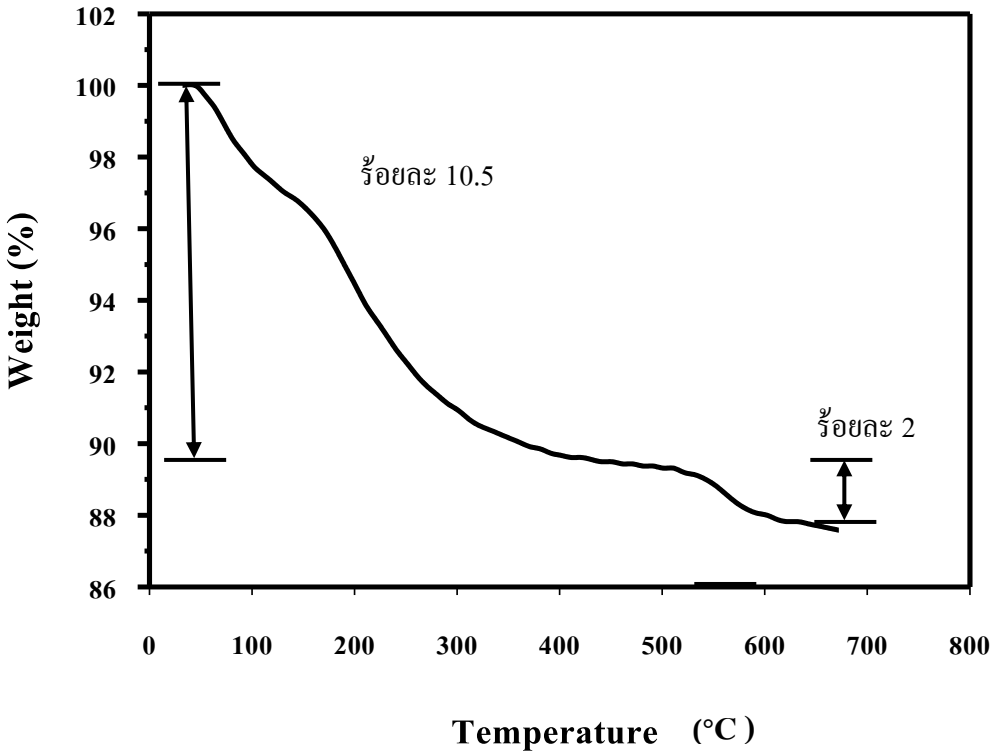
ภาคผนวก

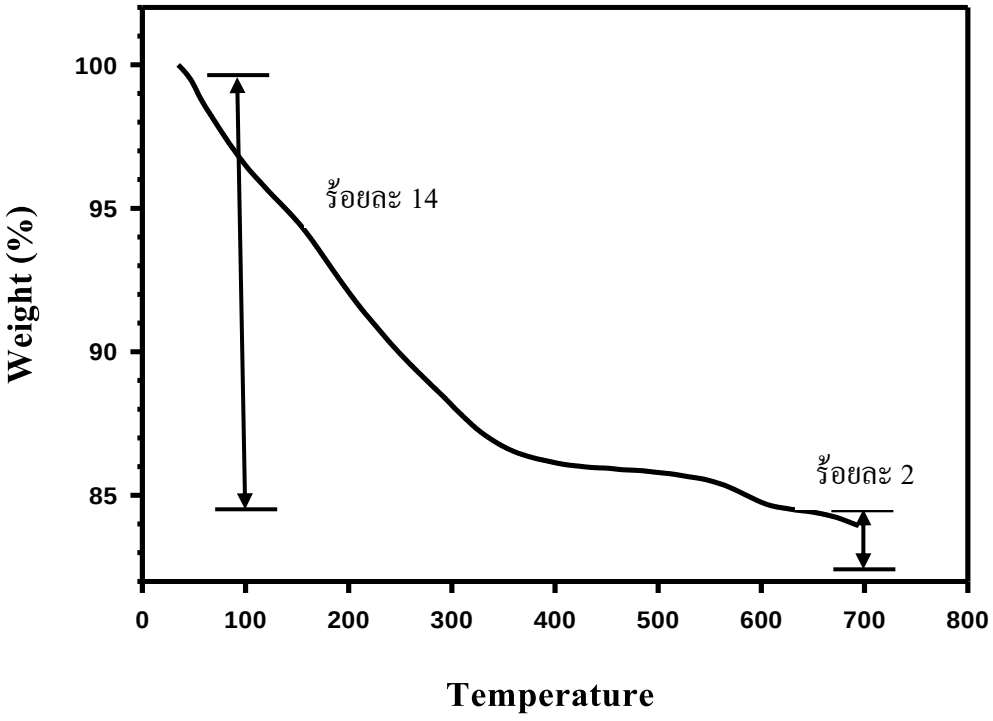
ภาคผนวก ก

ข้อมูลการทดลอง

