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**HASIL PENILAIAN SEJAWAT SEBIDANG ATAU PEER REVIEW**  
**KARYA ILMIAH: JURNAL ILMIAH**

**Judul Karya Ilmiah (Artikel)** : Reaction Kinetics Study of Methanol Dehydration for Dimethyl Ether (DME) Production Using Dealuminated Zeolite Y Catalyst

**Nama Penulis** : Luqman Buchori, Didi Dwi Anggoro

**Jumlah Penulis** : 2 orang

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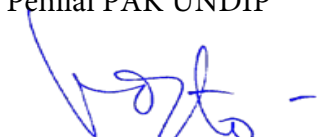
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- Ruang lingkup dan kedalaman pembahasan:** Artikel ini mengkaji tentang pengaruh temperatur terhadap konversi, konstanta kecepatan reaksi, energi aktivasi dan faktor tumbukan pada sintesa dimetil eter menggunakan katalis zeolite Y terdealuminasi. Isi artikel masih dalam ruang lingkup jurnal. Hasil percobaan disajikan dengan baik dan dibahas dengan mendalam dan komprehensif. Di dalam pembahasan melibatkan 10 rujukan dan sebagian besar berupa jurnal.
- Kecukupan dan kemutakhiran data/informasi dan metodologi:** Metode penelitian ditulis secara urut dan jelas. Kebaruan dari artikel ini terletak pada studi kinetika dehidrasi methanol menjadi dimetil eter menggunakan katalis zeolite Y terdealuminasi. Data yang dipakai cukup lengkap dan mutakhir. Hasil percobaan disajikan dalam bentuk tabel dan gambar. Artikel ini melibatkan 23 referensi. Sebanyak 11 referensi merupakan referensi yang mutakhir karena kurang dari 5 tahun. Rujukan berupa jurnal sebanyak 20, sisanya berupa prosiding, buku dan tesis.
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Semarang,  
Reviewer 1

Prof. Dr. Ir. Bakti Jos, DEA  
NIP. 196005011986031003

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- Kecukupan dan kemutakhiran data/informasi dan metodologi:** Artikel ini didukung dengan data pendukung yang cukup banyak. Metode penelitian disusun dengan cukup rapi dan runtut. Jumlah Pustaka yang mutakhir kurang dari 5 tahun sebanyak 11. Artikel ini didukung oleh 23 pustaka, sebagian besar berupa jurnal. Terdapat Pustaka berupa prosiding dan tesis. Artikel ini bebas dari plagiarisme yang ditunjukkan dari hasil Turnitin. Turnitin similarity indeks dari artikel ini cukup rendah yaitu 9%.
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Semarang,  
**Reviewer 2**



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# Reaction kinetics study of methanol dehydration for dimethyl ether (DME) production using dealuminated zeolite Y Catalyst

Buchori L. [✉](#), Anggoro D.D.[Save all to author list](#)

Department of Chemical Engineering, Faculty of Engineering, Diponegoro University, Jl. Prof. Soedarto, Semarang, 50275, Indonesia

Abstract

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**Abstract**

Dimethyl ether is classified as an alternative material that can be renewed and used for diesel engines, diesel fuel, and gas stoves as a household fuel. Dimethyl ether production was carried out by dehydration of methanol. The catalyst used in this process was dealuminated zeolite Y. This study aims to determine the effect of temperature on conversion, reaction rate constants, activation energy, and collision factor (A) in the synthesis of dimethyl ether. The reaction was carried out in a fixed bed catalytic reactor where the temperature was varied at 225-325 oC. The gas product was analysed by Gas Chromatography-Mass Spectrometry (GCMS), while the liquid product was analysed by High-Performance Liquid Chromatography (HPLC). The calculation of reaction kinetics was carried out using MATLAB. The results showed that the highest conversion was obtained at a reaction temperature of 225 oC which was 75.58 %. The reaction rate constant was obtained at 0.1795 l/mol.h with the activation energy and the collision factor values are  $1.044 \times 10^3$  cal/mol and 0.0589, respectively. © 2021 Italian Association of Chemical Engineering - AIChE. All rights reserved.

