

METAL ORGANIC FRAMEWORK FOR THE DEGRADATION OF RHODAMINE B

Submitted in partial fulfilment of the requirements for the award

of Bachelor of Science

By:

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**DEPARTMENT OF CHEMISTRY
SCHOOL OF SCIENCE AND HUMANITIES**

SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
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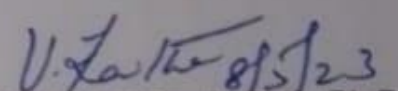
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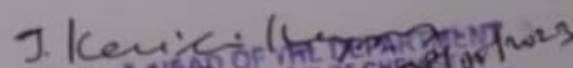
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BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of
R.SIVADHARANI(40030032), S.KALAIYARASI(40030014) who carried
out the project entitled "**METAL ORGANIC FRAMEWORK FOR THE
DEGRADATION OF RHODAMINE B**" under my / our supervision from
01/06/2022 to 31/03/2023.


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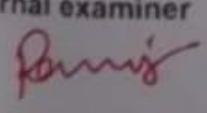
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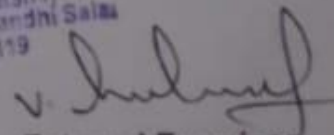

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DECLARATION

We R. Sivadharani and S. Kalaiyarasi, hereby declare that the Project Report entitled **METAL ORGANIC FRAMEWORK FOR THE DEGRADATION OF RHODAMINE B** done by us under the guidance of **Dr. V. KAVITHA M.Sc., M. Phil., Ph.D.**, Professor Department of Chemistry, Sathyabama Institute of Science and Technology is submitted in partial fulfilment of the requirements for the award of Bachelor of Science degree in Chemistry in April 2023.

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ABSTRACT

A metal–organic frameworks (MOFs) based on copper benzene dicarboxylates was applied to the adsorption of rhodamine B (Rh B) from aqueous solution. Cu-BDC [BDC = 1,4-benzene dicarboxylate] is a widely studied MOF. Cu-BDC mainly possessed high surface area and big pore volume which is benefit for the degradation. Characterization of Cu-BDC were achieved by XRD and FT-IR spectra. The effect of parameters such as pH, Initial dye concentration, catalyst, and Hydrogen peroxide amount. The maximum removal has been achieved at the pH = 2.0. The experimental results suggested that Cu-BDC materials have potential application for the wastewater treatment containing Rh B dye.

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LIST OF ABBREVIATIONS AND SYMBOL

S. NO	ABBREVIATIONS AND SYMBOLS	DEFINITION
1	Cu	Copper
2	BDC	1,4-Benzenedicarboxylate
3	Rh-B	Rhodamine B
4	H ₂ O ₂	Hydrogen peroxide
5	XRD	X-Ray Diffraction
6	ppm	Parts Per Million
7	mL	Milli Litre
8	pH	Potential Hydrogen
9	FTIR	Fourier Transform Infrared

CHAPTER 1

INTRODUCTION

1.1 Dye Contaminants in the Aquatic Environment

Water is the most vital substance for life on earth; the health of all living things, including humans, plants, and animals depends on its existence. Water pollution and water scarcity are severe environmental problems worldwide, where one of the most critical challenges of human society is the conservation and proper use of water resources. Industrial activities, daily activities of humans, agriculture, etc., cause water pollution. Hazardous substances in industrial wastewater endanger human life and aquatic organisms. Access to safe and clean water is essential for various activities, and discharging effluents into the environment leads to a severe challenge to safe water accessibility. Various pollutants enter the environment and pollute water resources. One of the most toxic pollutants of water resources is dyes. Leather, textiles, paper and rubber, plastic, and food are among the industries in which dyes have a wide range of applications. Over 1,600,000 tons of dyes are produced worldwide. Dyes are usually classified based on the structural or functional groups plus the ionic charge during dissolution in aqueous solutions. Organic dyes in wastewater are toxic, carcinogenic, and may cause health problems such as respiratory problems, cyanosis, skin irritation, and headache. In addition, the presence of dyes in water reduces dissolved oxygen in water and lowers sunlight irradiation to plants and organisms in water. Moreover, they cause bad odours due to the high chemical oxidation demand. Accordingly, treatment of dye contaminant wastewater before discharging into the environment is necessary.

1.2 Definition of MOFs

Metal organic frameworks are highly crystalline materials built from inorganic and organic building blocks with infinite inorganic-organic connectivity, forming soluble complexes that then self-assemble into one, two, or three-dimensional frameworks consisting of metal ions linked together by organic bridging ligands.

A metal-organic framework (MOF) material can be thought of as the composition of two major components are a metal ion and an organic molecule called a linker. These organic molecules act as a linker to link the metal ions. The backbone of the compound is constructed from metal ions which

act as connectors and organic bridging ligands as linkers.