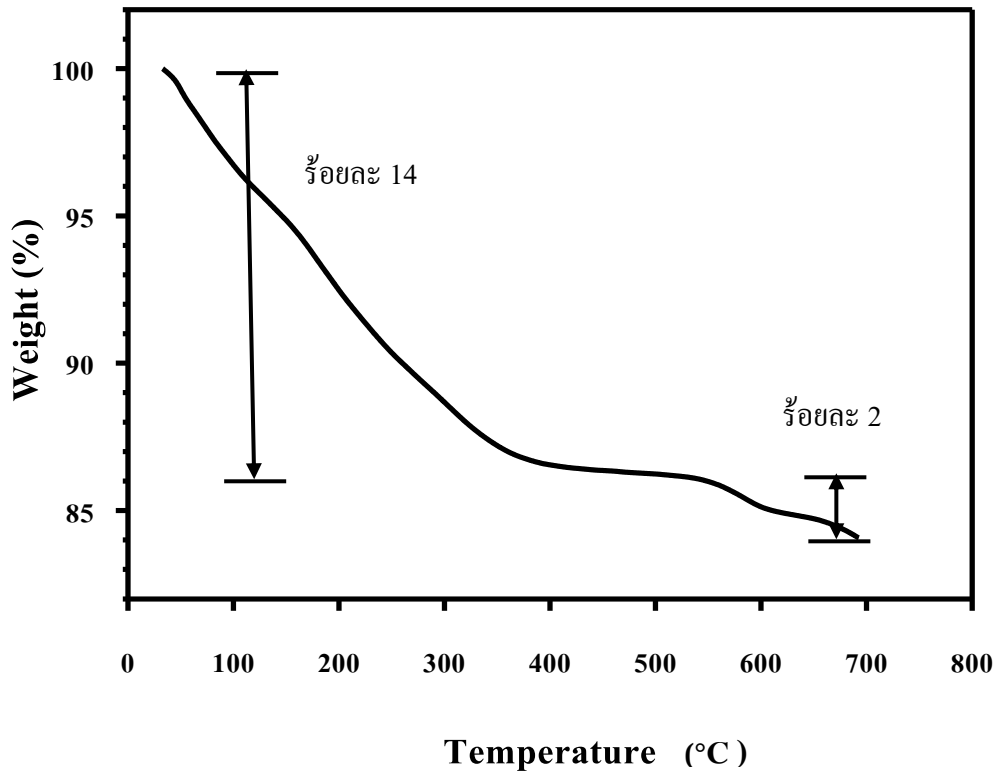
1. ผลการวิเคราะห์การดูดซับสารที่ผิวของตัวเร่งปฏิกิริยา โดยใช้เครื่อง TGA (Thermal gravimetric analysis)