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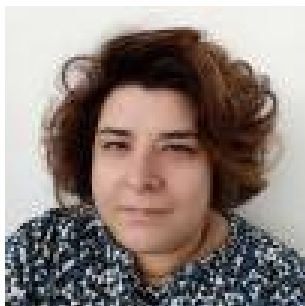


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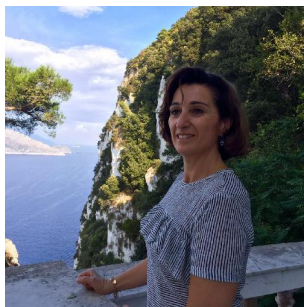


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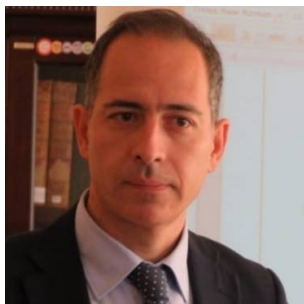
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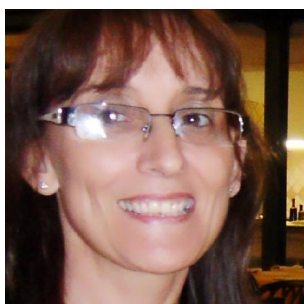


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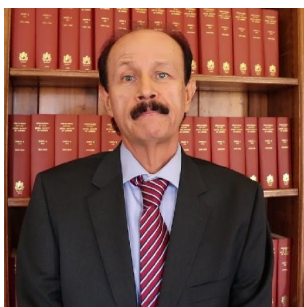
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# Reaction Kinetics Study of Methanol Dehydration for Dimethyl Ether (DME) Production Using Dealuminated Zeolite Y Catalyst

Luqman Buchori\*, Didi Dwi Anggoro

Department of Chemical Engineering, Faculty of Engineering, Diponegoro University, Jl. Prof. Soedarto, SH, Tembalang, Semarang, Indonesia 50275  
luqman.buchori@che.undip.ac.id

Dimethyl ether is classified as an alternative material that can be renewed and used for diesel engines, diesel fuel, and gas stoves as a household fuel. Dimethyl ether production was carried out by dehydration of methanol. The catalyst used in this process was dealuminated zeolite Y. This study aims to determine the effect of temperature on conversion, reaction rate constants, activation energy, and collision factor (A) in the synthesis of dimethyl ether. The reaction was carried out in a fixed bed catalytic reactor where the temperature was varied at 225-325 °C. The gas product was analysed by Gas Chromatography-Mass Spectrometry (GCMS), while the liquid product was analysed by High-Performance Liquid Chromatography (HPLC). The calculation of reaction kinetics was carried out using MATLAB. The results showed that the highest conversion was obtained at a reaction temperature of 225 °C which was 75.58 %. The reaction rate constant was obtained at 0.1795 l/mol.h with the activation energy and the collision factor values are  $1.044 \times 10^3$  cal/mol and 0.0589, respectively.

## 1. Introduction

Energy is a basic human need that continues to increase in line with the level of life. Oil fuel or fossil energy is one of the non-renewable energy sources that has been the mainstay of meeting energy needs in all activity sectors (Chen et al., 2021). Currently, petroleum is still the primary energy source to meet the needs of people in Indonesia. Like the consumption of petroleum, consumption of LPG (Liquid Petroleum Gas) is continuously increasing from year to year. LPG demand is estimated to increase from 7.2 million tons in 2017 to 17.4 million tons in 2050 or an average increase of 2.7 % per year (Agency for the Assessment and Application of Technology, 2019). Current LPG production in Indonesia is only 2.0 million tons, so importing LPG is required to meet this demand. However, it is feared that the increase in LPG imports will burden Indonesia's current trade balance. The increase in consumption of fossil-based energy, especially LPG (Liquid Petroleum Gas), which is not balanced with the availability of energy reserves, demands the development of other abundant and environmentally friendly alternative energy.

