 90min. The anionic surfactants concentration is estimated at different pH for 90min. The anionic surfactants concentration is observed from pH 3 to till it reaches stable. At pH 3 and pH 4 the concentration of anionic surfactants is little high when compared to initial pH of the domestic waste water (pH 6.52). At pH 5 to pH 8 the concentration of the anionic surfactants is decreased and stable at pH 7. The optimum pH is 7 with respect to removal of anionic surfactants using acidified saw dust. The % removal of anionic surfactants at pH is 83.3%. The concentration of anionic surfactants with respect to pH is shown in Fig-6.

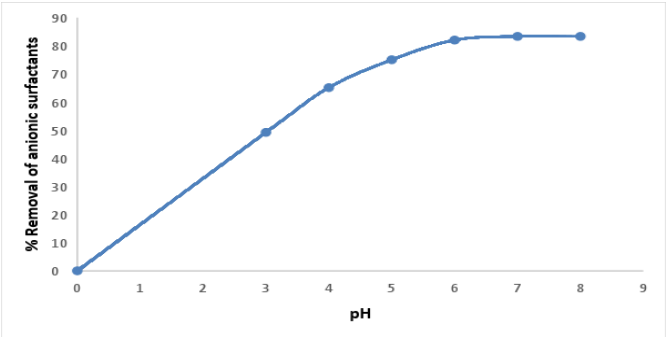


Fig. 6: Effect of pH on % Removal of Anionic surfactants

**d) Effect of acidified saw dust on temperature:**

The effect of temperature for removal of anionic surfactants using acidified saw dust is observed. The temperature estimated from rage of 20$^{o}$C to 45$^{o}$C. An 10ml of the sample is taken in conical flask allowed for treatment for 90min using acidified saw dust. It is observed that at 25oC temperature the concentration of the anionic surfactants is decreased drastically may be due endothermic adsorption of ions. The % removal of anionic surfactants at 25$^{o}$C is 87.7%. The concentration of anionic surfactants is shown in Fig-7.

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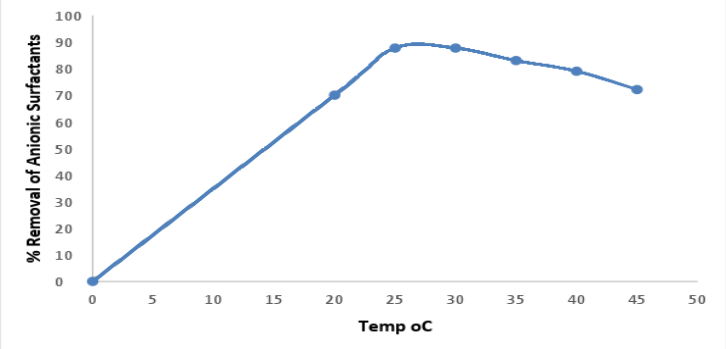


Fig 7: Effect of temperature on % Removal of Anionic surfactant

**Column Chromatography Studies And Their Kinetics**

Column separation was adopted as one of the technique for the removal of anionic surfactants from the Domestic wastewater. Mainly column can be used for many of separation process like surfactants, nitrates, metals, oils and fats, etc.Here the experiment is done batch process because initially batch process. The column first filled small cotton and onto that sea sand of 1mm height to reduce the escape of adsorbent and then it is filled with acidified saw dust(adsorbent) of 150 microns' mesh size up 10cm height. The initial conditions of pH-7 and temperature of 30oC were maintained. A sample of 150 ml of domestic wastewater is poured into column since it is batch process, for every 5min sample was collected from the bottom and the collected sample is taken to calculate the concentration. The concentration is estimated by solvent extraction method by using as solvent and Acridine orange as indicator. The experiment is done within the range of 0-60 min. In column chromatography 90% is the maximum removal efficiency is obtained at 45min. The results were displayed in Fig 8 and Fig 9.

Fig 8: Column Chromatography

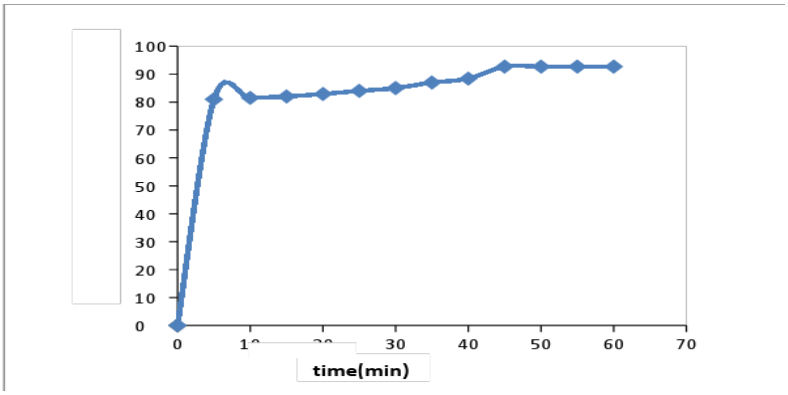


Fig. 9: Effect of column chromatography on % Removal of Anionic Surfactants

**Continuous stirred tank reactor(CSTR): Batch Mode**

CSTR is known as an back mix reactor and used to estimate the key unit operation variables when using a continuous agitated-tank reactor to reach a specified output.