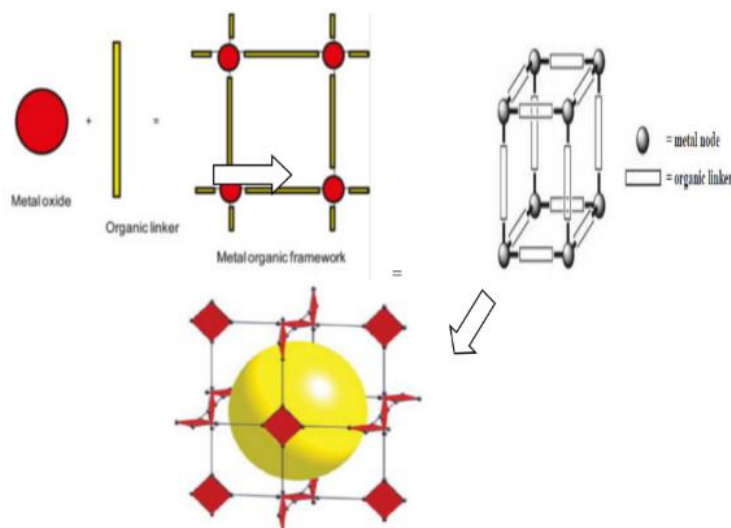
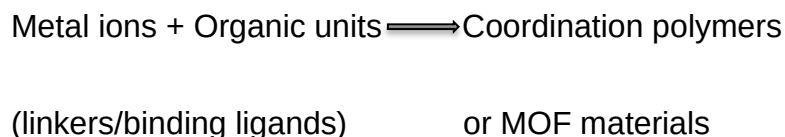


Fig 1.2 Schematic representation of MOF structure

This schematic representation of a MOF unit cell showing the arrangement of inorganic joints (red circles(c), black spheres(b) and red squares(c)) linked by organic struts (yellow rods (a), white rods (b) and black rods (c)). The yellow sphere represents the void space within the lattice framework. The organic ligands or linkers are groups that can donate multiple lone pairs of electrons (polydentate) to the metal ions, whereas the metal ions are made up with vacant orbital shells that can accept these lone pairs of electrons to form metal-organic framework materials.

1.2.1 Primary Building Units of MOFs

The metal ions and organic ligands used in the synthesis of MOFs are considered as the “primary building units”. The transition-metal ions are often used as versatile connectors in the construction of MOFs. The first-row transition metal ions, such as Cr^{3+} , Fe^{3+} , Cu^{2+} , Zn^{2+} , are especially commonly used. Some alkali metal ions, alkaline-earth metal ions and rare-earth metal ions have also been employed as metal nodes for construction MOF structures. Depending on the metal and its oxidation state, coordination numbers can range from 2 to 7, giving rise to various geometries, such as linear, T-or Y-shaped, square-planar, tetrahedral, square-pyramidal, octahedral etc., which play an important role in directing the MOF structures. The organic ligands, which are used for MOF construction,

generally contain coordinating functional group such as carboxylate, phosphate, sulfonate, amine, or nitrile.

1.2.2 Secondary Building Units of MOFs

The primary carboxylate ligands to metal ions can result in many metal-oxygen-carbon (M-O-C) clusters, which are called “secondary building units”, i.e., SBUs. Instead of one metal ion at a network vertex, the SBUs serve as connecting points that are joined together by the linkers leading to the formation of a MOF network. SBUs have intrinsic geometries, which play an important role in directing the MOF topology and thus, the MOFs constructed by SBUs generally exhibit high structural stability.

1.2.3 Synthesis Methods of MOFs

Some reaction parameters are needed to be considered in order to reproduce the MOF materials. These are composition of the reactants, pH of the reaction medium, reaction temperatures, reaction time, solubility of the reactants, solvent type, concentration of the reactants, heating and cooling rates and types of reaction container and they should be screened in order to identify the optimal reaction conditions. One starting approach is to vary one parameter at a time in a systematic way. Several preparation methods for the formation of MOFs have been developed throughout the years. The most commonly used synthetic approaches are given below.

1.3 Hydro- and Solvo-thermal Synthesis

Hydro- and solvothermal synthesis are the most common methods used for making MOFs. Hydrothermal synthesis involves water as the solvent whereas solvothermal refers to the use of organic solvents. The choice of solvent is based on its ability to dissolve the organic linker. In both cases, the reactions take place inside a Teflon-lined stainless-steel autoclave. Since it is a closed system, an auto genius pressure will be built up. The reaction mixture is normally heated at temperatures ranging from 80 to 220 °C, over a time of several hours to several days. Compared with microwave, electrochemical and mechanochemical techniques, the use of autoclaves is a slow method.