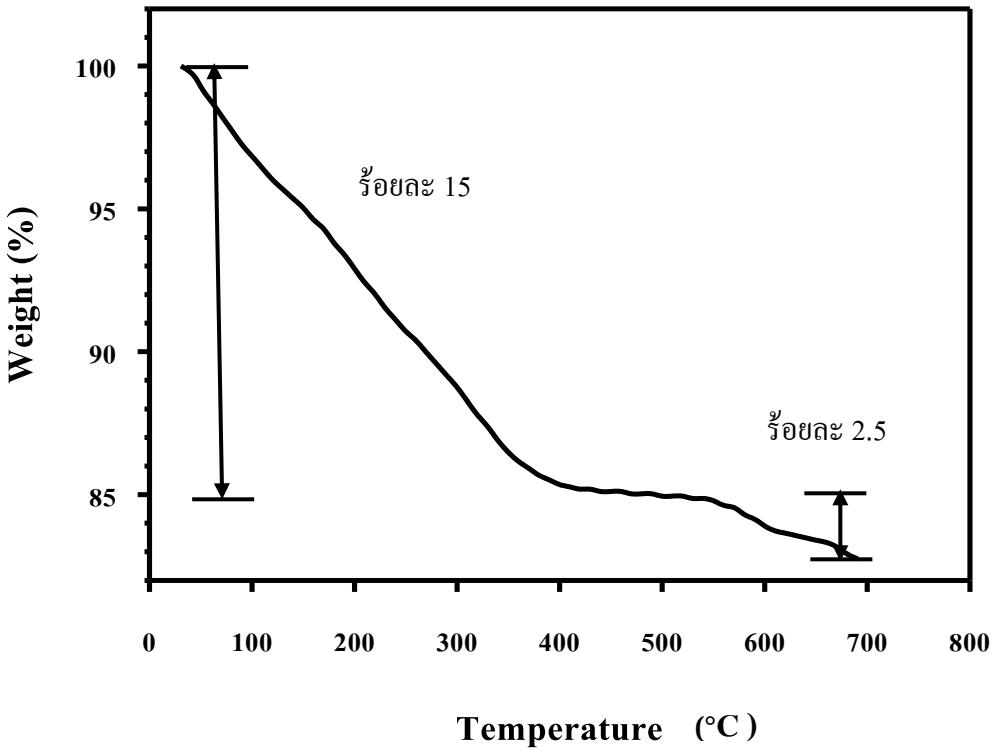
ภาพที่ 29 ปริมาณน้ำหนักที่หายไปของสารที่ผิวตัวเร่งปฏิกิริยา Fe-Ce-Zn (Fresh)



ภาพที่ 30 ปริมาณน้ำหนักที่หายไปของสารที่ผิวตัวเร่งปฏิกิริยา Fe-Ce-Zn ช่วง 5 นาทีแรกของปฏิกิริยาการดูดซับของตัวเร่งปฏิกิริยา



ภาพที่ 31 ปริมาณน้ำหนักที่หายไปของสารที่ผิวตัวเร่งปฏิกิริยา Fe-Ce-Zn ช่วง 5 นาทีแรกของการทำปฏิกิริยาโฟโตเฟนตอน



ภาพที่ 32 ปริมาณน้ำหนักที่หายไปของสารที่ผิวตัวเร่งปฏิกิริยา Fe-Ce-Zn ช่วงเริ่มต้นปฏิกิริยาจนกระทั่งสิ้นสุดปฏิกิริยา 120 นาที ของการทำปฏิกิริยาโฟโตเฟนตอน

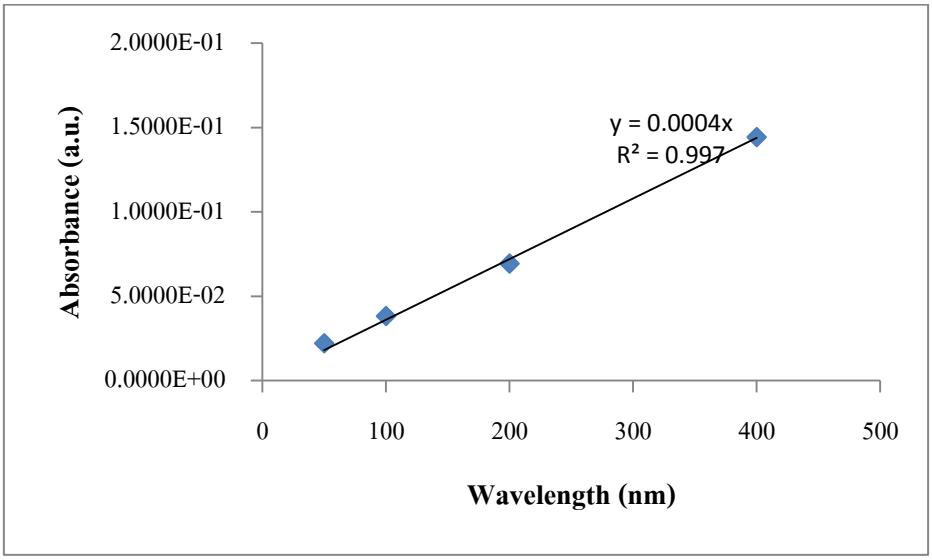
ภาคผนวก ข

ตัวอย่างการคำนวณ

1. **วิเคราะห์ประสิทธิภาพในการลดค่า COD**

   ร้อยละการสลาย COD = $\frac{\text{COD เริ่มต้น – COD ณ เวลานั้นๆ}}{\text{COD เริ่มต้น}}$

2. **ทำกราฟมาตรฐาน (Standard or Calibration Curve) และหาค่า COD ของตัวอย่างจากกราฟมาตรฐาน**



ภาพที่ 33 กราฟมาตรฐานในการหาค่า COD

ภาคผนวก ค

การเผยแพร่ผลงานวิทยานิพนธ์


Conference Proceedings
2013 Tokyo Japan
ICEAS| The 2nd International Conference on Engineering and Applied Science
LSBE| International Conference on Life Science & Biological Engineering
ACCMES| Asian Conference on Civil, Material and Environmental Sciences
ICEECS| International Conference on Electrical Engineering and Computer Sciences

Contents

LSBE International Committee Board.....vi
LSBE Session Chair.....vii
ACCMES International Committee Board.....viii
ACCMES Session Chair.....ix
ICEAS International Committee Board.....x
ICEAS Advisory Committee & Program Committee.....xi
ICEAS Session Chair xii
ICEECS International Committee Board.....xiii
ICEECS Session Chair.....xiv
Conference Schedule..... xv
Toshi Center Hotel..... xix
Program - Oral Sessions.....1
Life Science I.....1
Civil Engineering I.....49
Electrical Engineering I.....110
Life Science II.....155
Civil Engineering II.....200
Biomedical Engineering I.....267
Biological Engineering I.....310
Environmental Sciences I.....329
Chemical Engineering I.....384
Computer and information Sciences I.....427
Civil Engineering III.....489
Mechanical Engineering I.....565
Computer and Information Sciences II.....631
Civil Engineering IV.....670
Mechanical Engineering II.....740
Material Science and Engineering I.....804
Environmental Sciences II.....853
Life Science III.....882
Mechanical Engineering III.....929
Environmental Sciences III.....998
Civil Engineering V.....1057
Life Science IV.....1115
Mechanical Engineering IV.....1159
Wireless or Mobile Communication & Computing.....1199
Communication Engineering.....1199
Communication and Multimedia.....1199
Geosciences and Petroleum Engineering.....1255

Fundamental and Applied Science.....1283
Electrical Engineering II.....1321
Chemical Engineering II.....1357
Civil Engineering VI.....1400
Biological Engineering II.....1474
Computer and Information Science III.....1516
Material Science and Engineering II.....1562
Computer and Information Sciences IV.....1600
Biomedical Engineering II.....1641
Computer and Information Science V.....1683
Electronics Engineering.....1720
Life Science V.....1762
Civil Engineering VII.....1785
Program - Poster Sessions.....1847
Chemical Engineering /Mechanical Engineering/Environmental Sciences/ Material Science and Engineering/Civil Engineering/Computer.....1847
Life Sciences I.....1966
Material Engineering.....2030
Civil Engineering 2115
Biological Engineering.....2153
Electrical and Electronic Engineering.....2190
Electronics.....2214
Fundamental and Applied Science/ Material Science and Engineering.....2221
Life Sciences II.....2305
Biomedical Engineering/ Computer and Information Sciences.....2383
Environmental Sciences.....2491