In this present study using CSTR is also another technique used for the removal of anionic surfactants from domestic waste water using acidified saw dust. The experiment is done based on batch process.

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- The tank is filled with 250ml of the sample onto which 25gm of acidified saw dust is added and rpm is set to 500. For every 10 min, the sample is collected upto 160min and the concentration of Anionic surfactants is estimated by solvent extraction by using using as solvent and Acridine orange as indicator and it is seen in UV-Spectrophotometer at 467nm, The maximum removal efficiency was obtained at 20min and after 20min its started decreasing due non ideality. The results obtained is displayed below in Fig 10 and Fig 11. In CSTR studies 81% is the maximum removal efficiency is obtained at 20min.

Fig. 10: CSTR

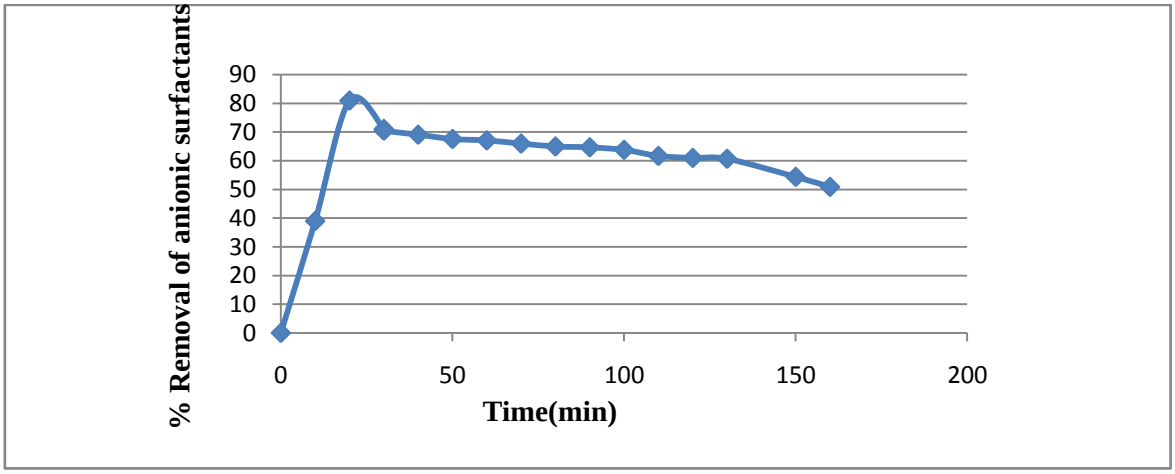


Fig-11: Effect of CSTR on % Removal of Anionic Surfactants

Table : Comparison of % Removal of Anionic Surfactants of various adsorbents with Acidified Saw Dust

| S.no | sample | Adsorbent/process | Surfactant | %Removal | Reference no |
|---|---|---|---|---|---|
| 1 | Synthetic water | Granular activated charcoal-Batch process | Sodium dodecyl sulphate(SDS) | 96 | 3 |
| 2 | Synthetic water | Rubber granules-Batch process | Sodium dodecyl sulphate(SDS) | 90 | 3 |
| 3 | Synthetic water | Wood charcoal-Batch process | Sodium dodecyl sulphate(SDS) | 88 | 3 |
| 4 | Synthetic water | Silica gel-Batch process | Sodium dodecyl sulphate(SDS) | 92 | 3 |
| 5 | Waste water | Rice husk-Batch process | Sodium linear alkyl benzene sulphonate | 88 | 13 |
| 6 | **Domestic Waste Water** | **Acidified saw dust-Batch process** | Anionic surfactants | 87.7 | **Present Study** |
| 7 | **Domestic Waste Water** | **Acidified saw dust in column chromatography-Batch process** | Anionic surfactants | 90 | **Present Study** |
| 8 | **Domestic Waste Water** | **Acidified saw dust in CSTR-Batch process** | Anionic surfactants | 81 | **Present Study** |

## V. CONCLUSIONS

- The experimental results showed the sorption of Anionic surfactants from domestic waste water using acidified saw dust.
- For batch studies, the optimum conditions were found to be as follows ,Time of 90min, Adsorbent dosage of 5%(W/V), pH-7 and at 25℃temperature obtained.

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- Under these optimized conditions the concentration of anionic surfactants in domestic waste water is reduced upto 90%.
- In column chromatography 90% is the maximum removal efficiency is obtained at 45min.
- In CSTR studies 81% is the maximum removal efficiency is obtained at 20min

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