

**RESEARCH PROJECT**

**MODIFICATIONS OF NANOCRYSTALLINE CELLULOSE WITH  
CHITOSAN FOR CONTROLLED RELEASE OF DRUG**



**Submitted by:**

**Lewi Peter Richardo**

**NRP. 5203013014**

**Vincentius A Paulo Endra Adi Nugraha**

**NRP. 5203013035**

**DEPARTMENT OF CHEMICAL ENGINEERING  
FACULTY OF ENGINEERING  
WIDYA MANDALA CATHOLIC UNIVERSITY  
SURABAYA**

**2016**

## LETTER OF APPROVAL

The research entitled:

**Modifications of Nanocrystalline Cellulose with Chitosan for Controlled Release of Drug**

Which was conducted and submitted by:

Name : Lewi Peter Richardo

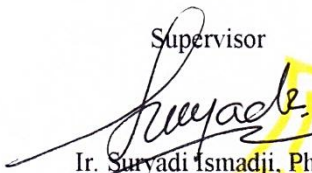
NRP : 5203013014

has been approved and accepted as one of the requirement for **Bachelor of Engineering** degree in Chemical Engineering Department, Faculty of Engineering, Widya Mandala Surabaya Catholic University by following supervisor/s and has been examined by the committees on May, 19<sup>th</sup> 2016.

Surabaya, June 1<sup>st</sup> 2016

Supervisor

Co-Supervisor



Ir. Suryadi Ismadji, Ph.D.  
NIK. 521.93.0198



Aning Avucitra, M.Eng.Sc.  
NIK. 521.03.0563

### The Committees

Chairman

Secretary




Dra. Adriana Anteng Anggorowati, M.Si.  
NIK. 521.86.0124




Ir. Suryadi Ismadji, Ph.D.  
NIK. 521.93.0198

Member

Member



Sandy Budi Hartono, Ph.D.  
NIK. 521.99.0401



Aning Avucitra, M.Eng.Sc.  
NIK. 521.03.0563

### Authorized by

Dean of  
Engineering Faculty

Head of Chemical  
Engineering Department



Ir. Suryadi Ismadji, Ph.D.  
NIK. 521.93.0198



Wenny Irawaty, Ph.D.  
NIK. 521.97.0284



## LETTER OF APPROVAL

The research entitled:

### **Modifications of Nanocrystalline Cellulose with Chitosan for Controlled Release of Drug**

Which was conducted and submitted by:

Name : Vincentius A Paulo Endra Adi Nugraha


NRP : 5203013035

has been approved and accepted as one of the requirement for **Bachelor of Engineering** degree in Chemical Engineering Department, Faculty of Engineering, Widya Mandala Surabaya Catholic University by following supervisor/s and has been examined by the committees on May, 19<sup>th</sup> 2016.

Surabaya, June 1<sup>st</sup> 2016

Supervisor

Co-Supervisor

  
Ir. Suryadi Ismadji, Ph.D.  
NIK. 521.93.0198


  
Aning Ayucitra, M.Eng.Sc.  
NIK. 521.03.0563

### The Committees

Chairman


Secretary


  
Dra. Adriana Anteng Anggorowati, M.Si.  
NIK. 521.86.0124

  
Ir. Suryadi Ismadji, Ph.D.  
NIK. 521.93.0198

Member

Member


  
Sandy Budi Hartono, Ph.D.  
NIK. 521.99.0401


  
Aning Ayucitra, M.Eng.Sc.  
NIK. 521.03.0563

### Authorized by

Dean of  
Engineering Faculty

Head of Chemical  
Engineering Department

  
Ir. Suryadi Ismadji, Ph.D.  
NIK. 521.93.0198



  
Wenny Irawaty, Ph.D.  
NIK. 521.97.0284



## **LEMBAR PERNYATAAN PERSETUJUAN PUBLIKASI KARYA ILMIAH**

Demi perkembangan ilmu pengetahuan, kami sebagai mahasiswa Universitas Katolik Widya Mandala Surabaya:

Nama/NRP : Lewi Peter Richardo / 5203013014  
Vincentius A Paulo Endra Adi Nugraha / 5203013035

Menyetujui skripsi kami yang berjudul:  
Modifications of Nanocrystalline Cellulose with Chitosan for Controlled Release of Drug

Untuk dipublikasikan/ditampilkan di internet atau media lain (Digital Library Perpustakaan Unika Widya Mandala Surabaya) untuk kepentingan akademik sebatas sesuai dengan Undang-undang Hak Cipta. Demikian pernyataan persetujuan publikasi karya ilmiah ini saya buat dengan sebenarnya.