Dimethyl ether is a simple ether compound produced from various raw material sources such as natural gas, coal, and biomass. Dimethyl ether (DME) has a high cetane number and has properties close to that of LPG, such as viscosity, boiling point, and pressure (Rosadi et al., 2020), so it is imperative to study the possibility of using DME to replace or reduce the use of diesel and LPG in Indonesia. Dimethyl ether not only can be used in industry and transportation as well as power generation as a substitute for diesel oil, but also possesses the opportunity to replace LPG as a fuel in the household, commercial, and industrial sectors (Azizi et al., 2014), which are currently mostly imported (Agency for the Assessment and Application of Technology, 2019). Dimethyl ether is classified as an alternative material that can be renewed and used for diesel engines, diesel fuel, gas stoves fuel as a multi-source and multi-use household fuel (Makos et al., 2019).

In general, the DME production process can be carried out in two stages: methanol synthesis from the conversion of biomass or the reaction of carbon monoxide or carbon dioxide gas with hydrogen, then followed by the methanol dehydration process to produce DME and water molecules (Azizi et al., 2014). Zeolite is one



## Chemical Activation of Biochar with $H_3PO_4$ – A Comparison between Two Reactor Types

Dominik Bosch<sup>a,b</sup>, Lukas Rendl<sup>a</sup>, Fabian Plangger<sup>a</sup>, Angela Hofmann<sup>a,\*</sup>, Günter Langergraber<sup>b</sup>

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As the use of medicine increases worldwide, more and more drugs are found in wastewaters. It is now known that wastewater is a main pathway to enter the environment. Even state-of-the-art WWTPs are not able to remove these organic micropollutants (OMPs), or only to a limited extent. Therefore, an additional treatment step can be required and activated powdered carbon (APC) could be a possible solution. In this work, phosphoric acid is used for chemical impregnation and further activation. Two reactor approaches were used, a standard tubular (TR) and a fluidized bed reactor (FBR). Reaction times (RT) vary between 0.5 and 2/1 h at 700 to 1000 °C. For comparison, various parameters were carried out, such as specific surface area (SSA), total carbon (TC), yield and pore size distribution. The new FBR achieved higher SSA ( $1354.19 \text{ m}^2\text{g}^{-1}$ ) and a better pore distribution while using less impregnation agent (IA), lower temperatures and a shorter RT.

### 1. Introduction

From several measurements all over the world, one common statement emerges, namely there are too many chemical compounds from anthropogenic sources in the environment (Luo et al., 2014). These impurities are from organic chemical origin and therefore called organic micropollutants (OMP's) and occur in the ng to µg range. Negative effects on human health are not completely ruled out (Pomati et al., 2006), but it's now known for a long time that hormones like estrogen have a long-term effect on the reproduction of fish population (Kienle, 2015). What also known is that even the state of the art wastewater treatment plants (WWTPs) are not able or only partly able to remove these pollutants (Clara et al., 2005, Froehner et al., 2011). There are approaches like ozonation and powdered activated carbon (PAC) for the fourth treatment step and the latter has been suggested and proven as a good method for elimination (Bui et al., 2016). The production of efficient PAC is not sustainable as it is mainly made from hard coal or lignite (Çeçen, 2012). Due to the activation process, negative environmental influences occur and the costs for adsorbents increase. Consequently, the necessity for a sustainable and low-cost resource is mandatory. The most common raw material used to make PAC – then called biochar – is biomass, glucose or even animal-based materials (Ali et al., 2012). The gasification system used is a multistage process in which spruce wood chips are used to generate thermal energy and synthesis gas, which can be used in a gas engine to produce electricity (Ruiz et al., 2013, