

## THE REMOVAL INVESTIGATION OF COCONUT ACID SURFACTANTS IN ACTIVATED SLUDGE'S SYSTEM

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### ABSTRACT

There are significant municipal concerns relating to the use of surfactants and enzymes in the process of wastewater treatment. Treatment plants use different techniques to remove impurities from water. As wastewater treatment plants use the latest technology to remove contaminants from water, there are high costs, and sometimes an enforcement of regulations is lax. Still, many municipalities across the country prohibit the use of surfactants and enzymes entering wastewater treatment because of the harmful effects of these products on the sewer lines and high damage costs. Surfactant compounds are organic. Their molecules include water-soluble and oil or an insoluble component. These molecular compounds seek the water surface and chemically reduce the boundaries between oil and water. When surfactants are in the water, they absorb into the soil and can cause injury to plants and organic organisms, but people find surfactants and enzymes useful in cleaning agents for emulsifying and dispersing oil and grease. Scientists have found that at least some surfactants are toxic to ecosystems, people and animals, but they have not been able to predict far-reaching consequences. And now the most important question is how to solve this problem or how to reduce these negative effects. In this paper we tried to remove surfactants from waste water with an activated sludge system.

**Keywords:** Cocamide DEA, surfactant, waste water, activated sludge, COD.

### INTRODUCTION

Cocamide DEA, or Cocamide DI Ethanolamine is a DI ethanol amide made by reacting the mixture of fatty acids from coconut oils with DI Ethanolamine. It is a viscous liquid and is used as a foaming agent in bath products like shampoos and hand soaps, and in cosmetics as an emulsifying agent (See Cocamide for the discussion of the lengths of carbon chains in the molecules in the mixture). The chemical formula is  $\text{CH}_3(\text{CH}_2)_n \text{C}(=\text{O}) \text{N} (\text{CH}_2\text{CH}_2\text{OH})_2$ , where  $n$  can vary depending on the source of fatty acids.

Three cases are reported by individuals allergic to Cocamide DEA, also known as coconut DI ethanol amide. In two cases, multiple

other cutaneous allergies were present. In both instances, Cocamide DEA was present in several personal care products used by patients. In the third case, occupational exposure was suspected. Cocamide DEA is an unusual allergen that may cause contact dermatitis in individuals who often have multiple other skin allergies. The International Agency for Research on Cancer (IARC) lists coconut oil di ethanolamine condensate (Cocamide DEA) as an IARC Group 2B carcinogen, which identifies this chemical as possibly carcinogenic to humans. In June 2012, the California Office of Environmental Health Hazard Assessment added Cocamide DEA to the California Proposition 65 (1986) a list of chemicals known to cause cancer.

**MATERIAL AND METHOD**

**Experiment**

In this experiment we used 4 bubbling stirred reactors. Three reactors contained activated sludge with surfactants (Cocamid DEA) with variance density 1000, 2000, 4000 ppm and the fourth one contained only activated sludge.

We used activated sludge for their more advantage; it is not expensive, does not have any danger for the environment and it is accessible. Activated sludge treatment is suitable for use in facilities that contain organic chemical waste. These may include municipal sewage treatment plants, oil refineries, food processing plants and chemical manufacturing. At the first day each of the surfactant's reactors contained 4 gr of dry matters with distilled water free from additive. We aerated the reactors for 28 days.

**Preparation of activated sludge**

Activated sludge culture was received from wastewater treatment plant of Oil National Company in Tehran, Iran. The aerobic reactor was inoculated with this culture. The constituents of wastewater used throughout the studies are given in Table 1. Lack of each of these materials can limit the growth of microorganisms, of course, there are all of them in the wastewater, except phosphorus, nitrogen, carbon and oxygen are required that were added every day. In the starting test, first and second day the sludge settling time was two hours then the dead cells were collected. On the third day sludge feeding began. The amounts of feed were equal to glucose 7.5 gr/day,

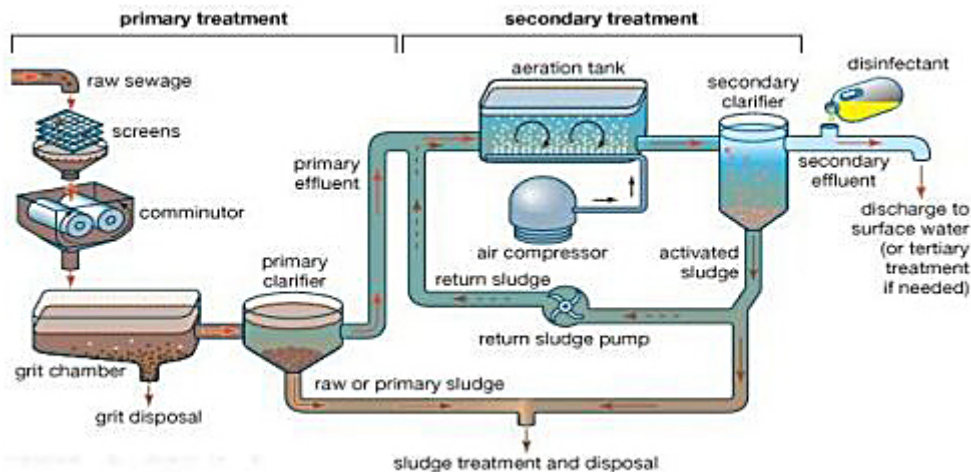
Ammonium phosphate 0.34 gr/day and Ammonium nitrate 0.93 gr/day. The feeding was done for a week. So the culture was ready for testing.