Surabaya, 1 Juni 2016  
Yang menyatakan



Lewi Peter Richardo  
NRP. 5203013014



Vincentius A Paulo Endra Adi Nugraha  
NRP. 5203013035

## COPY RIGHT AGREEMENT

In order to support the development of science and technology, I am as the student of Widya Mandala Surabaya Catholic University:

Name : Lewi Peter Richardo  
Student ID : 5203013014

Agree to transfer the copyright of my thesis/paper:

Title:  
Modification of Nanocrystalline Cellulose with Chitosan for Controlled Release of Drug

To be published in internet or other media (Digital Library of Widya Mandala Surabaya Catholic University) for academic purposes according to copyright law in Indonesia.

Surabaya, June 1<sup>st</sup> 2016  
Author,



Lewi Peter Richardo  
NRP. 5203013014

## COPY RIGHT AGREEMENT

In order to support the development of science and technology, I am as the student of Widya Mandala Surabaya Catholic University:

Name : Vincentius A Paulo Endra Adi Nugraha  
Student ID : 5203013035

Agree to transfer the copyright of my thesis/paper:

Title:

Modification of Nanocrystalline Cellulose with Chitosan for Controlled Release of Drug

To be published in internet or other media (Digital Library of Widya Mandala Surabaya Catholic University) for academic purposes according to copyright law in Indonesia.

Surabaya, June 1<sup>st</sup> 2016

Author,



Vincentius A Paulo Endra Adi Nugraha  
NRP. 5203013035

## LETTER OF DECLARATION

I declare that this research was my own work and does not contain any material that belongs to the others, unless it was stated in the references. Should it is known that this research belongs to others. I aware and accept the consequences that this research cannot be used as a requirement to achieve a **Bachelor of Engineering** degree.

Surabaya, June 1<sup>st</sup> 2016

Student,



Lewi Peter Richardo

NRP. 5203013014

## LETTER OF DECLARATION

I declare that this research was my own work and does not contain any material that belongs to the others, unless it was stated in the references. Should it is known that this research belongs to others. I aware and accept the consequences that this research cannot be used as a requirement to achieve a **Bachelor of Engineering** degree.

Surabaya, June 1<sup>st</sup> 2016

Student,



Vincentius A Paulo Endra Adi Nugraha

NRP. 5203013035



## PREFACE

The authors would like to thank God for His blessing that the Research Project entitled Modifications of Nanocrystalline cellulose with Chitosan for Controlled Release of Drug has been accomplished. This report is a prerequisites in achieving Bachelor of Engineering degree in Chemical Engineering.

The writers realize that the completion of this report is achieved by the help of many people. There for, the writers would like to thank the persons below:

- 1 Ir. Suryadi Ismadji, Ph.D., as Principal Supervisor and Aning Ayucitra, M.Eng.Sc., as Co-Supervisor
- 2 Dra. Adriana Anteng Anggorowati, M.Si, as Head of the Committees, Felycia Edi Soetaredjo, Ph.D. and Sandy Budi Hartono, Ph.D. as members of committees
- 3 Ir. Suryadi Ismadji, Ph.D. as the Head of Chemical Engineering Process Laboratorium and Dra. Adriana Anteng Anggorowati, M.Si. as the Head of Chemical Analysis Laboratorium
- 4 Mr. Novi as laborant of Chemical Engineering Process Laboratorium and Mr. Pudjo as laborant of Chemical Engineering Operation Laboratorium
- 5 Ir. Suryadi Ismadji, MT, Ph.D., as Dean of Engineering Faculty
- 6 Wenny Irawaty, ST., MT. Ph.D., as Head of Chemical Engineering Department
- 7 Our parents and family who have given a lot of help and support, both materially and morally.
- 8 Our lecturers, friends and also those who are too many to be listed by name that had contributed their kind assistance

The authors realize that this report is far from perfect, therefore any critics and comments which will better improve the research is gladly accepted. Lastly the authors hope that the report will be useful to all readers who need information regarding the research of the report.

Surabaya, June 1<sup>st</sup> 2016

The authors

## ABSTRACT

A new drug carrier with specific ability are studied by many researchers. Many drug carrier are using materials such as nanocrystalline cellulose and chitosan. By combining these materials, a new ability will be formed. *Cerbera manghas* as cellulose source will be delignified, bleached and hydrolyzed to produce nanocrystalline cellulose (NCC) and then Chitosan with certain mass ratio will be grafted onto NCC surface by mixed it for 12 hours and known as nanocomposite. Nanocomposite solution will be dried and the used for drug loading and release experiment. The result of this study was nanocrystalline cellulose with promising characteristic was found with sulfuric acid 60 wt.% at 30°C and then used as NCC for nanocomposite preparation. Amoxicillin used as drug model adsorped by nanocomposite made from nanocrystalline cellulose modified with chitosan, the ration were 2:1, 1:1, and 1:2. These composite took about 150 minutes to adsorp and less than 10 hours to release the drug. Cellulose from *Cerbera manghas* characterized by TGA, while NCC and nanocomposite were characterized by using FTIR, SEM and XRD. The drug solution and SBF were characterized by using UV-Vis Spechtrphotometer.

