

PAPER • OPEN ACCESS

## Preface

To cite this article: 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **980** 011001

View the [article online](#) for updates and enhancements.



**ECS** **240th ECS Meeting**  
Oct 10-14, 2021, Orlando, Florida

**Register early and save  
up to 20% on registration costs**

Early registration deadline Sep 13

**REGISTER NOW**

## PREFACE

The 1<sup>st</sup> **International Conference on Science and Technology for Sustainable Industry** (ICSTSI) is organized as a collaboration between The Institution of Research and Standardization of Industry Banjarbaru (Balai Riset dan Standardisasi Industri Banjarbaru) and The Chemistry Department of Lambung Mangkurat University. The theme of this conference is “*Emerging Science and Technology as a Solution for Global Challenge on Research and Technology Based on Sustainable Resources*”. Sustainability remains a crucial issue regarding how the industrial sectors use technology to explore and utilize resources in the era of industrial revolution 4.0. This revolution has started with the applications of advanced manufacturing and digital information technologies. The world is undergoing a fundamental transformation, which is changing the way we live, work and think. The fourth industrial revolution presents a future filled with exciting opportunities and new challenges and the potential to meet specific requirements during the COVID-19 crisis. Industry 4.0 technologies have the capability of providing better digital solutions for our daily lives during this crisis.

The main goal of this conference is to bring together scientists, academics, and practitioners who work in various fields to exchange their ideas by presenting their research findings. This two-day of conference are certainly the moment of scientific forum that can be used as a means of knowledge exchange to connect participants (in any discipline) with each other, so they can discuss their work, learning from one another, and achieving improvements in results.

In the initial plan, this conference should have been held in Banjarbaru, a city in the province of South Kalimantan, Indonesia on August 6<sup>th</sup>-7<sup>th</sup> 2020. Unfortunately, due to the extraordinary global health issue with the coronavirus disease (Covid-19) that causes the large-scale social restrictions in the framework of the acceleration of Covid-19 handling, ICSTSI was held virtually while maintaining its original schedule. There were about 250 attendees that participated in the conference meeting, and 154 of them were presenting their papers in the plenary sessions. The meeting was done by virtual instead of being postponed because virtual meetings have become the new normal under COVID-19. The virtual meeting was held by Zoom meeting video-conference method. This virtual conference could be used as a tool to speed up existing discussions and timelines among scientists. Each presenter delivered the paper for approximately 7 minutes presentation and followed by 3 minutes discussions and Q&A sessions. The event was appreciated by the participants because it was well-organized and being one of the pioneers in the new normal video-conference trends. The YouTube channel of the opening ceremony ICSTSI 2020 could be found here <https://s.id/u1Kmu>.

The plenary session in the first day consisted of the presentation by keynote speakers and poster presentations. The parallel session in the second day contained of invited speakers and oral presentations, divided into 6 different topics: material and applied chemistry; wood and non-wood forest products technology; food, cosmetics, and medicine; analysis and method validation industrial, process optimalization technology; biorefinery, bioenergy, and renewable energy and biotechnology; and waste treatment and environmental management. The keynote and invited speakers who had been presented on this conference are listed below.



**Keynote Speakers:**

Dr. Ir. Doddy Rahadi, MT (Ministry of Industry, Indonesia)

Prof. Dr. Shinso Yokota (Utsunomiya University, Japan)

Assoc. Prof. Dr. Azlan Kamari (Universiti Pendidikan Sultan Idris, Malaysia)

Prof Dr. Ir. Umar Santoso, M. Sc. (Faculty of Agricultural Technology Gadjah Mada University, Indonesia)

Mukhlis Bahrainy (The CEO of Pachira Group)

Prof. Dr. Is Fatimah (The Islamic University of Indonesia)

**Invited Speakers:**

Prof. Rodiansono, Ph.D (Lambung Mangkurat University)

Prof. Gustan Pari (Forest Products Research and Development Center)

Dr. Nazarni Rahmi (The Institution of Research and Standardization of Industry Banjarbaru, Ministry of Industry)

Ir. Lies Indriati (Center for Pulp and Paper, Ministry of Industry)

Dr. Lisman Suryanegara (Center for Research of Biomaterial, Indonesian Institute of Science)

Dr. Aris Mukimin (Center for Industrial Pollution Prevention Technology, Ministry of Industry)

The committee has received 154 papers from both oral and poster presentations, with the participants spread from many countries like Indonesia, Japan and Malaysia. The participants of conference came from various research institutions and universities such as Indonesian Rubber Research Institute, Palembang Institute for Industrial Research and Standardization; Center for Craft and Batik; Bandar Lampung Institute for Industrial Research and Standardization; Sembawa Research Centre; Department of Metallurgical and Materials Engineering; University of Indonesia; Department of Chemical Engineering; Politeknik Negeri Sriwijaya, Indonesia; Department of Agroindustrial Technology, Bogor Agricultural University; Department of Agroindustrial Technology, Lambung Mangkurat University; Department of Chemical Engineering, Engineering Faculty, University of Lambung Mangkurat; Departement of Chemistry, Gadjah Mada University; Wetland-Based Materials Research Center, Lambung Mangkurat University; State Islamic University of Sunan Gunung Djati, Bandung; Center for Ceramic, Bandung; Department of Chemistry, Universitas Palangka Raya; Institution of Research and Standardization of Industry – Padang; Environmental Technic Study Program of Lambung Mangkurat University; Department of Chemistry, Universiti Pendidikan Sultan Idris; Department of Leather Processing Technology, Politeknik ATK Yogyakarta; Faculty of Animal Science, Gadjah Mada University; Banjarbaru Enviroment and Forestry Research Development Institute; Research Division for Natural Product Technology (BPTBA), Indonesian Institute of Sciences (LIPI); Department of Pharmaceutical Chemistry, Gadjah Mada University; Institute of Research and Standardization of Industry, Banjarbaru; Indonesian Swampland Agricultural Research Institute, Banjarbaru; Research Division for Natural Products Technology-Indonesian Institute of Sciences; Faculty of Agriculture, Kyushu University; Faculty of Agriculture, Pattimura University; Accounting, Pamulang University; Center of energy resources technology and chemical industry, BPPT; Chemical Engineering,

Pamulang University. These papers were reviewed by scientific committee and 85 full papers were accepted to be published in IOP Proceeding Conference Series. We would like to thank the participants who have submitted their papers. We are grateful to IOP Publishing as our publication media partner. We also highly appreciate the sponsors who financially supported this event especially to the Industrial Research and Development Council Ministry of Industry, Indonesia.