ICEAS 1397

Treatment of wastewater from pulp processing using UV/Fe-Ce/H_2O_2

Siwaporn Choorueang
Khonkaen University, Khon Kaen, Thailand, 40002
Som_funwan@hotmail.com

Sutasinee Neramittagapong
Khonkaen University, Khon Kaen, Thailand, 40002
sutasineene@kku.ac.th

Arthit Neramittagapong
Khonkaen University, Khon Kaen, Thailand, 40002
artner@kku.ac.th

The corresponding author: Sutasinee Neramittagapong

ABSTRACT

Treatment of wastewater from pulp processing by photo-Fenton reaction over Fe-Ce bimetal catalysts is use to compose the contaminants in waste water such as Lignin which is difficult to treat. The purpose of this research is to remove COD and colour in wastewater from pulping process. The reactions were carried out in batch reactor for 120 minutes under UV lights. The effects of some operating parameters such as catalyst concentrations in the range of 50-600 ppm, hydrogen peroxide concentrations in the range of 1000-15000 ppm, and the pH range were investigated. It has been found that 66.67% of COD has been removed in 5 min by using Fe-Ce bimetal catalyst and H_2O_2 concentrations of 450 ppm and 10000 ppm, respectively.

Key Words : Decolourization, wastewater treatment, lignin removal, photo-Fenton

1.Introduction

Effluents from the pulping process contain a large number of toxic compounds and may also be harmful to environments if it is discharged into receiving waters directly [1]. The release of pulping process into natural waters can cause necessary environmental problems, for example: colour and toxic problems. The problem of lignin is a strong colour in the effluent and it is very difficult to decompose by biomass. Nowadays, the contaminants in pulping process effluents are non-biodegradable. Thus, the conventional biological treatment processes are not adequate for treatment.

Advanced oxidation processes (AOPs) have been successful in decomposing organic compounds in wastewater. The composition of UV radiation and H_2O_2 with Fe (II) or Fe (III), that called photo-Fenton system, is the promising process based on this concept, where iron salts serve as photocatalysis and H_2O_2 as oxidizing agent, the hydroxyl radicals must be generated by photochemical reactions. It is a good combination of oxidation and photochemical reaction for wastewater treatment [2]. The present of Fe ions may cause some problem in the effluent. Thus the solid catalyst such as Fe-Ce bimetal catalyst becomes interesting to use as the catalyst in this treatment.

The objective of this study is to investigate the performance of advanced oxidation methods and their combinations for COD and colour removals from pulping process effluent. UV/Fe-Ce/H_2O_2 treatment was employed at different operating parameter of pH (3-11), Fe-Ce bimetal doses (50-600 ppm) and H_2O_2 doses (1000-15000 ppm) for the

treating pulp and paper wastewater.

2.Research Methodology

2.1Catalyst preparation and Characterizations

The Fe-Ce bimetal catalyst was prepared by co-precipitation method [3]. The combination of 0.08 mol/L $Ce(SO_4)_2.4H_2O$, 0.2 mol/L $FeCl_3.6H_2O$ and 0.1 mol/L $FeCl_2.4H_2O$ were dissolved mixing in water of 2 L, then gentle stirring , the pH was raised to around 10, 6 mol/L NaOH solution added to adjust. Continue stirring 30 min until the pH at 10. After 10 h of aging at room temperature, the suspension was washed with distilled water and finally dried at 100 °C for 10 h. Fe-Ce oxide hydrate catalyst used in the experiment. Catalysts characterization was carried out by BET and XRD in order to observe surface area and material structure, respectively.

2.2Photo-reactor and analytical methods

The reactions were carried out in batch photo-reactor. The photo-reactor was equipped with two UV lamps. 500 ml of real wastewater was added to a 1 L reactor. The desired amount of Fe-Ce catalyst, hydrogen peroxide and pH adjusting agent were added into the reactor. The mixture was continuous stirring with constant rate. The samples were sampling along the reaction. The COD concentrations of all samples were analyzed by closed reflux method.

