

RESEARCH PROJECT

**PREPARATION AND CHARACTERIZATION OF FORMIC ACID
MODULATED HKUST-1 FOR DORIPENEM DRUG DELIVERY**



Submitted by

Erwhyanta Monorizho Denesa NRP. 5203019023

Steven Yohanes NRP. 5203019028

DEPARTMENT OF CHEMICAL ENGINEERING

FACULTY OF ENGINEERING

WIDYA MANDALA CATHOLIC UNIVERSITY

SURABAYA

2022

LETTER OF APPROVAL

Seminar of **RESEARCH PROJECT** for student with identity below:

Name : Erwhyanta Monorizho Denesa

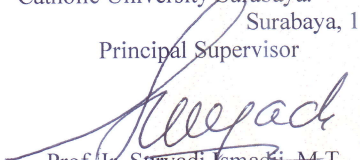
NRP : 5203019023

has been conducted on 19 October 2022, therefore the student has fulfilled one of several requirements to obtain **Bachelor of Engineering** degree in Chemical Engineering Department, Faculty of Engineering, Widya Mandala Catholic University Surabaya.


Surabaya, 16 November 2022

Principal Supervisor

Co-Supervisor


Prof. Ir. Suryadi Ismadji, M.T.,
Ph.D., IPU., ASEAN Eng.

NIK. 521.93.0198


Ir. Jenni Lie, S.T., Ph.D.

NIK. 521.17.0949

Committees

Chairman

Secretary


Dr. Christian Julius Wijaya, S.T.,
Ph.D., IPM.

NIK. 521.17.0948


Ir. Jenni Lie, S.T., Ph.D.

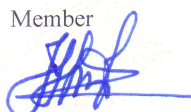
NIK. 521.17.0949

Member

Member


Nathania Puspitasari, S.T., Ph.D.


NIK. 521.17.0952


Dr. Ir. Suratno Lourentius, M.S.,
IPM.


NIK. 521.87.0127

Dean of Engineering Faculty

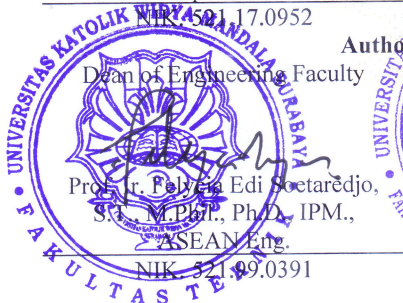
Head of Chemical Engineering
Department


Prof. Ir. Polya Edi Soetareidjo,
S.T., M.Phil., Ph.D., IPM.,
ASEAN Eng.

NIK. 521.99.0391


Ir. Sandy Budi Hartono, S.T.,
M.Phil., Ph.D., IPM.

NIK. 521.99.0401



LETTER OF APPROVAL

Seminar of **RESEARCH PROJECT** for student with identity below:

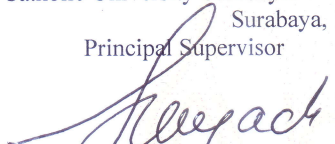
Name : Steven Yohanes

NRP : 5203019028

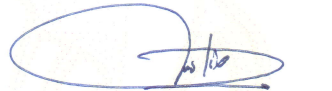
has been conducted on 19 October 2022, therefore the student has fulfilled one of several requirements to obtain **Bachelor of Engineering** degree in Chemical Engineering Department, Faculty of Engineering, Widya Mandala Catholic University Surabaya.

Surabaya, 16 November 2022

Principal Supervisor



Prof. Ir. Suryadi Ismadi, M.T.,
Ph.D., IPU., ASEAN Eng.
NIK. 521.93.0198

Co-Supervisor

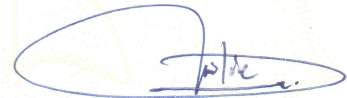

Ir. Jenni Lie, S.T., Ph.D.
NIK. 521.17.0949

Committees


Chairman


Dr. Christian Julius Wijaya, S.T.,
Ph.D., IPM.
NIK. 521.17.0948

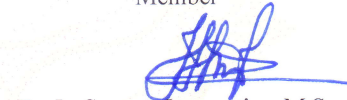
Secretary


Ir. Jenni Lie, S.T., Ph.D.
NIK. 521.17.0949

Member


Nathania Puspitasari, S.T., Ph.D.
NIK. 521.17.0952

Member

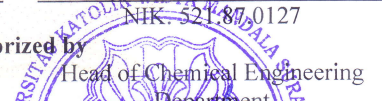

Dr. Ir. Suratno Lourentius, M.S.,
IPM.
NIK. 521.87.0127

Dean of Engineering Faculty


Prof. Ir. Ceceia Edi Soetaredjo,
S.T., M.Phil., Ph.D., IPM.,
ASEAN Eng.
NIK. 521.99.0391