## LIST OF COMMITTEE

### Steering Committee

- Head of The Institution of Research and Standardization of Industry Banjarbaru
- Head of Research and Development of Industry, Ministry of Industry
- Head of Agro Industry Research Center, Ministry of Industry
- Head of Department of Chemistry, Faculty of Mathematics and Natural Sciences, Lambung Mangkurat University
- Dean of Faculty of Mathematics and Natural Sciences, Lambung Mangkurat University
- Chairman of Indonesia Association of Food Technologist

### Organizing Committee:

- Person in Charge : Ratri Yuli Lestari, S.Hut., M.Env.  
Chair : Dr. Nazarni Rahmi, S.TP., M.Si  
Vice Chair : Sunardi, S.Si., M.Sc., Ph.D.  
Secretariat : Utami Irawati, S.Si., M.E.S., Ph.D; Rais Salim, S.Hut.; Faiza Elisa Hasfianti, S.Hut., Fitri Yuliaty, S.Si.  
Treasurer : Endang Gembirawati, A.Md, Maria Dewi Astuti, S.Si., M.Si.  
Event and protocoler : Hamlan Ihsan, S.Si; Desi Mustika Amaliyah, S.T., M.M.; M. Listianto Raharjo, S.T.; Drs. Taufiqur Rohman, M.Si.  
Plenary session : Rodiansono, Ph.D.; Dr. Evy Setiawati, S.Si., M.T.; I Dewa Gede P. P., S.Si.  
Equipments and transportation: Isa Anshari; Saibatul Hamdi, S.Hut, M.P.; Budi Tri Cahyana, S.T.; Ahmad Budi Junaidi, S.Si., M.Sc.; Dr. Rahmat Yunus, M.Si.  
Food and Beverages : Rufida, A.Md.; Nadra Khairiah, S.Si, Dahlena Ariyani, S.Si., M.Si.; Kholifatu Rosyidah, S.Si., M.Si.  
Publication and Documentation: Dwi Harsono, S.Hut.; M. Sobirin; Vemby Danang N.; Dwi Rasy Mujiyanti, S.Si., M.Si.; Noer Komari, S.Si., M.Kes.

### Scientific Committee:

#### Editor in Chief:

- Prof. Rodiansono, Ph.D. (Chemistry Department, Lambung Mangkurat University)

#### Scientific Committee Members:

- Prof. Ris. Dr. Muhammad Hanafi (RC Chemistry-Indonesian Institute of Sciences LIPI)
- Prof. Dr. Enos Tangke Arung, S.Hut, M.P. (Faculty of Forestry, Mulawarman University, Samarinda)
- Prof. Dr. Is Fatimah (Department of Chemistry, Islamic University of Indonesia)

- Prof. Iriyanti Fatyasari Nata, S.T., M.T., PhD. (Faculty of Engineering, Lambung Mangkurat University)
- Prof. Rudianto Amirta, S.Hut, M.P. (Faculty of Forestry-Mulawarman University, Samarinda)
- Prof. Dr. Ir. Subyakto, M.Sc. (Center for Research of Biomaterial, Indonesian Institute of Science)
- Prof. Ris. Dr. Ir. Gustan Pari, M.S. (Forest Products Research and Development Center, Ministry of Forestry, Indonesia)
- Dr. Evy Setiawati, S.Si., M.T. (The Institution of Research and Standardization of Industry Banjarbaru)
- Dr. Ragil Widyorini, S.T.M.T. (Faculty of Forestry, Gadjah Mada University)
- Ir. Lies Indriati (Center for Pulp and Paper (BBPK), Ministry of Industry Indonesia)
- Dr. Dede Heri Yuli Yanto (Center for Research of Biomaterial, Indonesian Institute of Sciences-LIPI)
- Sunardi, S.Si., M.Sc., Ph.D. (Chemistry Department, Lambung Mangkurat University)
- Dr. Lisman Suryanegara, S.Si., M.Agr. (Center for Research of Biomaterial, Indonesian Institute of Sciences-LIPI)
- Muthia Elma, ST., M.Sc., PhD. (Chemical Engineering Study Program Engineering Faculty)
- Agung Nugroho, S.TP., M.Sc., Ph.D. (Department of Agro-Industrial Technology, Faculty of Agriculture, Lambung Mangkurat University)
- Dr. Hendra Wijaya, S.Si., M.Si. (Center for Agro-Based Industry-BBIA, Ministry of Industry Indonesia)
- Dr. Nazarni Rahmi, S.TP., M.Si. (The Institution of Research and Standardization of Industry Banjarbaru)
- Dr. Wiwin Tyas Istikowati, S.Hut., M.Sc. (Faculty of Forestry, Lambung Mangkurat University)
- Dr. Ihak Sumardi, S.Hut, M.Si., PhD. (Bandung Institute of Technology)
- Utami Irawati, Ph.D. (Chemistry Department, Lambung Mangkurat University)
- Adi Setyo Purnomo, S.Si., M.Sc., Ph.D. (Department of Chemistry, Faculty of Science and Data Analytics, Institut Teknologi Sepuluh Nopember, Surabaya, Indonesia)
- Dr. Maherawati, S.TP., M.P. (Faculty of Agriculture, Tanjung Pura University, Pontianak, Indonesia)
- Dr. Andriati Ningrum, S.TP, M.Sc. (Faculty of Agriculture Technology, Gadjah Mada University, Yogyakarta, Indonesia)

### CONFERENCE DOCUMENTATION

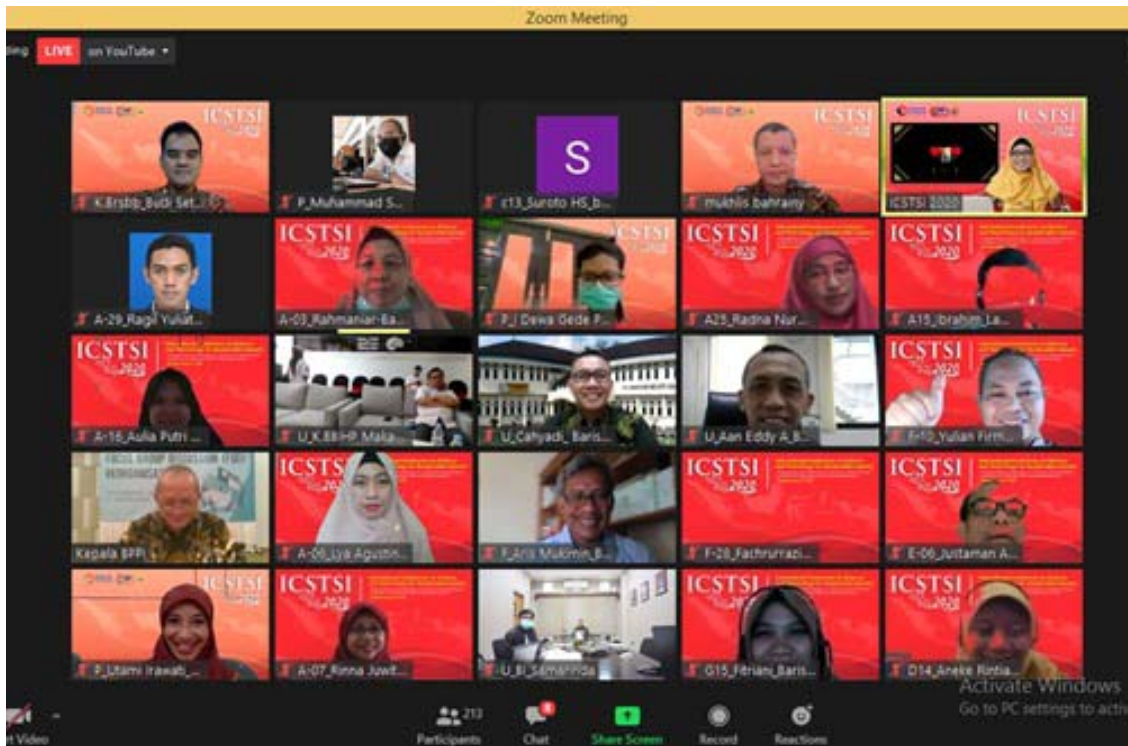


Figure 1. Conference guests and participants.