1.4 Ionothermal Synthesis

Ionothermal synthesis involves the use of, as the name implies, ionic liquid, which act as the solvent. Ionic liquids have many attractive properties and have been used for producing many new structures.

Their high polarity and pre-organized structure give them excellent solvating abilities. They are suitable for high temperature reactions, as in autoclaves and microwave ovens, since they have high thermal stability and possess little measurable vapour pressure.

1.5 Microwave Synthesis

Microwave-assisted synthesis can be applied for making MOFs to reduce the reaction time and/or heating temperature and increase the purity of the product. Microwave synthesis in organic chemistry has attracted considerable attention over the last decade as a result of its short reaction times. Microwave synthesis was extended to the synthesis of zeolites and more recently has been applied for the production of MOFs. It was not until recently that this method was applied to the synthesis of MOFs. Fast reaction rates, high yields and selectivity's, low amounts of waste and the possibility to control the size, shape and quality of the crystals are the main advantages of microwaves synthesis. The fast reaction times achieved with microwave heating can be explained by the increased number of nucleation sites due to the rapid heating.

The particle size generally decreases using microwave heating compared with conventional methods. The promotion of uniform and rapid nucleation throughout the mixture results in high quality crystals with a narrow size distribution within a short time scale. Instead of days, as in solvothermal synthesis, it can take just a few minutes to synthesize a MOF. The product can be isolated within an hour. This method is applicable to functionalized devices for thin films, conductive materials, catalysis and gas sorption, storage and separation. The fact that the microwave instruments are device specific in terms of the irradiation power and the experimental setups, can lead to an uncertainty in the reproducibility of the experiments. This limitation is an ongoing discussion among scientists from different chemistry fields.

1.6 Sonochemical Synthesis

Sonochemical synthesis is a technique that could compete with microwave heating due to the ability to reduce both time and temperature of the reaction of MOFs. In one case, where three different methods for preparing MOF- 177 were compared, sonication showed better results than both solvothermal and microwave syntheses. High yield of good quality MOF-177 ($[\text{Zn}_4\text{O}(\text{BTB})_2]$), which gave greater CO_2 uptake than samples prepared by conventional or microwave-assisted syntheses,

was obtained after only half an hour.

1.7 Electrochemical Synthesis

Electrochemical synthesis was used for preparing a MOF for the first time in 2006 by Müller. The electrochemical reaction was performed inside a glass reactor containing Cu-plates as an electrode material, supplying metal ions to a solution of linker and methanol (time: 150 min, voltage: 12-19 Volt, currency: 1.3 Ampere). Pure solid of octahedral crystals were collected. By varying the voltage, the concentration of metal ions was changed and thereby the crystal sizes could be controlled. The short reaction times compared with hydrothermal synthesis, together with the fact that the system is solvent-free and can form the coatings continuously; make it applicable in industry.

1.8 Mechanochemical synthesis

Mechanochemical synthesis can work in the absence of solvent. Solvents are nearly always added to reactions to facilitate the diffusion and collision of the components. However, solvent is not always necessary. The first example of a solvent-free synthesis, or mechanochemical synthesis, of a MOF was Cu. The metal salt and the acid, both solids, were ground using a ball mill without any addition of solvent or heat. The reaction was initiated by minimizing the particle size, which facilitated the interaction between the metal salt and the acid. The reaction was accelerated by further grinding.

1.9 Room Temperature Synthesis

In this method the metal salt solution in a specific solvent and the linker solution in the same/different solvent are prepared and mixed with stirring. The resultant solution is further stirred for longer hours upon magnetic stirrer and the product is separated by filtration, washed plenty times with the solvent and dried at room temperature.

1.10 Applications of MOFs

Factors such as high surface areas together with outstanding porosity with nano sized pores and the possibility to produce MOFs from simple starting material in already established industrial processes are essential for the successful future of MOFs. MOFs have been studied widely and found application in many fields. In this review, some extensive studied applications of MOF materials are introduced briefly.

1.10.1 MOFs as Host Materials

Given the high porosity of MOF materials, it is expected that MOFs could serve as host materials with exceptional guest molecules loading capacity. All kinds of gas molecules, liquid adsorbates, and nano particles have been encapsulated into MOFs. The most notable study of MOFs as loading materials is the storage of fuel gas H_2/CH_4 and greenhouse gas CO_2 . The adsorption of other gas molecules, such as hydrogen sulphide (H_2S), ammonia (NH_3), acetylene (C_2H_2), and bioactive molecule nitric oxide (NO), in MOF materials have also been performed. Liquid adsorbates (or dissolved in liquid), such as hydrocarbons, drugs, ferrocene, even large molecules like fluorescent dyes, C_{60} have also been successfully accommodated into MOFs and thereby generating properties.