Authorized by

Head of Chemical Engineering
Department


Ir. Sandy Budi Hartono, S.T.,
M.Phil., Ph.D., IPM.
NIK. 521.99.0401

COPYRIGHT AGREEMENT

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

Name : Erwhyanta Monorizho Denesa

NRP : 5203019023

agree to transfer the copyright of my research project:

Title:

Preparation and Characterization of Formic Acid Modulated HKUST-1 for Doripenem Drug Delivery

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

Surabaya, 14 November 2022

Author



Erwhyanta Monorizho Denesa

NRP. 5203019023

COPYRIGHT AGREEMENT

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

Name : Steven Yohanes

NRP : 5203019028

agree to transfer the copyright of my research project:

Title:

Preparation and Characterization of Formic Acid Modulated HKUST-1 for Doripenem Drug Delivery

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

Surabaya, 14 November 2022

Author



Steven Yohanes

NRP. 5203019028

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 obtain **Bachelor of Engineering** degree.

Surabaya, 14 November 2022

Student,



Erwhyanta Monorizho Denesa

NRP. 5203019023

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 obtain **Bachelor of Engineering** degree.

Surabaya, 14 November 2022

Student,



Steven Yohanes

NRP. 5203019028

PREFACE

All Praise and Gratitude we pray to God Almighty for His blessings and help, the author was able to complete the thesis entitled "Preparation and Characterization of Formic Acid Modulated HKUST-1 for Doripenem Drug Delivery". On this occasion, the author would like to express his deepest gratitude to:

1. Prof. Ir. Suryadi Ismadji, M.T., Ph.D., IPU., ASEAN Eng., as the Dean of the Faculty of Engineering who has provided facilities to the authors in undertaking and completing research;
2. Ir. Sandy Budi Hartono, S.T., M.Phil., Ph.D., IPM., ASEAN Eng., as the Head of the Chemical Engineering Study Program who has provided support and facilities during the research;
3. Prof. Ir. Suryadi Ismadji, M.T., Ph.D., IPU., ASEAN Eng. and Ir. Jenni Lie, S.T., Ph.D. as a supervising lecturer who has guided, directed, provided advice, instructions and directions so that research can be completed properly;
4. Mr. Hadi Pudjo, and Mr. Novi Triono as laboratory assistants for their assistance and assistance in providing the needs for glassware, instruments, and chemicals used to support research;
5. All educators and educators of the Chemical Engineering Study Program, Faculty of Engineering, Widya Mandala Catholic University Surabaya, who have indirectly helped us in completing the research;
6. Parents and family who always provide support during the research process and the preparation of the thesis report;
7. Colleagues in the class of 2019 who have supported the research process and the preparation of thesis reports;

8. All parties that the author cannot mention one by one.

Finally, the author apologizes profusely if there are words or behaviour that are less pleasing to the supervisor and the people involved in the process of making the thesis report. The author always hopes for suggestions and input from readers for the perfection of research and this thesis report. Hopefully this thesis report can be useful for readers and useful for science and technology.

Thank you.

Surabaya, 14 November 2022

Author

CONTENTS

LETTER OF APPROVAL	ii
COPYRIGHT AGREEMENT	iv
LETTER OF DECLARATION	vi
PREFACE.....	viii
CONTENTS	x
LIST OF FIGURES	xi
LIST OF TABLES.....	xii
ABSTRACT	xiii
I. INTRODUCTION	1
I.1. Background	1
I.2. Research Purposes	2
I.3. Problem Boundaries	2
II. LITERATURE REVIEW.....	3
II.2. Previous Research	3
II.3. Theory	6
III. EXPERIMENTAL METHOD.....	12
III.1. Tools and Materials	12
III.2. Working Method.....	12
IV. RESULTS AND DISCUSSIONS.....	17
IV.1. HKUST-1 Synthesis	17
IV.2. Characterization.....	19
IV.3. Isotherm Adsorption	24
IV.4. Kinetic Adsorption	28
IV.5. Drug Release	29
V. CONCLUSIONS AND RECOMMENDATIONS	32
V.1. Conclusions.....	32
V.2. Recommendations.....	32
REFERENCES	33
APPENDIX	39