**EXPERIMENTAL PROCEDURE**

We used four reactors with the same structure and volume as explained above in parallel tests. Experiments were started batch wise. Activated sludge from wastewater treatment plant was added to the reactors as seed. The similar value of sludge was inoculated in four parallel reactors. The test reactors (R1, R2 and R3) contained bio surfactant. The Cocamid DEA bio surfactant concentration was added to them, in 1000, 2000, 4000 ppm respectively. In the control reactor (R4), the feed water did not contain any surfactant in order to specify the effect of surfactant. Each of the test series dissolve in distilled water and make up 1 liter. The entire reactor was aerated by an air pump. These conditions were fixed for the entire duration of the experiment. The temperature and Pressure were 250 °C and 625 mm Hg and pH adjusted to 7. A schematic diagram of the experimental setup is shown in Figure 2.

**Table 1.** Inorganic constituents of microorganisms

Chemical Compounds	Percent
MgO	8
K <sub>2</sub> O	6
Fe <sub>2</sub> O <sub>3</sub>	1
P <sub>2</sub> O <sub>5</sub>	50
SO <sub>2</sub>	15
Na <sub>2</sub> O	11
CaO	9



**Figure 1.** Activated sludge acquisition

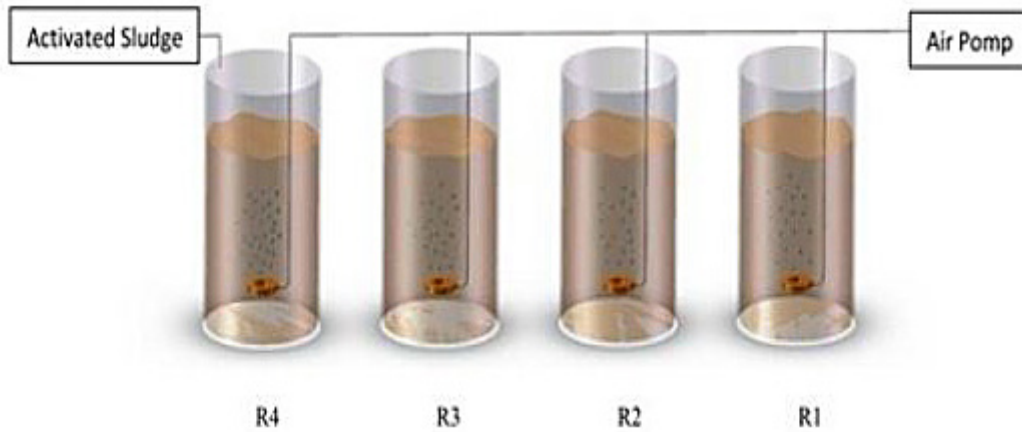


Figure 2. Schematic diagram of the experimental setup

## RESULTS AND DISCUSSION

MLSS testing measures the total concentration of mixed liquor suspended (non-soluble) solids in the aeration basin of an activated sludge system. The mixed liquor suspended solids (MLSS) data are critical in determining the operational behavior and solids inventory of the system and it is used to determine when to waste and/or recycle sludge.

In order to test the mixed liquor suspended solids (MLSS) a well-mixed sample should be filtered through a weighed filter. The residue left on the filter is dried to a constant weight at a temperature between 103 °C and 105 °C. The increase in weight of the filter represents the total suspended solids of the sample. The size of sampling should also be limited to a size the yields, no more than 200 mg residue. After the mixed liquor suspended solids value is determined a mixed liquor volatile suspended solids (MLVSS) test may be per-

formed in order to determine the concentration of volatile suspended solids in the aeration basin of an activated sludge system. Mixed liquor volatile suspended solids data are critical in determining the operational behavior and biological inventory of the system. The filter used for mixed liquor suspended solids (MLSS) testing is ignited at 550°C for 30 minutes. The weight lost on ignition of the solids represents the volatile solids in the sample. Figure 3 shows the rate of MLSS and MLVSS. During 28 days MLSS increased from 1.259 g/lit to 1.299 g/lit and MLVSS increased from 1.257 g/lit to 1.295 g/lit.