Figure 2. Conference opening ceremony.





Figure 3. Conference invited speaker.



Figure 4. Conference committee.



**Figure 5.** Behind the scenes.



PAPER • OPEN ACCESS

## Peer review declaration

To cite this article: 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **980** 011002

View the [article online](#) for updates and enhancements.

A promotional banner for the 240th ECS Meeting. The banner features a colorful striped border at the top. On the left, the ECS logo is displayed in a green circle. To its right, the text reads "240th ECS Meeting" in large blue font, followed by "Oct 10-14, 2021, Orlando, Florida" in a smaller black font. Below this, it says "Register early and save up to 20% on registration costs" in bold black text, and "Early registration deadline Sep 13" in a smaller black font. At the bottom left, there is a red "REGISTER NOW" button. On the right side of the banner, there is a photograph of a diverse group of people in a professional setting, with a man in a white shirt and tie clapping and smiling in the foreground.

**ECS** **240th ECS Meeting**  
Oct 10-14, 2021, Orlando, Florida  
**Register early and save  
up to 20% on registration costs**  
Early registration deadline Sep 13  
**REGISTER NOW**

## Peer review declaration

All papers published in this volume of IOP Conference Series: Materials Science and Engineering have been peer reviewed through processes administered by the Editors. Reviews were conducted by expert referees to the professional and scientific standards expected of a proceedings journal published by IOP Publishing:

- **Type of peer review: Double-blind**  
All papers came through a basic review which includes checking of initial technical criteria (paper scope and similarity checks). The initial technical criteria were checked by the editorial team. Any paper that out of scope was immediately rejected. The accepted papers received were continued to a peer-review process (submission structure, English language usage, and manuscript content) by two professional experts in a related subject area. The identities of both the authors and reviewers were kept hidden. After completing the peer review process, the process was continued by proofreading and layout.
- **Conference submission management system:**  
Google forms that connected to email of 1<sup>st</sup> International Conference on Science and Technology for Sustainable Industry
- **Number of submissions received:** 154 papers
- **Number of submissions sent for review:** 120 papers
- **Number of submissions accepted:** 85 papers
- **Acceptance Rate (Number of Submissions Accepted / Number of Submissions Received X 100):** 55.19%
- **Average number of reviews per paper:** two reviews
- **Total number of reviewers involved:** 23 reviewers
- **Any additional info on review process:**  
The reviewers were asked to answer a number of questions related to the quality of the content (reviewed form). Thus, the review processes were not personal and formalized. The review process for each paper took more than one month. The decision to accept or reject was based on the suggestions of each reviewer. If differences of opinion occurred between two reviewers, the editorial team pointed out one additional reviewer to review. The decision was based on majority votes based on all comments.
- **Contact person for queries:** seminar.brsbb@gmail.com



# Table of contents

Volume 980

2020

◀ Previous issue      Next issue ▶

1st International Conference on Science and Technology for Sustainable Industry (ICSTSI 2020)  
6-7 August 2020, Banjarbaru, Indonesia

Accepted papers received: 04 November 2020



Published online: 31 December 2020

Open all abstracts

## Preface



OPEN ACCESS 011001

Preface

+ Open abstract       View article       PDF

OPEN ACCESS 011002

Peer review declaration



+ Open abstract       View article       PDF

## Materials and Applied Chemistry

OPEN ACCESS 012001

The effect of natural rubber on physical and mechanical properties of rubber seal for LPG tube valve



H Handayani, A Ramadhan, A Cifriadi, N A Kinasih, A F Falaah and D R Maspanger

+ Open abstract       View article       PDF

OPEN ACCESS 012002

Thermal aging and chemical resistance evaluation of carbon black filled natural rubber blending: effect of the composition of acrylo nitrile and styrene butadiene rubber

T Susanto, Rahmaniari, Farida, D W Lestari and K Abdullah

+ Open abstract       View article       PDF

OPEN ACCESS

The effect of pumice and clay composition in natural rubber-ethylene propylene diene  
This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more,  
see our Privacy and Cookies policy.

012003



Rahmaniar, T Susanto, H A Prasetya, P Marlina, M Purbaya, M Chalid and A Hasan

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

Failure analysis of aluminum alloys casting in four-wheels vehicle rims

Surasno and B Tjahjohartoto

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

Current development, potentials, and challenges of biological synthesis of nanoparticle (as a photocatalyst): A review

L Agustina, S Suprihatin, M Romli and P Suryadarma

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

Synthesis and characterization of amine-functionalized sugarcane bagasse fiber magnetic nanoparticle biocomposites

R Juwita, C Irawan, R Jelita and I F Nata

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

Preparation of magnetic nanoparticle biocomposites using rice husk and sugarcane bagasse fibers as the matrix

Y S Dewi, H Wijayanti, R A Lestari and I F Nata

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

Molecular dynamics simulation of nanocellulose-oil-water interaction in enhanced oil recovery application

M Ledyastuti and J Jason

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

Modified physical properties of kaolin by intercalation and exfoliation method

I D G P Prabawa, R Y Lestari, S Hamdi and Sunardi

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

The development of Indonesian local clay as a lightweight expanded clay aggregate (LECA) for organic growing medium

Subari, Hernawan, K Wahyudi, I Rosmayanti, and Nurhidayati

[+ Open abstract](#) [View article](#) [PDF](#)

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our privacy and cookie policy.




OPEN ACCESS


o (II) desorption from silica gel and mercapto-silica hybrid

012018

R Mujiyanti, U Irawati and N M Akhir

Open abstract

 View article

 PDF


OPEN ACCESS


The exploration of banana bunch as a new vegetable tanning agent

012019

Maryati, A Pertiwiningrum, Z Bachrudin and R Yuliatmo

Open abstract

 View article

 PDF


OPEN ACCESS


Application of cocoa pod husk (*Theobroma cocoa* Spp) for natural dyes powder on silk batik cloth

012020

Masiswo, A Haerudin, Isnaini, D W Lestari, G B Mandegani, Y Satria, T K Arta and V Atika

Open abstract

 View article

 PDF


OPEN ACCESS


Biduri (*Calotropis gigantea*) leaves extract as natural dyes and ultraviolet protector applied on silk fabric with an exhaust dyeing method

012021

Nugraha, A Sukmawati, A S Mulyawan and D Sugiyana

+ Open abstract

 View article

 PDF


OPEN ACCESS


Improving aluminum strength with chemical modification based on titanium and boron elements

012022

E Rahman, R Kumar, V Monandes and R Yadi

+ Open abstract

 View article

 PDF

## Wood and Non Wood Forest Products Technology


OPEN ACCESS


Redistillation of wood vinegar from peat swamp species

012023

R S Wahyuningtyas

+ Open abstract

 View article

 PDF


OPEN ACCESS


Redistillation and characterization of liquid smoke from ulin wood (*Eusideroxylon zwageri* Teijsm. & Binn.) and its ability as a chitosan solvent

012024

A B Junaidi, A Nursyifa and Abdullah

+ Open abstract

 View article

 PDF

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more,



[View our Privacy and Cookies policy.](#)

012025

OPEN ACCESS

The Effect of TiO<sub>2</sub> additives on the antibacterial properties (*Escherichia coli* and *Staphylococcus aureus*) of glaze on ceramic tiles

E Maryani, N S Nurjanah, E P Hadisantoso and R B Wijayanti



+ Open abstract  View article  PDF

012011

OPEN ACCESS

The effect of solvent in the hydrogenation of lauric acid to lauryl alcohol using Ru-Fe/TiO<sub>2</sub> catalyst

Ibrahim, M Riski and Rodiansono



+ Open abstract  View article  PDF

012012

OPEN ACCESS

Selective hydrogenation of levulinic acid to  $\gamma$ -valerolactone using bimetallic Pd-Fe catalyst supported on titanium oxide

A P Damayanti, H P Dewi, Ibrahim and Rodiansono



+ Open abstract  View article  PDF

012013

OPEN ACCESS

Synthesis and characterization of magnetic adsorbent based on Fe<sub>2</sub>O<sub>3</sub>-fly ash from Pulang Pisau's power plant of Central Kalimantan

D A P Wardani, L Rosmainar, R M Iqbal and S N Simarmata



+ Open abstract  View article  PDF

012014

OPEN ACCESS

The identification of the components, molecular structures and quality of stamp ink from gambier extract

S Silfia, S Sofyan, F Failisnur and G Yeni



+ Open abstract  View article  PDF

012015

OPEN ACCESS

Properties of cellulose and modified cellulose-alginate for rifampicin drug delivery

R J D Arianto and Sunardi



+ Open abstract  View article  PDF

012016

OPEN ACCESS

Sodium alginate-chitosan nanocomposite as a novel carrier agent for cinnamaldehyde: characterisation and release studies

S T S Wong, A Kamari and J Jumadi



+ Open abstract  View article  PDF

012017

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.

Investigation on the antibacterial activity of the methanol extract of purun tikus root (*Eleocharis dulcis*)

K Rosyidah, L A P Sari and T Rohman



+ Open abstract  View article  PDF

OPEN ACCESS

The antioxidant activity of white kapul (*Baccaurea macrocarpa*) fruit rinds

012040

M D Astuti, W F Ana, K Rosyidah and Rodiansono



+ Open abstract  View article  PDF

OPEN ACCESS

Structural characterization and antioxidant activity of liquid sugar from Alabio potato using enzymatic hydrolysis processes

012041

VS Angkasawati, I Kamaliyah, MD Putra, IF Nata and C Irawan



+ Open abstract  View article  PDF

OPEN ACCESS

Antioxidant activity of *Porphyridium cruentum* water extracts for cosmetic cream

012042

S Agustina, N N Aidha, E Oktarina and I Setiawati



+ Open abstract  View article  PDF

OPEN ACCESS

Physicochemical properties of fermented rice bran in optimal lactic acid bacteria growth

012043

K Nisa, S Handayani, V T Rosyida, S Nurhayati, W Apriyana, A W Indrianingsih, C Darsih, D A Ekamuri, D A S Ningrum and Siswanti



+ Open abstract  View article  PDF

OPEN ACCESS

The effect of heat treatment of java plum seed extract on its polyphenolics content and antioxidant activities

012044

R Rohadi, I Iswoyo and D Larasati

+ Open abstract  View article  PDF



## Analysis and Methods Validation, Industrial Process Optimalization & Manufacturing Science and Technology

OPEN ACCESS

Empty fruit bunches, potential fiber source for Indonesian pulp and paper industry


012045

L Indriati, N Elyani and S F Dina

+ Open abstract  View article  PDF

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more,



see our Privacy and Cookies policy.

 012046



The sustainability of the iron industry based on local wisdom in the Barito watershed



Hartatik, H O Soffian, Sunarningsih, N N Susanto and R B Sulistiyo

+ Open abstract  View article  PDF

OPEN ACCESS

Online monitoring for processes and condition of a machine using smart management card

I A V Damanik, R D Rumbara and N Juhana

+ Open abstract  View article  PDF

OPEN ACCESS

Improving the stability of catechin from gambier in  $\beta$ -cyclodextrin and nanoemulsion-based inclusion complexes



G Yeni, K Syamsu, O Suparno, E Mardiyati, Silfia, E Syafri, N Nazir and A Fudholi

+ Open abstract  View article  PDF

OPEN ACCESS

Optimization of linear transducer calibration system using laser interferometer based on the Abbe principle



A Rahman, E Pratiwi, N Alfiyati, O Novyanto and O Hedrony

+ Open abstract  View article  PDF

OPEN ACCESS

Development of a rapid-test method for the determination of calcium, zinc, phosphorus, and sulfur in automotive engine oil by WD-XRF (wavelength dispersive x-ray fluorescent)



D Cahyadi, E Susilowati, M Arsyansyah and S Febriny

+ Open abstract  View article  PDF

OPEN ACCESS

Phenol degradation by fenton reaction in air injection using plasma electrolysis method

J Z Wahono, R D Yusharyahya, Harianingsih and N Saksono

+ Open abstract  View article  PDF

OPEN ACCESS

The effect of sodium bicarbonate ratio for the mechanical properties of underarm pads rubber for crutches

Nasruddin, A T Bondan and S Agustini

+ Open abstract  View article  PDF

OPEN ACCESS

Characterization of 17-4 PH stainless steel metal injection molding feedstock using mixing torque data

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.