LIST OF FIGURES

Figure IV.1. Yield (%) of Synthesized Samples	17
Figure IV.2. Competition Mechanism of HKUST-1 Modulator.....	18
Figure IV.3. XRD Patterns of Synthesized HKUST-1 Nanoparticles	19
Figure IV.4. HKUST-1 Structure	20
Figure IV.5. Crystallinity of HKUST-1 Samples	21
Figure IV.6. SEM Result	23
Figure IV.7. SEM Result with Close Magnification	24
Figure IV.8. Sips Model Isotherm for HKUST-1 Samples.....	25
Figure IV.9. Kinetic Adsorption of Synthesized.....	28
Figure IV.10. Drug Release for HKUST-1 Samples	30
Figure IV.11. Drug Release for HKUST-1 and HKUST-1@FA-1 in three days	31
Figure B.1. Standard Curve of Doripenem at 296.5 nm Wavelength	42
Figure C.1. HKUST-1 Langmuir Fit.....	45
Figure C.2. HKUST-1 Freundlich Fit	45
Figure C.3. HKUST-1 Redlich-Peterson Fit.....	46
Figure C.4. HKUST-1@AcOH Langmuir Fit	47
Figure C.5. HKUST-1@AcOH Freundlich Fit	48
Figure C.6. HKUST-1@AcOH Redlich-Peterson Fit.....	48
Figure C.7. HKUST-1@FA-1 Langmuir Fit	50
Figure C.8. HKUST-1@FA-1 Freundlich Fit.....	50
Figure C.9. HKUST-1@FA-1 Redlich-Peterson Fit.....	51
Figure C.10. HKUST-1@FA-5 Langmuir Fit	52
Figure C.11. HKUST-1@FA-5 Freundlich Fit.....	53
Figure C.12. HKUST-1@FA-5 Redlich-Peterson Fit.....	53

LIST OF TABLES

Table II.1. Previous Research	5
Table II.2. Isotherm Model Equation.....	9
Table II.3. Kinetics Model Equation.....	11
Table III.1. List of Samples	13
Table IV.1. R ² Value and Equation Fittings for HKUST-1 Samples.....	26
Table A.1. HKUST-1 Yield.....	40
Table B.1. Absorbance of Doripenem Solution.....	41
Table C.1. HKUST-1 Experimental Data	44
Table C.2. HKUST-1 Isotherm.....	44
Table C.3. HKUST-1@AcOH Experimental Data	46
Table C.4. HKUST-1@AcOH Isotherm.....	47
Table C.5. HKUST-1@FA-1 Experimental Data	49
Table C.6. HKUST-1@FA-1 Isotherm.....	49
Table C.7. HKUST-1@FA-5 Experimental Data	51
Table C.8. HKUST-1@FA-5 Isotherm.....	52
Table D.1. HKUST-1 Kinetic	54
Table D.2. HKUST-1@AcOH Kinetic	55
Table D.3. HKUST-1@FA-1 Kinetic	55
Table D.4. HKUST-1@FA-5 Kinetic	56
Table E.1. HKUST-1 Samples Drug Loading	57
Table F.1. HKUST-1 Drug Release	58
Table F.2. HKUST-1@AcOH Drug Release.....	59
Table F.3. HKUST-1@FA-1 Drug Release	59
Table F.4. HKUST-1@FA-5 Drug Release	59
Table G.1. HKUST-1 Crystallinity Calculation.....	61

ABSTRACT

Doripenem is an antibiotic with high effectiveness in treating infections. However, the dose of doripenem is only partially used, so the rest will be wasted through the secretory system. Therefore, a drug carrier is needed to control the release of doripenem efficiently. Hong Kong University of Science and Technology-1, or HKUST-1, is a metal organic framework used as a drug carrier of doripenem. Formic acid is a carboxylic acid other than acetic acid, which is used in synthesizing HKUST-1 as a modulator. This study aimed to examine the effect of modulators on the synthesis of HKUST-1 as the doripenem drug carrier. The addition of a modulator gave the different yields and particle sizes of HKUST-1. The results of this study indicate that the modulated HKUST-1 used has a sips isotherm model. For the Q_{\max} value of HKUST-1 of 413.66 mg/g, acetic acid fragmented HKUST-1 of 445.36 mg/g, 1 mL of formic acid-fragmented HKUST-1 of 486.65 mg/g and 5 mL of formic acid-fragmented HKUST-1 298.28 mg/g. In drug loading and drug release application, the modulator positively affects the adsorption process but not in the drug release process.