Biochemical oxygen demand (BOD) and chemical oxygen demand (COD) are two different parameters to measure how much oxygen the water will consume when it enters the recipient. In both cases the oxygen-consuming substances are mainly of organic origin. These substances should be reduced to a minimum in the waste-

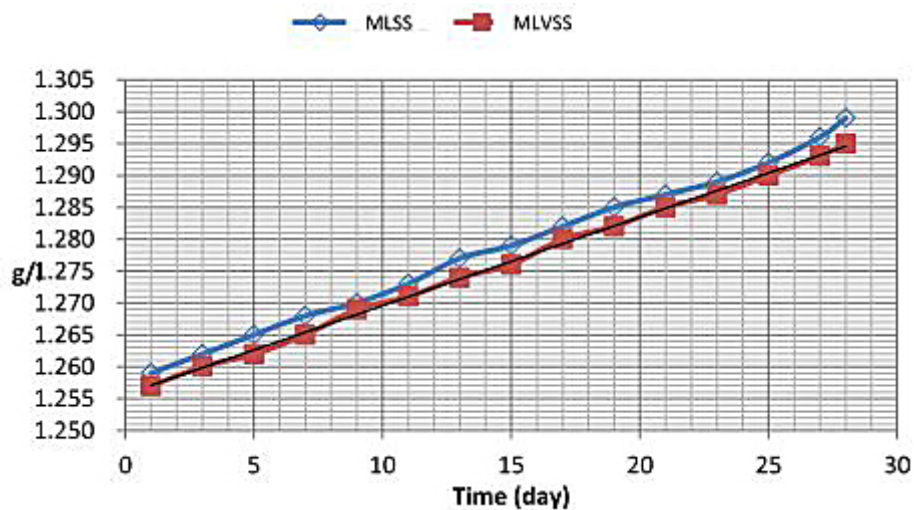


Figure 3. The rate of MLSS and MLVSS of activated sludge, during the test

water treatment plant. Industries normally focus more on COD and municipalities than on BOD removal. With a chemical treatment, removal of COD is improved at basically all kinds of wastewater plants. The more particle-bound COD, the more efficient the removal rate. Our products can separate some dissolved substances as well, but when the COD consists of small organic molecules a biological treatment process is normally preferred. As shown in Table 2 in the 3 days, COD removal efficiencies were from 61% to 81% in the R1, it was from 1.3% to 48% in R2 and 12% to 24% in R3. The reduction was observed in the first week, equal to 95% in R1, 97% in R2 and 93% in R3.

Figure 4 depicts a shift of COD removal efficiency rates with time. Rapid slope increase in

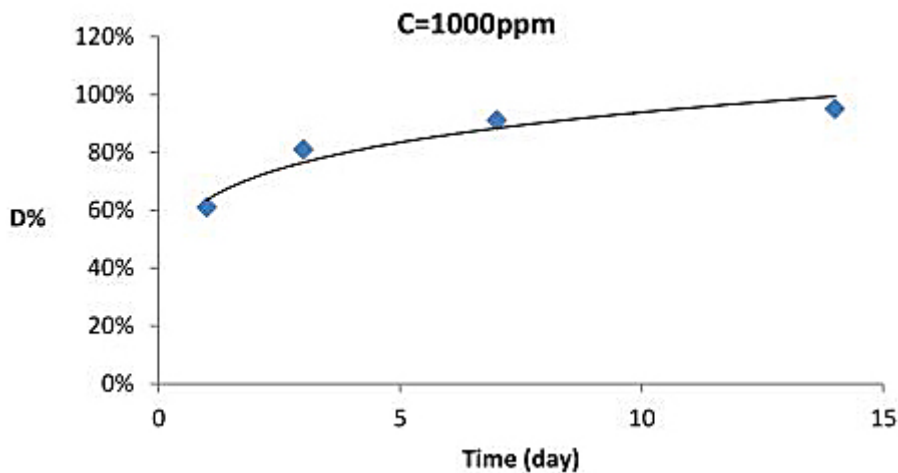
COD removal efficiency rate with the time in R1, the high decreases in COD concentrations occur in the first 3 days. After that, the removal rate is linear. At the end of the test, the maximum removal was 95% after 14 days.

Figure 5 depicts shift of COD removal efficiency rates with time. Rapid slope increase in COD removal efficiency rate with the time in R2, the high decreases in COD concentrations occur in the first 3 days. After that, the removal rate is linear. At the end of the test, the maximum removal was 97% after 21 days.