## CONTENTS

LETTER OF APPROVAL .....	ii
COPY RIGHT AGREEMENT .....	iv
LETTER OF DECLARATION .....	vi
PREFACE.....	viii
ABSTRACT .....	x
CONTENTS .....	xi
LIST OF FIGURES .....	xii
LIST OF TABLES.....	xv
CHAPTER I. INTRODUCTION .....	1
I.1. Backgrounds.....	1
I.2. Objectives.....	2
I.3. Problems Limitation .....	3
CHAPTER II. LITERATURE REVIEW .....	4
II.1. Nanocrystalline Cellulose.....	4
II.2. Controlled Released of Drug .....	10
CHAPTER III. RESEARCH METHODOLOGY .....	14
III.1. Experimental Design .....	14
III.2. Process Variables .....	17
III.3. Materials.....	20
III.4. Equipment .....	20
III.5. Research Procedure .....	21
CHAPTER IV. RESULTS AND DISCUSSION.....	24
IV.1. Pretreatment of Raw Materials .....	24
IV.2. The Effect of Concentration and Temperature of Nanocrystalline cellulose Preparation .....	25
IV.3. The Effect of Mass Ratio of Nanocomposite Preparation .....	30
IV.4. Drug Loading .....	32
IV.5. Drug Release .....	41
CHAPTER V. CONCLUSION AND RECOMMENDATION.....	56
REFERENCES .....	57
APPENDIX A. PREPARATION OF SOLUTIONS .....	59
APPENDIX B. STANDARD CURVE OF AMOXICILLIN .....	63
APPENDIX C. ADSORPTION KINETIC OF NANOCOMPOSITE.....	64
APPENDIX D. ADSORPTION ISOTHERM OF NANOCOMPOSITE .....	66
APPENDIX E. DESORPTION KINETIC OF NANOCOMPOSITE .....	68

## LIST OF FIGURES

Figure II.1. A Picture of <i>Cerbera manghas</i> (Sea Mango) Fruits, Flower and Leaves .....	10
Figure III.1. The Schematic Diagram of Nanocrystalline cellulose Preparation .....	15
Figure III.2. The Schematic Diagram of Nanocomposites Preparation ....	16
Figure III.3. The Schematic Diagram of Drug Loading Process .....	16
Figure III.4. The Schematic Diagram of Drug Release Process .....	17
Figure IV.1. TGA Characterization of <i>Cerbera manghas</i> After Treatment .....	25
Figure IV.2. The Spectrum of NCC Preparation .....	25
Figure IV.3. SEM Characterization of NCC 60 wt.%, 30°C .....	26
Figure IV.4. SEM Characterization of NCC 50 wt.%, 50°C .....	27
Figure IV.5. SEM Characterization of NCC 50 wt.%, 40°C .....	27
Figure IV.6. XRD Characterization of NCC 60wt.% 30°C .....	29
Figure IV.7. The Specturm of (a) NCC 60 wt.%, 30°C, (b) Chitosan (c) 2 NCC : 1 Chitosan, (d) 1 NCC : 1 Chitosan, and (e) 1 NCC : 2 Chitosan .....	28
Figure IV.8. SEM Characterization of Nanocomposite 2:1 .....	29
Figure IV.9. SEM Characterization of Nanocomposite 1:1 .....	30
Figure IV.10. SEM Characterization of Nanocomposite 2:1 .....	30
Figure IV.11. Pseudo First Order Plot of Adsorption Kinetic of Nanocomposite 2:1 .....	31
Figure IV.12. Pseudo Second Order Plot of Adsorption Kinetic of Nanocomposite 2:1 .....	32
Figure IV.13. Pseudo First Order Plot of Adsorption Kinetic of Nanocomposite 1:1 .....	32
Figure IV.14. Pseudo Second Order Plot of Adsorption Kinetic of Nanocomposite 1:1 .....	33
Figure IV.15. Pseudo First Order Plot of Adsorption Kinetic of Nanocomposite 1:2 .....	33
Figure IV.16. Pseudo Second Order Plot of Adsorption Kinetic of Nanocomposite 2:1 .....	34
Figure IV.17. Freudlich Plot of Adsorption Isotherm of Nanocomposite 2:1 .....	35
Figure IV.18. Langmuir Plot of Adsorption Isotherm of Nanocomposite 2:1 .....	36
Figure IV.19. Freudlich Plot of Adsorption Kinetic of Nanocomposite 1:1 .....	36

