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Photocatalytic Treatment of Soap Containing Copper Metal-Organic Complexes: A One-Step Approach for Efficient Metal Complex as Copper Soya Soap Degradation

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Abstract:
Photodegradation is a well-known interdisciplinary field in science and technology, focused on developing new methods to protect and preserve the environment. The goal of this work to provide an outline about photocatalytic degradation of Copper soap complexes synthesized from natural edible oils with long chain fatty acids. The goal of this work is to determine the accurate kinetics of the photocatalytic degradation of the Copper(II) Soya Thiourea complex and to provide accurate kinetics of photocatalytic degradation of Copper (II) Soya Thiourea complex containing N and S as donor atoms, as a function of various operating parameters such as catalyst loading light intensity, reactivity in polar and non-polar solvent. The relative photocatalytic activities of Copper Soya soap complexes were analyzed based on their percent degradation, with the expectation that these findings could open new possibilities in biological applications. Photocatalysis also holds broad potential in the field of renewable energy.

Keywords: Copper (II) Soya Thiourea complex, percent degradation, polarity of solvent.

1.Introduction:
Copper(II) soap complexes with nitrogen and sulfur-containing ligands play a significant role across various fields of science and technology. Anionic surfactants containing copper ions are gaining attention for their practical applications, including use as herbicides and fungicides.
Copper(II) soaps and their complexes play a key role in specific applications such as fungicides, pesticides, herbicides, and other antimicrobial agents. However, their potential to cause environmental pollution poses a significant challenge for materials scientists.
Studying the photodegradation of biologically active molecules in various solvents under different conditions can yield valuable insights for advancing safe and sustainable green chemistry. Several Copper(II) complex systems have already been employed in the degradation of lignin, polycyclic aromatic hydrocarbons, and synthetic dyes. [1]
Recently work on transition metal complexes of heterocyclic ligands and polymetallic complexes have been done and also their structure and biological characteristics have been discussed.[2] The effectiveness of Copper soaps as insecticides fungicides, bactericides, and herbicides were also studied.[3]
This article discusses the photocatalytic degradation of Copper(II) soap complexes derived from edible oils (mustard oil and soybean oil), conducted in the presence of semiconducting zinc oxide (ZnO) and monitored spectrophotometrically. Studies like time of irradiation and polarity of solvent with Copper (II) soap complex concentrations are also discussed.
Research on zinc oxide is rapidly advancing as a promising technique for water and air purification.

2.Experimental
Copper(II) soaps were synthesized by direct metathesis \[4], and their complexes were prepared by refluxing a 1:1 ratio of Copper(II) mustard soap and Copper(II) soya soap with ligands such as urea and thiourea [5]. The resulting precipitate was filtered, washed with hot purified benzene, and dried. The sticky product that passed through the filter was washed multiple times with ethanol and then dried. The final

product was distinctly green in color and soluble in benzene, other non-polar, and organic solvents, but insoluble in polar solvents such as water [6].

Complexes are abbreviated as:
Copper Mustard Thiourea complex-[CMT]
Copper Soya Thiourea complex-[CST]

The photocatalytic activity of the complexes has been evaluated by measuring the rate of degradation and the kinetics of photodegradation of CMT and CST complexes. Covered glass bottles (pyrex-50 ml) containing 25 ml solutions were used for shielding of evaporation of solvent during irradiation with a 200 W tungsten lamp (visible light, Philips). A water strain was used to eliminate thermal emission in degradation method.

Amount of catalyst (ZnO) used for the study were range from 0.01 g to 0.06 g. The reaction mixture, containing ZnO as photocatalyst has exposed to a 200 W tungsten lamp (Philip) for light radiation 18 $mWcm^{2-}$to 42 $mWcm^{2-}$. Variation in the light intensity had done by changing the distance between the light source and reaction mixture and Suryamapi (CEL model SM 201) measured it. Calibration of the spectrophotometer was done after each observation. During analysis, absorbance measured with reference to benzene blank. The reported absorbance maxima were 680 nm for blank.

3.Result and discussion

Percent degradation of the complex has calculated by this expression. [7]

% degradation= Ao-At/Ao *100.