3.Results and discussion

3.1Effects of initial H_2O_2 dose

A set of the experiments were carried out with variable H_2O_2 concentrations between 1000 and 15000 ppm and Fe-Ce bimetal concentration was kept constant of 450 ppm in the presence of UV light. Fig. 1 describes variation of COD removals with the H_2O_2 concentration. Percentage of COD removal slightly decreased with H_2O_2 concentration up to 10000 ppm due to the excess of H_2O_2 may react with iron ion. Maximum COD removal efficiency (66.67%) obtained with the addition of 10000 ppm and 450 ppm of Fe-Ce catalyst.

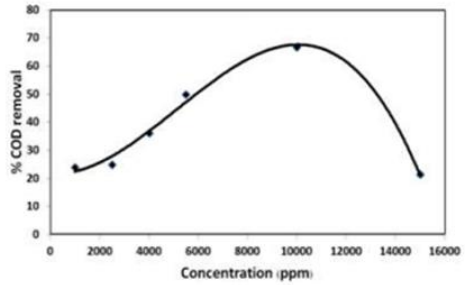


Fig.1. Variations of percent COD removals with initial H_2O_2 concentration in UV/H_2O_2/Fe-Ce treatment at 450 ppm Fe-Ce catalysts, at 5 min.

3.2Effect of initial Fe-Ce bimetal dose

A set of experiments with UV/H_2O_2/Fe-Ce were carried out with variable Fe-Ce bimetal concentration. Fig. 2 describes variation of COD removals with the Fe-Ce catalysts dose at a constant initial H_2O_2 of 10000 ppm and Fe-Ce doses of between 50-600 ppm for 120 min. After addition of Fe-Ce bimetal catalysts and turning on the UV lamp, a fast decrease in COD was observed within 5 min. Percentage of COD removals increased with Fe-Ce bimetal concentration up to 450 ppm due to the excess of catalyst. Thus, it was non-energenic hydroxyl radicals in the decomposition of organic matter.

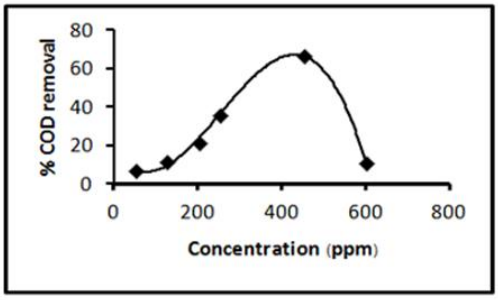


Fig.1. Variations of percent COD removals with initial Fe-Ce bimetal concentration in UV/H_2O_2/Fe-Ce treatment at 10000 ppm H_2O_2 catalysts, at 5 min.

4.Conclusions

COD and colour removals from a pulp and paper mill effluent were investigated by using UV/Fe-Ce/H_2O_2 processes. The effect of the amount of the initial hydrogen peroxide and Fe-Ce catalysts concentrations on the treatment processes were investigated and the best suitable operating conditions were determined.

5.References

[1] Tarek S. Jamil, Montaser Y.Ghaly, Ibrahim E.El-Seesy, Eglal R.Souaya, Rabab A.Nasr. A comparative study among different photochemical oxidation process to enhance the biodegradability of paper mill wastewater. Hazardous Materials 185 (2011): 353-358.

[2] Montaser Y. Ghaly, Georg Hartel, Roland Mayer, Roland Haseneder. Photochemical oxidation of p-chlorophenol by UV/ H_2O_2 and photo-Fenton process. A comparative study. Waste Management 21 (2001): 41-47.

[3] Yu Zhang, Xiaomin Dou, Jian Liu, Min Yang, Liping Zhang, Yoichi Kamagata. Decolorization of reactive brilliant red X-3B by heterogeneous photo-Fenton reaction using an Fe–Ce bimetal catalyst. Catalysis Today 126 (2007): 387–393.