Figure IV.20. Langmuir Plot of Adsorption Isotherm of Nanocomposite 1:1 .....	37
Figure IV.21. Freudlich Plot of Adsorption Isotherm of Nanocomposite 1:2.....	37
Figure IV.22. Langmuir Plot of Adsorption Isotherm of Nanocomposite 1:2.....	38
Figure IV.23. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 2:1 First Desorption.....	40
Figure IV.24. Pseudo Second Order Plot of Desorption Kinetic of Nanocomposite 2:1 First Desorption.....	41
Figure IV.25. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 2:1 Second Desorption .....	42
Figure IV.26. Pseudo Second Order Plot of Desorption Kinetic of Nanocomposite 2:1 Second Desorption .....	42
Figure IV.27. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 2:1 Third Desorption .....	43
Figure IV.28. Pseudo Second Order Plot of Desorption Kinetic of Nanocomposite 2:1 Third Desorption .....	44
Figure IV.29. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 1:1 First Desorption.....	45
Figure IV.30. Pseudo Second Order Plot of Desorption Kinetic of Nanocomposite 1:1 First Desorption.....	46
Figure IV.31. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 1:1 Second Desorption .....	46
Figure IV.32. Pseudo Second Order Plot of Desorption Kinetic of Nanocomposite 1:1 Second Desorption .....	47
Figure IV.33. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 1:1 Third Desorption .....	48
Figure IV.34. Pseudo Second Order Plot of Desorption Kinetic of Nanocomposite 1:1 Third Desorption .....	48
Figure IV.35. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 1:2 First Desorption.....	49
Figure IV.36. Pseudo Second Order Plot of Desorption Kinetic of Nanocomposite 1:2 First Desorption.....	50
Figure IV.37. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 1:2 Second Desorption .....	51
Figure IV.38. Pseudo Second Order Plot of Desorption Kinetic of Nanocomposite 1:2 Second Desorption .....	51
Figure IV.39. Pseudo First Order Plot of Desorption Kinetic of Nanocomposite 1:2 Third Desorption .....	52

Figure IV.40. Pseudo Second Order Plot of Desorption Kinetic of  
Nanocomposite 1:2 Third Desorption ..... 53

## LIST OF TABLES

Table II.1.	Recent Nanocrystalline cellulose Studies.....	7
Table II.2.	Recent Nanocrystalline cellulose Studies (Cont.) .....	8
Table IV.1.	Percent Yield of NCC .....	25
Table IV.2.	Adsorption Kinetic Parameter .....	36
Table IV.3.	Adsorption Isotherm Parameter.....	40
Table IV.4.	Nanocomposite 2:1 First Desorption Parameter.....	42
Table IV.5.	Nanocomposite 2:1 Second Desorption Parameter .....	44
Table IV.6.	Nanocomposite 2:1 Third Desorption Parameter .....	45
Table IV.7.	Nanocomposite 1:1 First Desorption Parameter.....	47
Table IV.8.	Nanocomposite 1:1 Second Desorption Parameter .....	48
Table IV.9.	Nanocomposite 1:1 Third Desorption Parameter .....	50
Table IV.10.	Nanocomposite 1:2 First Desorption Parameter.....	51
Table IV.11.	Nanocomposite 1:2 Second Desorption Parameter .....	53
Table IV.12.	Nanocomposite 1:2 Third Desorption Parameter .....	54
Table IV.13.	Nanocomposite Desorption Efficiency.....	54
Table A.1.	Sulfuric acid Concentration and Volume .....	60
Table B.1.	Concentration vs Absorbance of Amoxicillin Standard Curve.....	63
Table C.1.	Values of $q_t$ for Nanocomposite 2:1 .....	64
Table C.2.	Values of $q_t$ for Nanocomposite 1:1 .....	64
Table C.3.	Values of $q_t$ for Nanocomposite 1:2.....	65
Table D.1.	Values of $q_e$ for Nanocomposite 2:1.....	66
Table D.2.	Values of $q_e$ for Nanocomposite 1:1.....	66
Table D.3.	Values of $q_e$ for Nanocomposite 1:2.....	67
Table E.1.	Values of $q_t$ for Nanocomposite 2:1 First Desorption .....	68
Table E.2.	Values of $q_t$ for Nanocomposite 2:1 Second Desorption.....	68
Table E.3.	Values of $q_t$ for Nanocomposite 2:1 Third Desorption.....	69
Table E.4.	Values of $q_t$ for Nanocomposite 1:1 First Desorption .....	69
Table E.5.	Values of $q_t$ for Nanocomposite 1:1 Second Desorption.....	70
Table E.6.	Values of $q_t$ for Nanocomposite 1:1 Third Desorption.....	70
Table E.7.	Values of $q_t$ for Nanocomposite 1:2 First Desorption .....	71
Table E.8.	Values of $q_t$ for Nanocomposite 1:2 Second Desorption.....	71
Table E.9.	Values of $q_t$ for Nanocomposite 1:2 Third Desorption.....	72