Here Ao = initial concentration of Copper (II) soap complex
At = concentration of Copper (II) soap complex after irradiation

4.Overall Percent Degradation Analysis

Photocatalytic degradation of Copper(II) soap complexes was measured in terms of percent degradation. The progress of degradation was visually indicated by a change in color. Initially, the complex appeared dark green-blue, which gradually faded to light green after 2 hours. With continued light exposure, the light green color slowly disappeared, and the solution became nearly colorless after 18 hours, indicating the completion of degradation.

Percentage degradation of the complex calculated by this expression:

% degradation= Ao-At/Ao *100.

Here Ao = initial concentration of Copper (II) soap complex
At = concentration of Copper (II) soap complex after irradiation

Different rate affecting parameters for percentage degradation were varied to obtain the maximum rate of degradation for photocatalytic degradation of Copper (II) soap complexes.

5.Percent degradation and effect of solvent polarity

As the polarity of solvent increase percent degradation also increase for some extent but after that it remains constant. A perusal of data suggests that the rate of degradation increases with the increase in percentage of polar component in solvent mixture.[8] This may be due to the increase in early participation of the macromolecular solute to get excited by absorbing the electron and degradation starts earlier up to a certain limit. In all the Copper (II) soap complexes, Copper (II) Soya complexes degrades first as compared with Copper (II) Mustard complexes as reported in Figure **-1**

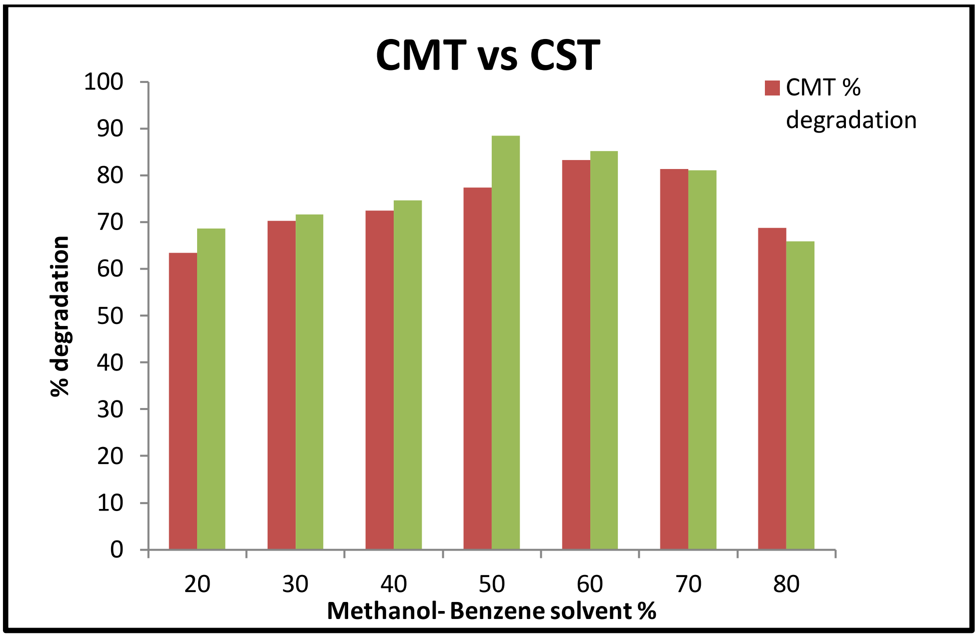

Figure- 1 Percent degradation and effect of solvent polarity of CMT and CST complexes.

6. Conclusion

This study involves the synthesis of a Copper(II) soap complex (CST) and the photocatalytic degradation of complex systems (CST and CMT) in the solution phase using non-polar, non-aqueous media. Zinc oxide (ZnO) was used as the semiconductor under UV-visible light. The rate of photocatalytic degradation of Copper(II) soap complexes initially increases with solvent polarity, but decreases beyond a certain threshold. The percentage degradation is also influenced by various operational parameters. This work presents a comparative analysis of Copper(II) Mustard Thiourea and Copper(II) Soya Thiourea complexes in relation to solvent polarity. Experimental data indicate a two-step degradation process, as observed from plots of concentration versus optical density, which follow the kinetic order $K_1 > K_2$. These findings suggest that photocatalytic degradation could offer a novel contribution to an emerging area of scientific research.

7. Consent for publication

Not applicable.

8.Funding

Not applicable.

9. Conflict of interest

The authors declare no conflict of interest, financial or otherwise.

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