OPEN ACCESS

Water management and rice husk biochar application to solve acid sulfate soil problems to promote rice yield and reduce greenhouse gas emission

012067

W A Yusuf and Mukhlis



+ Open abstract  View article  PDF

OPEN ACCESS

Effectiveness of compost and vermicompost from market organic waste to improve soil chemical properties

012068

Syarifinnur, Y Nuraini, B Prasetya and E Handayanto



+ Open abstract  View article  PDF

OPEN ACCESS

The utilization of agricultural waste for peatland management; in case chili cultivation

012069

A Fahmi and A Susilawati

+ Open abstract  View article  PDF

OPEN ACCESS

The potential of anaerobic-constructed wetland system for wastewater treatment of rice straw pulping

012070

Y Setiawan and H Hardiani



+ Open abstract  View article  PDF

OPEN ACCESS

Utilization of lightweight brick waste as soils stabilizing agent

012071

Y F Arifin and A S Kusworo



+ Open abstract  View article  PDF

OPEN ACCESS

Overcoming constraint of tidal swampland with water management with one-way flow system to increase of rice growth

012072

W A Yusuf and E Setiawati



+ Open abstract  View article  PDF

OPEN ACCESS

Activated carbon from *Nypa (Nypa fruticans)* leaves applied for the Fe and Mn removal

012073

I Syauqiah, M Elma, D P Mailani and N Pratiwi

+ Open abstract  View article  PDF

OPEN ACCESS

The effect of addition of bacterium *Pseudomonas aeruginosa* on biodegradation of methyl orange dye by brown-rot fungus *Gloeophyllum trabeum*

012074

This site uses cookies. By continuing to use this site you agree to our use of cookies. To find out more, see our Privacy and Cookies policy.



A S Purnomo, F D Rahmadini, R Nawfa and S R Putra

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Degradation of linear alkylbenzene sulfonate (LAS) using  $TiO_2$ -chitosan composite as a photocatalyst

N A Rizky, U Irawati and T Rohman

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Water quality assessment and a study of current palm oil mill effluent (POME) treatment by ponding system method

J Junadi, A Kamari and S T S Wong

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Comparing the effectiveness of chitosan and conventional coagulants for coal wastewater treatment

A Maria, E Mayasari, U Irawati and Zulfikurrahman

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Rapid start-up of expanded granular sludge bed (EGSB) reactor using granulated anaerobic bacteria in pharmaceutical wastewater treatment: pilot scale

R A Malik, H Vistanty, A Mukimin and N Zen

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Comparison of ferrate ( $FeO_4^{2-}$ ) and ultrasonic waves ability as *Coliform* antibacterial in Kahayan River water Central Kalimantan

N Kurniawati, S Sunariyati, K Karelius, L Hakim, W Krestina and D A P Wardani

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

Low concentration lead ion adsorption determination performance using activated carbon from bambu betung (*Dendrocalamus asper*)

A Zakaria, N Yuliani, A Oktaviani and Fachrurrazie

[+ Open abstract](#) [View article](#) [PDF](#)

OPEN ACCESS

The implementation of green industry standard batik industry to develop eco-friendly

This site uses cookies. By continuing to use this site you agree to our use of cookies. See our Privacy and Cookies policy.

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

The potential of food waste as bioplastic material to promote environmental sustainability: A review 012082  
M O Ramadhan and M N Handayani

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

A review: The use of mangrove for biomonitoring on aquatic environment 012083  
R Wilda, A M Hamdan and R Rahmi

[+ Open abstract](#) [View article](#) [PDF](#)

**OPEN ACCESS**

Biodegradation of buried crude oil in soil microcosm by fungal co-culture 012084  
D H Y Yanto and A Hidayat

[+ Open abstract](#) [View article](#) [PDF](#)

**JOURNAL LINKS**

[Journal home](#)

[Journal scope](#)

[Information for organizers](#)

[Information for authors](#)

[Contact us](#)

[Reprint services from Curran Associates](#)

PAPER • OPEN ACCESS

## Co (II) desorption from silica gel and mercapto-silica hybrid

To cite this article: D R Mujiyanti *et al* 2020 *IOP Conf. Ser.: Mater. Sci. Eng.* **980** 012018

View the [article online](#) for updates and enhancements.

A promotional banner for the 240th ECS Meeting. The banner features a colorful striped border at the top. On the left, the ECS logo is displayed in a green circle. To its right, the text reads "240th ECS Meeting" in large blue font, followed by "Oct 10-14, 2021, Orlando, Florida" in a smaller black font. Below this, it says "Register early and save up to 20% on registration costs" in bold black text, and "Early registration deadline Sep 13" in a smaller black font. At the bottom left, there is a red "REGISTER NOW" button. On the right side of the banner, there is a photograph of a diverse group of people in professional attire, smiling and clapping, suggesting a successful event or presentation.

**ECS** **240th ECS Meeting**  
Oct 10-14, 2021, Orlando, Florida  
**Register early and save  
up to 20% on registration costs**  
Early registration deadline Sep 13  
**REGISTER NOW**



## Co (II) desorption from silica gel and mercapto-silica hybrid

D R Mujiyanti<sup>1,2\*</sup>, U Irawati<sup>1</sup>, and N M Akhir<sup>1</sup>

<sup>1</sup>Department of Chemistry, Faculty of Mathematics and Natural Sciences, Lambung Mangkurat University, Jalan A. Yani km 36 Banjarbaru Indonesia

<sup>2</sup>Laboratory of Inorganic Chemistry, Laboratory of Faculty of Mathematics and Natural Sciences, Lambung Mangkurat University, Banjarbaru Indonesia

Email: drmujiyanti@ulm.ac.id

**Abstract.** This paper aims to study Co (II) desorption from silica gel (SG) and mercapto-silica hybrids (MSH) by many desorbing agents. SG was prepared from sodium silicate from rice husk ash, whereas MSH was SG modified by organic compounds 3- (trimethoxysilyl) -1-propanthiol. The characterization of adsorbents covered by an X-ray diffractometer and an FTIR spectrophotometer. Optimization of contact time for adsorption of Co (II) on HMS and the procedure of desorption agents (H<sub>2</sub>O, HCl, Na<sub>2</sub>EDTA.2H<sub>2</sub>O) at different contact times and concentrations via batch methods. The results showed that the optimum contact time for Co (II) adsorption on MSH was 120 minutes. The most appropriate desorbing agents for SG and MSH were HCl and Na<sub>2</sub>EDTA.2H<sub>2</sub>O. The optimum contact times for Co (II) desorption on SG and MSH were 90 and 120 minutes, respectively. The optimum concentration of HCl for desorbing Co (II) on SG was 0.025 M. While, the optimum concentration of Na<sub>2</sub>EDTA.2H<sub>2</sub>O for Co (II) desorption on MSH was 0.1 M.

### 1. Introduction

Abundant rice husk from the rice mills had been used as a fuel for combustion of red brick, cooking, media hydroponic plants, or burned away. Another application, waste rice husk ash (ASP) has a great potential as the source of silica-based adsorbent because numerous studies showed that the ASP contains sufficiently high points of silica, equivalent to 98% (w/w) [1]. Mujiyanti, et al. [2] reported that the silica content in the rice husk ash from the peat, Banjar Regency, South Kalimantan extended 95.6% (w/w).

Expenditure of the adsorbent adsorbs heavy metals, became a smaller amount of consideration. The adsorbent can be reused through recovery. Natalia [3] has investigated for desorption studies hybrid silica on metal sulfonate with Ca (II) and Cd (II) ions via technique column. The results showed that the result of desorption was Cd (II) ion, 98% with 0.1 M HCl and 100% with 0.05 and 0.1 M Na<sub>2</sub>EDTA.2H<sub>2</sub>O. On the other side, Ca (II) ion desorbed on HCl 0.5 M, amounting to 78.13% and for Na<sub>2</sub>EDTA.2H<sub>2</sub>O, Ca (II) ion desorbed amounting to 88.66%.

Furthermore to adsorbent recovery, desorption can be carried out for the recovery of adsorbed metals. Through desorption studies, we can also find out the adsorption mechanism between the metal and the adsorbent. Mujiyanti (2007) conducted a study of the multi-metal adsorption-desorption of Ag (I), Pb (II), Cr (III), Cu (II), and Ni (II) through a column system in mercapto-silica hybrids (MSH) using three types of eluents, HCl, H<sub>2</sub>O, and Na<sub>2</sub>EDTA.2H<sub>2</sub>O. The desorption with H<sub>2</sub>O % was variety 0.8-31.0% for monometallic solutions and 0.3-24.4% for multi-metal solutions. Meanwhile, the contribution of the adsorption mechanism for the formation of complex bonds with Na<sub>2</sub>EDTA.2H<sub>2</sub>O in



monometallic solutions alternated from 0.3-29.4% and multi-metal solutions reached from 0.2-14.3%. The desorption process indicated that the adsorption mechanism tends to the formation of hydrogen bonds. This is maintained by the formation of an octahedral aqua complex from the five metal ions in water.

Mujiyanti, et.al [4], stated that Co (II) adsorption on silica gel (SG) optimum at pH 5 and contact time of 75 minutes, while the MSH takes place optimally at pH 3, but the optimum time on MSH could not be determined. The contact time of adsorption was only until 90 minutes in a 50 mL solution of Co (II) 100 mg/L at pH 3 and the amount of adsorbed metal showed a tendency to rise. Therefore, one of the initial steps in this paper was to study the effect of the optimum contact time for Co (II) adsorption by MSH. Furthermore, this paper will observe some aspects of Co (II) desorption from SG and MSH.

## 2. Materials and methods

### 2.1. Materials

The material used was rice husk ash from peat area, South Kalimantan as a source of silica, NaOH (pa Merck), HCl 37% (pa Merck), 3- (trimethoxysilyl) -1-prophantiol (pa Merck), the stock solution of Co (II) 10000 ppm (pa Merck), Na<sub>2</sub>EDTA•2H<sub>2</sub>O (pa Merck).

### 2.2 Determining optimum contact time of Co(II) adsorption

The procedure of determining optimum contact time of Co (II) adsorption on the MSH referred to research that had been conducted by Mujiyanti,et.al [4]. A total of 100 mg of MSH interacted with 50 mL solution of Co (II) 100 mg / L at pH 3. The solution was stirred with a variation of the contact time 30, 60, 90, 120, and 150 minutes, and strained with filter paper. The filtrate was analyzed by Atomic Absorption Spectrophotometry (AAS).

### 2.3 The adsorption of Co (II) on silica gel and mercapto-silica hybrid

The adsorption process referred to research by Mujiyanti,et.al [4] in optimum conditions, pH = 5 and contact time 75 minutes for SG. For MSH accomplished at pH 3 and contact time obtained in determining the optimum contact time adsorption Co (II) at MSH. A total of 1 g of MSH contacted with 50 mL solution of metal ions Co (II) 100 mg/L at the optimum condition. The mixture was filtered then the filtrate was analyzed by AAS. The same treatment was also examined for SG.

### 2.4 The desorption of Co(II) Ion by silica gel and mercapto-silica hybrid

**2.4.1 Determining desorption agent of Co(II) desorption.** The desorption agent used in this study were H<sub>2</sub>O, HCl 0.1 M and 0.1 M Na<sub>2</sub>EDTA• 2H<sub>2</sub>O. Total of 25 mL desorption agent contained in erlenmeyer and MSH residues that have adsorbed metal ions Co (II), then solution shaken by contact time for 120 minutes. The mixture strained then the filtrate was analyzed by AAS. The same treatment was also examined for SG.

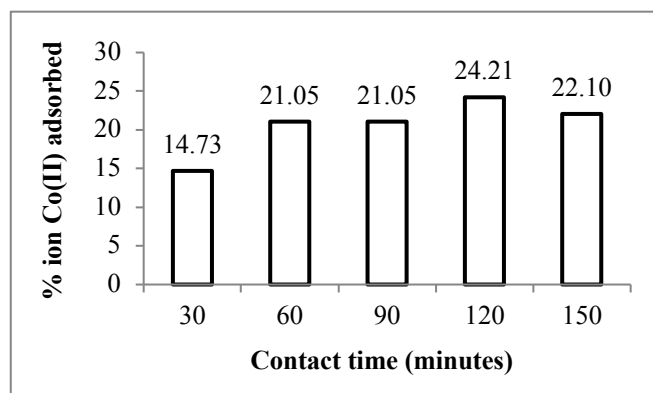
**2.4.2 Determining optimum contact time of Co (II) desorption.** Desorption was done as in the determination of desorption agent in variation of 30, 60, 90, 120, and 150 minutes.

**2.4.3 Determining optimum concentration of desorption agent for Co (II) desorption.** Desorption was done as in the determination of desorption agent and contact time, but consuming the suitable agent with a concentration of 0.025; 0.05; 1; 1.5; and 2 M for optimum contact time.

## 3. Results and discussion

### 3.1 Determining optimum contact time of Co(II) adsorption

Interaction time between adsorbent and the metal ion was one of the factors that play a role in determining the optimum conditions for interaction of metal ions and the equilibrium state of the adsorbent [5]. Figure 1, showed that the number of ions Co (II) adsorbed MSH on contact time 30, 60, 90, 120, and 150 minutes, respectively



**Figure 1.** The chart of % ion Co(II) adsorbed with the various contact time.

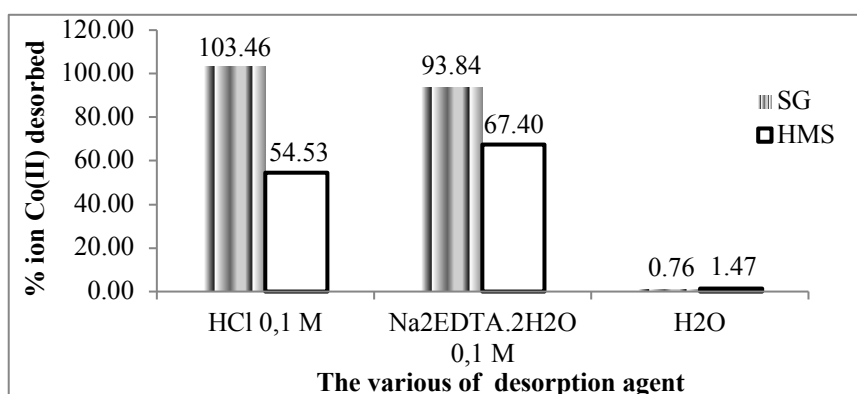
The quantity of Co (II) ions adsorbed was enlarged with an accumulative interval of stirring (30-120 minutes). The extended contact time of MSH and metal ion approved diffusion and annealing process taken more immaculate adsorbate molecules and the amount of Co (II) ions that absorbed increasingly. Adsorption was assessed by the maximum point when the contact time of 120 minutes, in which the percentage of adsorption MSH compared to Co (II) ion was 24.21%. Adsorption equilibrium was characterized by the lack of the concentration of metal ion alterations both on the surface of the adsorbent and metal ion in solution [6], in which the rate of adsorption was equal to the rate of desorption [7]. After passing through 120 minutes of the percentage of Co (II) ions adsorbed tended constantly, even declining. This trend suggested that the active sites on the surface of the adsorbent had been saturated by metal adsorbates and MSH no longer able to adsorb Co (II) ions. Metal ions that had been adsorbed could be desorbed from the surface of the adsorbent. This could occur if the interaction between Co (II) metal ions with the active site on MSH was fragile.

### 3.2 The desorption of Co(II) ion by silica gel and mercapto-silica hybrid

**3.2.1 Determining desorption agent of Co(II) desorption.** Desorption is the opposite of the adsorption process. Desorption is the process of releasing the adsorbate from the adsorbent into a solution [8]. The desorption process can provide information about the adsorption mechanism that plays a role in the adsorption of Co (II) by SG and MSH adsorbents. Co (II) metal ion, which had been adsorbed by the adsorbent, desorbed by the eluents; H<sub>2</sub>O, 0.1 M HCl and 0.1 M Na<sub>2</sub>EDTA• 2H<sub>2</sub>O by batch method. The relationship between percent Co<sup>2+</sup> which was desorbed with desorption agent types is showed in figure 2.

Distilled water (H<sub>2</sub>O) as a solvent metal ion was attached to the surface of the adsorbent. Desorption result with distilled water did not have a significant effect to release ions Co (II), just 0.76 and 1.47% for SG and MSH. Co(II) metal ion desorbed on surface SG and MSH by HCl solution was successively as much as 103.46 and 54.53%. HCl was a strong acid group that releases H<sup>+</sup> ions to replace metal ions adsorbed by ion exchange process or through hydrogen bonding interactions. Desorption percentage by HCl on SG exceed 100% due to the addition of HCl was expected to dissolve some of the SG, so that Co(II) less reacted with SG. Desorption with Na<sub>2</sub>EDTA•2H<sub>2</sub>O solution indicated that as many as 93.84 and 67.40% of ions Co(II) previously adsorbed by SG and MSH desorbed. The results showed that the adsorption of Co (II) in the adsorbent occurred such as through the formation of a complex between Co(II) with active sites, mercapto (-SH) in the adsorbent.

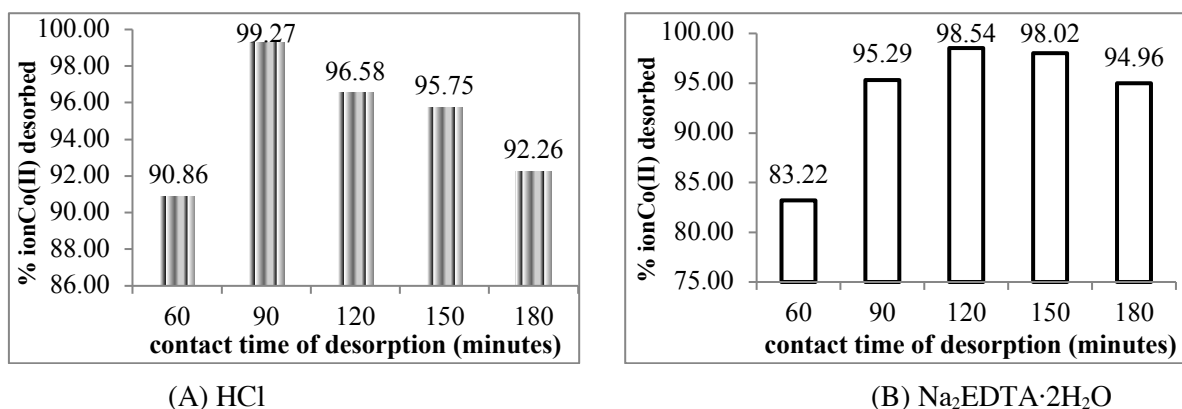
EDTA is a strong ligand, so when the ability of the ligand adsorbent active group is weaker than the EDTA then the metal ions on the adsorbent will be adsorbed by the formation of a stable complex [3].



**Figure 2.** The chart of % ion Co(II) desorbed with the various of desorption agent.

From figure 2, showed that the main interaction on SG and MSH was chemisorption. The adsorption mechanism of Co (II) cations on SG adsorbent was the most dominant estimated by ion exchange and /or hydrogen bonding, because the percentage of desorption with HCl equated to other desorbing agents maximum. However, the adsorption mechanism on MSH adsorbent, assumed mostly through the complex formation, an interaction was stronger than ion exchange interactions and the formation of hydrogen bonds.

**3.2.2 Determining optimum contact time of Co (II) desorption.** Determination of the optimum contact time of desorption aimed to obtain information on how long it takes to achieve optimum Co (II) desorption from the adsorbent. The variation of contact time was from 60 to 180 minutes. This research was using the desorbent agents 25 ml of 0.1 M HCl and 0.1 M Na<sub>2</sub>EDTA·2H<sub>2</sub>O as. The amount of Co (II) depleted for each variation of contact time is shown in figure 3.



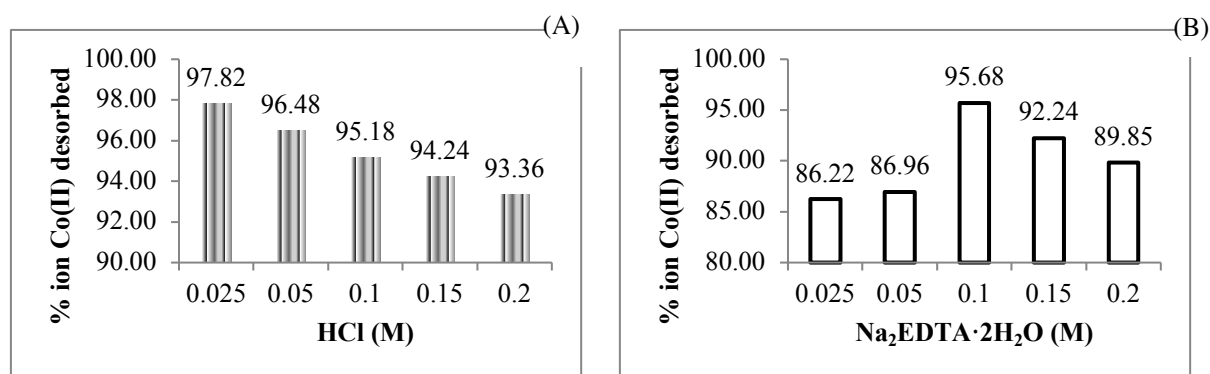
**Figure 3.** The relationship of Co(II) desorpted in various contact time of desorption.