1.10.2 MOFs as Absorbents for Molecule Separation

Beside the high porosity, another feature of MOF is their high structure tenability with adjustable pore size, channel topology and inner surface properties, which makes them promising candidates as adsorbents for selective gas/solvent separation and purification. The pore sizes within the MOF are crucial to include highly efficient separation of guest molecules by the size/shape exclusion effect in which large molecules are prevented from entering the pores while small molecules are allowed to pass through. Optimizing the pore surface, either using customized metal nodes and organic linkers with functionality already present or by post-synthetic covalent organic linkers with modification, aiming at controlling the adsorbates framework interaction is another way to facilitate selective molecule adsorption/separation. So far, MOFs with pores ranging from 2 to $48\text{\AA}$ have mainly been studied for separating gas molecules, such as CO_2 , CH_4 , H_2 , O_2 , and small-sized solvent molecules, such as methanol, ethanol, and water.

1.10.3 MOFs as Template Materials

Using MOFs as templates to direct the growth of embedded materials aiming at generating nano scale particles or porous materials have attracted increasing attention recently. Since then, a range of nano scale metals, e.g., Cu, Ru, Pd, Au, Ag, Pt, and metal-oxides such as TiO_2 , CuO, ZnO, as well as hybrids like $NaAlH_4$, were generated inside MOF cavities by loading their precursors into the framework through a vapour deposition, solution impregnation or solid grinding method.

1.10.4 MOFs for Biological Applications

Among numerous studies, the biological application of MOFs is still a very new field. Until now, only few studies concerning MOFs as biomaterials have been reported. Several properties, such as biocompatibility, efficacy, and imaging properties of MOFs remain to be investigated. And, extended biological applications of MOFs need to be explored. MOFs applied as a potential drug carrier for biomedical and pharmaceutical applications aiming at targeted drug delivery to specific sites with controlled rate and avoiding the “burst effect” has attracted more interest recently. Complexes of highly paramagnetic metal ions, such as Gd^{3+}/Mn^{2+} , MOFs are often administered to enhance the MRI contrast by increasing water proton relaxation rates.

CHAPTER 2

LITERATURE SURVEY

2.1 Design of MOF

MOFs are a kind of porous crystalline materials that composed of an inorganic three-dimensional structure of metal ions and organic ligands (Chen and Zhang, 2019a, Chen and Zhang, 2019c, Kaneti et al., 2017a, Sánchez et al., 2019, Shi et al., 2017, Tang et al., 2016). MOFs have a high surface area which is achieved based on the coordination interactions between metal cations (clusters or secondary building units) and organic ligands (linkers) via coordinative bonds. Between the MOFs, a copper-based MOFs particularly draws great attention because they can be synthesized with commercially available reagents and possesses the high surface area (Jabbari et al., 2016, Lin et al., 2014). Copper (Cu) was selected as a classical transition metal which is considered to be one of the most attractive elements for use in the preparation of MOFs due to its abundance of resources, low cost, non-toxic properties, and most importantly high complexation. The high and excellent stability of Cu based MOFs is related to the strong interaction between Cu (II) from metal and -O- from organic ligands which make these materials stable in aqueous solution and over a wide pH range. Terephthalic acid as a common ligand which have very low toxicity and is easily available was applied in which the COOH groups can strongly interact with Cu^{2+} cations via coordination interaction. Also, molecules with aromatic rings tend to interact with MOFs due to the π - π interactions (Doherty et al., 2012).

2.2 Synthesis Of MOF

One of the main parameters that can affect the extraction process is ultrasonic irradiation. Ultrasonic irradiation improves the interaction of sorbent and analytes, enhances mass transfer of analyte from sample solution to sorbent and subsequently enhances adsorption capacity. The use of sonication as means to construct MOF materials was recently explored by Son et al. sonication resulted in significantly shorter reaction fragment of the crystal structure of the open MOF, as determined by powder X-ray diffraction. The reaction time and crystal quality during sonication synthesis could also be readily controlled by modifying the sonication power level. MOF synthesis under sonication conditions occurred at a significantly higher temperature (155°C) than during conventional solution synthesis (100°C) and resulted in the formation of approximately 60 times smaller crystals. Consequently, DMF was recognized as the most suitable solvent for MOF synthesis.

2.3 MOFs for Adsorption

For the past 10 years, MOFs have received considerable attention as potential adsorbent materials for the removal of pollutants in water. The number of articles that were published from 2010–2020 on the adsorption and photocatalytic degradation by MOFs. MOFs also offer selective adsorption of organic molecules due to the functionalities of the organic linkers, possibly forming inclusion complexes with the guest adsorbate molecules. The mode of adsorption interactions is usually through covalent bonding, hydrogen bonding, dative bonding, Vander Waals forces, and π - π interactions. Molecular modelling has shown that when the pore sizes of the MOF is bigger than the pollutant molecule. Thus, choosing the MOF for the adsorption of an analyte is important to optimize the adsorption. MOFs with promising adsorption properties have been selectively used for the removal of contaminants in water. Their stabilities, adsorption capacities, and ease of reusability have been reported.

CHAPTER 3

AIM AND SCOPE

3.1 AIM:

To prepare Metal organic Framework (Cu-BDC) for degradation of Rhodamine B

3.2 SCOPE:

This will mainly focus on the adsorptive removal of common hazardous materials that exist in the environment as gas or liquid with widely studied porous MOFs. The advantageous characteristics of MOFs that play a key role in the degradation of particular hazardous compounds will be pointed out. The effects of pH, catalyst, concentration of initial dye and H_2O_2 will be discussed.

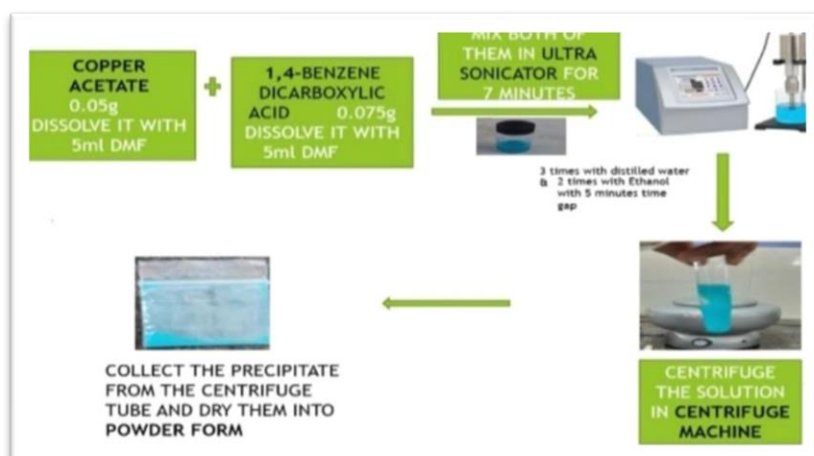


Fig 3.2 Schematic representation of synthesis of MOF

CHAPTER 4

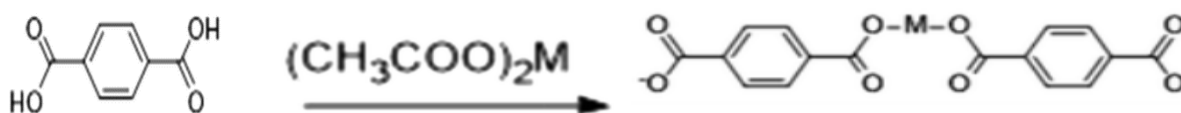
MATERIALS AND METHODS

4.1 MATERIALS:

Copper acetate monohydrate, Benzene1,4 dicarboxylic acid, Dimethylformamide, Ethanol, Rhodamine-B, Hydrogen Peroxide.

4.2.1 Preparation of Cu-BDC MOF:

For the synthesis of Cu-BDC by sonochemical synthesis, 0.05g Cu (CH₃COO)₂.H₂O and 0.075g of BDC is weighed and dispersed separately in 5mL of DMF and obtained solution is transfer to 100mL beaker for Ultrasonication for 7mins. After that, it was taken out and transfer into centrifuge tube and centrifuge at 10000 rpm for 5minutes. Discard the supernatant and resuspend the pellet(precipitate). Then, the pellet washed with 5ml of distilled water for 3 times and 5mL of ethanol for 2 times. Finally, MOF was obtained by drying the pellet(precipitate) at 65°C in oven for 1hr. The Cu-BDC formed during this process is shown in fig 3.2.



[Where, M=Cu]

Fig 4.2.1 Cu-BDC catalyst

4.2.2 OPTIMIZATION OF METAL TO LIGAND RATIO

The metal to ligand ratio of the copper metal-organic framework was optimized by taking a different metal to ligand ratio (1:1, 1:2, and 1:3). The synthesized MOFs were then subjected to an XRD and FTIR analysis. The one with the maximum degradation percentage value was taken as the optimum ratio.

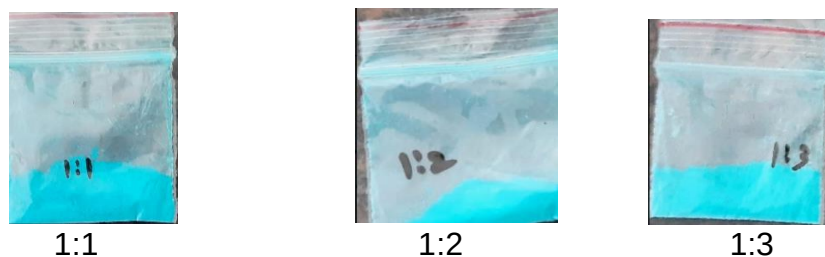


Fig 4.2.2 Ratio of metal to ligand catalyst

4.2.2.1 PREPARATION OF STOCK SOLUTION OF Rh- B:

Rhodamine-B is azo dye. The studies were carried out by preparing the stock solution (i.e., 0.1g of Rh B) in 100mL distilled water. The resulting stock solutions were stored in the standard flask. Absorbance measurements were carried out by using Photo colorimeter. Absorbance maxima of Rhodamine-B ($\lambda_{\text{max}} = 553.75 \text{ nm}$) was used to monitoring the wavelength of the concentration of dye solution.

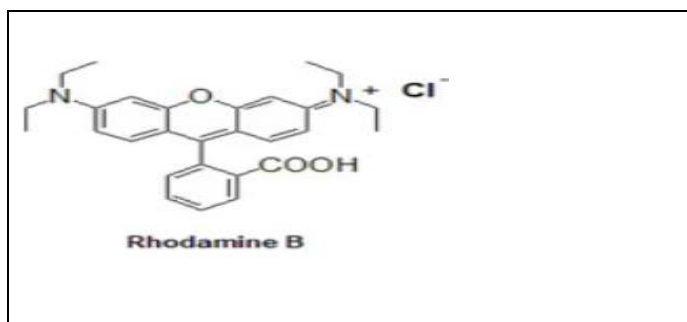


Fig 4.2.2.1 Chemical structure of Rhodamine B

4.2.2.1.1 MECHANISM OF DEGRADATION OF RHODAMINE B

The experiment carried out to obtain degradation from 0.5g of Cu-BDC was dispersed in 10 ml of Rh-B solution at 10 ppm concentration and 3mL of H₂O₂ (30wt%) was added to the solution. These solutions were stirred using glass rod and subjected to natural sunlight for 3hrs. The samples were drawn from the Rh-B solution for every 30minutes were analysed in photo colorimeter at wavelength of 540nm. The initial concentration(*C*₀) of Rh-B solution is noted.

The degradation rate of Rh-B was calculate using following equation:

$$\text{Degradation efficiency} = \frac{C_0 - C}{C_0} \times 100\%$$

Where *C* is the concentration of dye solution after solar radiation fixed intervals of time

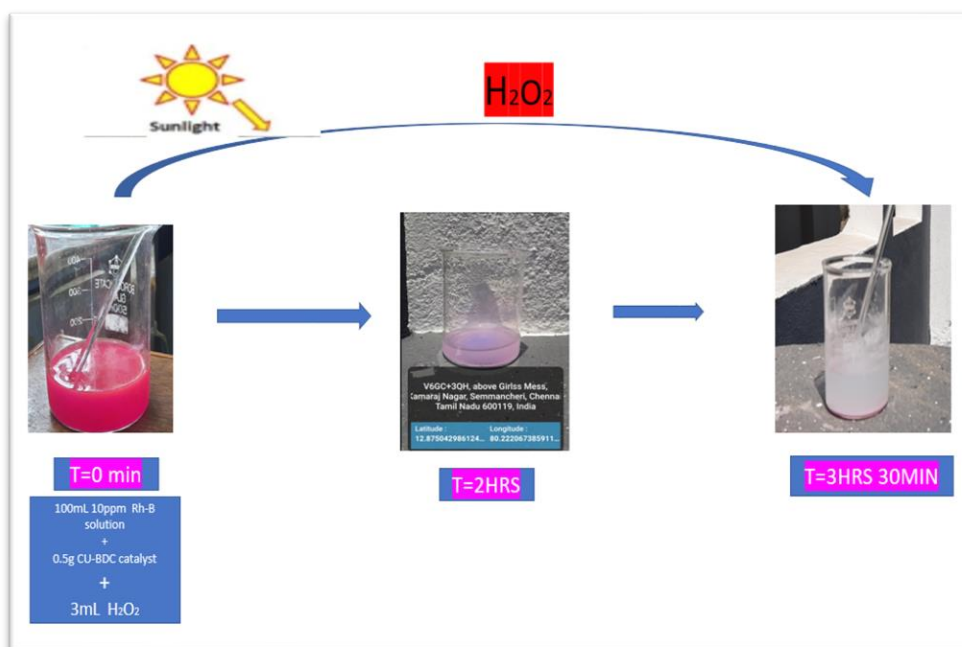


Fig 4.2.2.1.1 Schematic representation of degradation of Rhodamine -B

CHAPTER 5

RESULTS AND DISCUSSION

5.1 SELECTION OF CATALYST:

The degradation of Rhodamine B dye in solar radiation is reported to be 50.2% at optimized conditions (pH ~ 3, 3mL of [H₂O₂] & [Dye] = 10ppm/100mL and reaction time ~ 210 min) in without catalyst and with CU-BDC catalyst, at optimized conditions (initial conc. Of Rhodamine B dye ~ 10ppm/100mL, amount of catalyst ~ 0.5 g, pH ~ 3, 3mL of [H₂O₂] and reaction time ~ 210 min) is achieved to be 88.6%. Similar experiment is repeated with different metal to ligand ratio of Cu-BDC catalyst

Cu-BDC catalyst (Metal to Ligand ratio)	Rh-B degradation %
1:1	88.6%
1:2	74.2%
1:3	80.6%

5.1 Degradation of Rhodamine-B for Cu-BDC catalyst by varying metal to ligand ratio

5.2 STRUCTURE CHARACTERISATION OF MOF

5.2.1 Fourier-Transform Infrared spectroscopy

Fourier-transform infrared (FTIR) spectra of the MOFs were acquired in the region of 500–4000 cm⁻¹ region and are shown in fig 5.1.1. The spectra displayed the peaks characteristic for the main functional groups of carboxylic acid strong peak observed at 1558cm⁻¹ and 1378cm⁻¹ respectively. The prepared materials displayed no strong peak at 1710cm⁻¹. This observation was mainly attributed to the fact that the carboxyl anions can form π after the formation of the carboxylate, and the two resulting oxygen atoms on the carboxyl group tend to be equivalent, thus leading to a delocalized electronic cloud and appearance of characteristic carboxylate peaks in the range of 1660-1550 cm⁻¹. Thus, these results confirmed that the metal salts and organic acids formed the target coordinating compound.

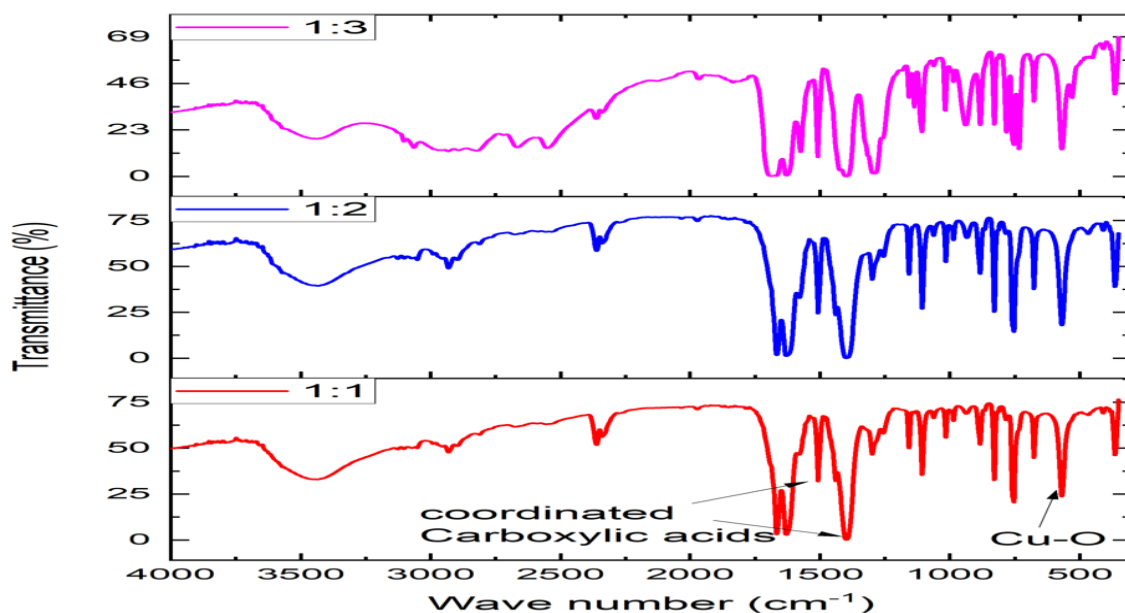


Fig 5.2.1 FTIR spectra for Cu-BDC Catalyst

5.2.2 X-RAY DIFFRACTION

The synthesized MOF structures were elucidated by powder X-ray diffraction (XRD). It can be seen at MOFs exhibited main diffraction peaks at 2θ values of 10.1° , 12.17° , 24.63° , 11.7° , respectively. The patterns showed fairly high intensities, indicating the high crystallinity of the samples.

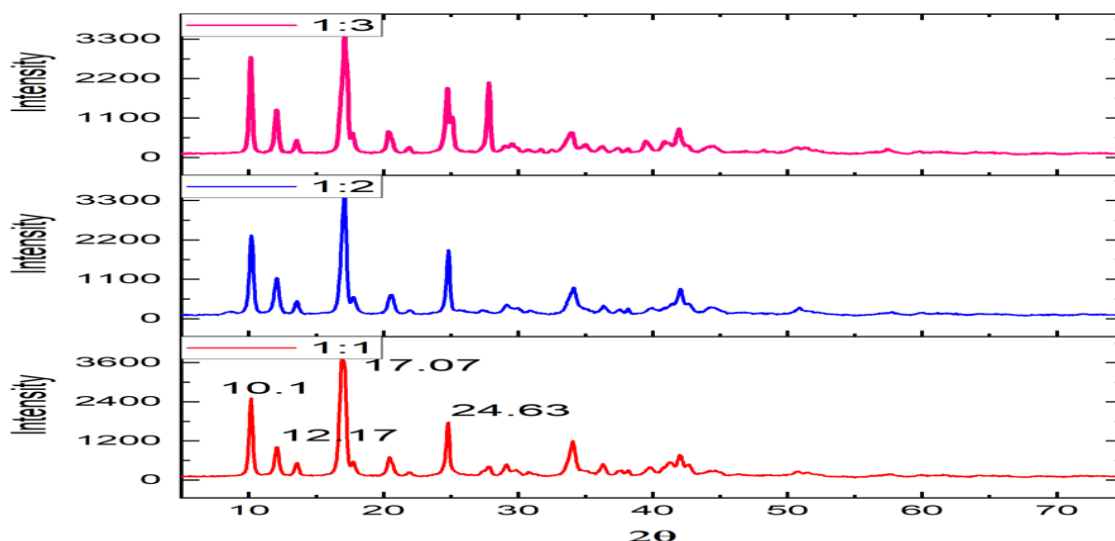


Fig 5.2.2 XRD for Cu-BDC catalyst

5.2.3 EFFECT OF pH

The effect of pH on the degradation capacity of Rhodamine B was studied at different pH (2.0, 3.0, 4.0 and 5.0) in 100 mL of 10ppm of dye solution with 0.2 g of catalyst at solar radiation. It has been observed that the degradation of Rhodamine-B dye uptake by Cu-BDC was higher at lower pH, i.e., at pH 2.0.

5.2.4 EFFECT OF CATALYST

The effect of catalyst on the degradation capacity of Rhodamine B was studied at different amount of catalyst (0.1g, 0.2g, 0.3g, 0.4g and 0.5g) in 100mL of 10ppm of dye solution at solar radiation. It has been observed that the degradation of Rhodamine-B dye uptake by Cu-BDC catalyst was maximum efficiency of catalyst in 90minutes of 0.1g ,0.2g, 0.3g, 0.4g and 0.5g reached 5.66%,15.09%, 60.37%, 86.79%, and 94.33%.

5.2.5 EFFECT OF H₂O₂ AMOUNT

H₂O₂ is another crucial factor that determine the photocatalytic performance of Cu-BDC catalyst. The influence of H₂O₂ amount was systematically studied through series of comparative tests, degradation efficiency of Rhodamine-B was increased when the amount of H₂O₂ were increased from 1mL to 4mL in 0.5g of 100mL of 10ppm of dye solution at solar radiation. However, when the amount of H₂O₂ increased further, the photocatalytic activities were inhibited. The highest degradation rate of 98.11% was obtained with 4mL H₂O₂. The high degradation rate may be attributed to the fact that H₂O₂ molecules can act as electronic trap to react with photo-generated electrons, and the generated OH radicals can further react with Rhodamine B and enhanced the dye degradation.

5.2.6 EFFECT OF INITIAL DYE CONCENTRATION

The effect of initial dye concentration was investigated by varying the initial Rhodamine B concentration from 10ppm to 40ppm with 0.5g catalyst indicates that the lower concentration of Rhodamine B solutions has the higher degradation rates. After solar radiation for 90 min, the degradation efficiency of 10 ppm, 20 ppm, 30 ppm and 40 ppm reached 98.11%, 62.26%, 41.50%, and 26.41%, respectively.

CHAPTER 6

SUMMARY AND CONCLUSION

The present work is an effort to explore the use of degradation technique for removal of toxic. Rhodamine B dye from aqueous solution using Cu-BDC catalyst. Our result indicated that Cu-BDC catalysts effectively promoted dye degradation. The optimum condition for the degradation of Rhodamine B is achieved. The maximum degradation capacity was achieved to be in 90 minutes. These results demonstrate that the Sonochemical process is effective method for fast and simple preparation of MOFs for practical applications.

- In the applied pH range (2-5), the catalytic performance is increased by decreasing the pH of the solution. The optimal pH was confirmed to be 2 due to the relatively high degradation ratio of Rh B.
- The major reactive species leading to the Rh B degradation in the present system are confirmed to be OH and O_2^-
- The photocatalytic degradation of Rh B was to be found to be dependent on various parameters like pH, concentration of the dye, catalyst and H_2O_2 .

CHAPTER 7

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