Figure 6 depicts shift of COD removal efficiency rates with time. Rapid slope increase in COD removal efficiency rate with the time in R3, the high decreases in COD concentrations occur in the first 7 days. After that, the removal rate is

**Table 2.** Comparison of operational parameters of the reactors with different surfactant concentration

Reactor	Run	Time (day)	COD Removal Efficiency
R1	Run No.1	1	61%
	Run No.2	3	81%
	Run No.3	7	91%
	Run No.4	14	95%
R2	Run No.1	1	1.3%
	Run No.2	3	48%
	Run No.3	7	86%
	Run No.4	14	91%
	Run No.5	21	97%
R3	Run No.1	1	12%
	Run No.2	3	24%
	Run No.3	7	33%
	Run No.4	14	85%
	Run No.5	21	91%
	Run No.6	28	93%



**Figure 4.** Shift of COD volumetric removal rates with overtime for C = 1000 ppm

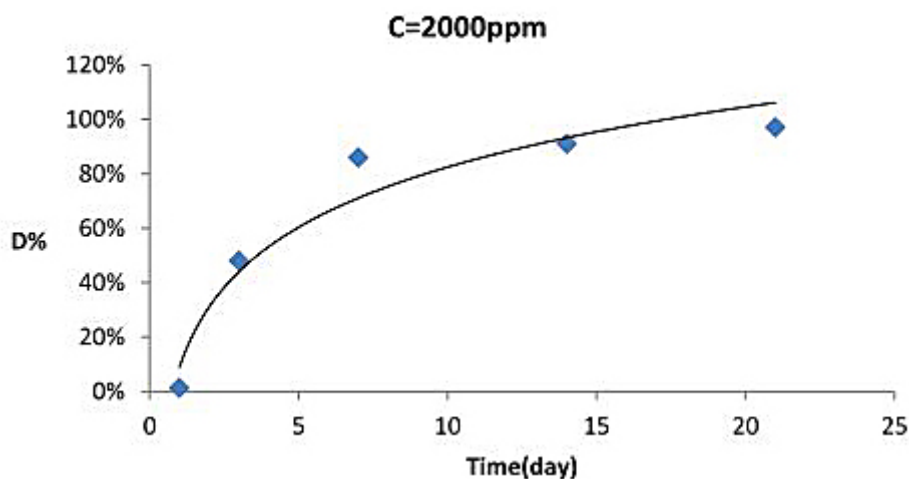


Figure 5. Shift of COD volumetric removal rates with overtime for C = 2000 ppm

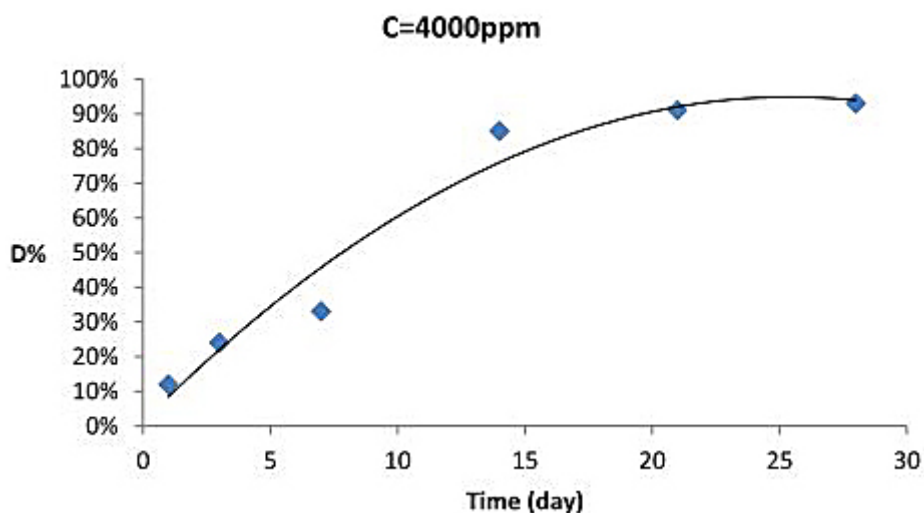


Figure 6. Shift of COD volumetric removal rates with overtime for C = 4000 ppm

linear. At the end of the test, the maximum removal was 93% after 28 days.

## CONCLUSION

In this paper, the authors investigated the impact of Cocamide DEA on the activated sludge system of biological treatment. Increasing the concentration of surfactant would lead to treatment plant efficiency enhance. Also the result showed that increasing the concentration of solids MLSS makes the removal efficiency increase.

According to the result of this study, it can be complete, proven by further investigations that bio surfactant-enhance degradation would result in prompter (reduced treatment times) and modified water quality, and overall cheaper treatment cost. The interaction between bio surfactant and

the pollution in wastewater is a very complex phenomenon and is not the subject of this study. But it is possible to say that bio surfactants are very effective in the COD removal as demonstrated in this study. So, the effectiveness of different bio surfactants in the removal of more pollutions should be investigated in the future studies in order to distinguish the best combination.

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