From figure 3 it was shown that the extended contact time of metal ions using 0.1 M HCl and 0.1 M Na<sub>2</sub>EDTA·2H<sub>2</sub>O in SG and MSH, the number of Co (II) ions were separated greatly. However, at a certain moment the addition of time would decrease the percent desorption Co (II) ion which was separated from the adsorbent. Figure 3(A) indicated that the optimum contact time of desorption achieved after SG interacted with HCl for 90 minutes. This was due to the H<sup>+</sup> ion from HCl was strong enough to replace metal ions attached to the adsorbent SG [9]. While the pattern of desorption time



relationship with the percentage of Co (II) ions was separated on MSH by  $\text{Na}_2\text{EDTA}\cdot 2\text{H}_2\text{O}$  showed in figure 3(B). Desorption of MSH continued to rise until it reached a maximum desorption at 120 minutes, which amounted to 98.54%. For the interaction time of 150 and 180 minutes, separate Co (II) ions decreased. According to Khasanah [10] a similar tendency was possible due to a decrease in the surface of the adsorbent that had been saturated by Co-EDTA complex was formed.

**3.2.3 Determining the optimum concentration of desorption agent for Co (II) desorption.** This research also studied the effect of the concentration of desorption agent compared to Co (II) desorption (variation of the concentration of the agent 0.025 M to 0.2 M). The relationship between the concentration of HCl with Co (II) ions which desorbed on SG can be seen in figure 4(A). by desorption at 97.82 %.



**Figure 4.** The relationship % ion Co(II) desorbed on various concentration of desorption agent.

According to Natalia [3], one factor was the effectiveness of competition desorption  $\text{H}^+$  ions with adsorbed metal, the concentration of the solvent greatly gave affect the effectiveness of desorption. At the appropriate concentration, the ability of  $\text{H}^+$  ion to replace the presence of metal ions on the adsorbent being highest. Figure 4(A) showed the increasing of concentration of HCl had lower percentage desorption of Co (II) ions. It was possible that the solvent concentration was too high affecting Co (II) which were separated partially settled down as  $\text{CoCl}_2$ . From this research, it was found that the maximum percentage of Co (II) ions was desorbed at a concentration of 0.025 M for HCl as a desorption agent for the Co (II) attached to SG. Figure 4(B) shows that the accumulated concentration of  $\text{Na}_2\text{EDTA}\cdot 2\text{H}_2\text{O}$  caused the desorbed Co (II) ion to increase at a certain concentration. At a concentration of 0.1 M, the optimum amount of Co (II) ions was absorbed at 95.68%. The increase in the desorbed Co (II) ion is proportional to the increase in the concentration of  $\text{Na}_2\text{EDTA}\cdot 2\text{H}_2\text{O}$ . But after the concentration had exceeded the optimum, a decrease Co (II) ion was desorbed. This phenomenon was possible due to the partial of deprotonation  $\text{Na}_2\text{EDTA}\cdot 2\text{H}_2\text{O}$  therefore the acid groups ionized carboxyl was less active and caused the formation of the coordination bonding between EDTA and metal ions was not intensive.

#### 4. Conclusion

Based on the results of the research, adsorption of Co (II) ion on MSH had reached a maximum point at a contact time of 120 minutes as much as 24.21%. The maximum desorption process of Co (II) ions from SG with HCl and in MSH with  $\text{Na}_2\text{EDTA}\cdot 2\text{H}_2\text{O}$  as a desorbing agent. The contact time used in desorption of Co (II) ions on SG by 0.1 M HCl reached a maximum in 90 minutes, as much as 99.27% and MSH by 0.1 M  $\text{Na}_2\text{EDTA}\cdot 2\text{H}_2\text{O}$  was 120 minutes, as much as 98.54%. The concentration of 0.025 M HCl as desorbent ion Co (II) in SG which maximally absorbed Co(II) was 97.82% and the concentration of  $\text{Na}_2\text{EDTA}\cdot 2\text{H}_2\text{O}$  in the desorption of ion Co(II) from MSH was 95.68%.

## References

- [1] Nuryono 2004 Pengaruh konsentrasi NaOH pada peleburan abu sekam padi cara basah. *Prosiding Seminar Nasional Hasil Penelitian MIPA 2004* Semarang
- [2] Mujiyanti D R, Astuti MD, & Umaningrum D 2010 *Pembuatan Silika Amorf pada Limbah Sekam Padi Gambut di Kabupaten Banjar Kalimantan Selatan* Laporan DIPA (Banjarbaru : FMIPA, Universitas Lambung Mangkurat)
- [3] Natalia V 2009 Study of desorption of Ca(II) and Cd(II) in sulfonate silica hybrid adsorbent using column technic Skripsi (Yogyakarta: FMIPA Universitas Gadjah Mada)
- [4] Mujiyanti D R, Komari N and Sari N I 2013 Kajian Adsorpsi hibrida merkapto-silika dari abu sekam padi terhadap ion Co(II) *Jurnal Kimia Valensi* **3(2)** 71
- [5] Buhani, Narsito, Nuryono and Kunarti E S 2009 Hibrida amino-silika dan merkapto-silika sebagai adsorben untuk adsorpsi ion Cd(II) dalam larutan *Indo. J. Chem.* **9(2)** 170
- [6] Lesbani A 2011 Studi interaksi vanadium dan nikel dengan pasir kuarsa *Jurnal Penelitian Sains* **14(4)** 43-6
- [7] Riapanitra A, Setyaningtyas T and Riyani K 2006 Penentuan waktu kontak dan pH optimum penyerapan metilen biru menggunakan abu sekam padi *J. Molekul* **1(1)** 44
- [8] Triani L 2006 *Desorpsi Ion Logam Tembaga (II) dari Biomassa Chlorella Sp yang Terimobilisasi dalam Silika Gel*. Skripsi. (Semarang: FMIPA, Universitas Negeri Semarang)
- [9] Sembiring Z, Suharso, Regina, Marta F, & Murniyarti 2008 Studi Proses Adsorpsi-desorpsi Ion Logam Pb(II), Cu(II) dan Cd(II) terhadap Pengaruh Waktu dan Konsentrasi pada Biomassa *Nannochloropsis Sp.* yang Terenkapsulasi Aqua-gel silika dengan Metode Kontinyu. *Prosiding Seminar Nasional Sains dan Teknologi* (Bandar Lampung) p591-607
- [10] Khasanah D R 2006 Studi Penggunaan Na<sub>2</sub>EDTA dalam Desorpsi Ion Logam Kobalt(II) pada Kitin Terdeasetilasi dari Limbah Cangkang Kepiting Hijau (*Scylla serrata*) dalam Medium Air Skripsi (Semarang: FMIPA, Universitas Negeri Semarang)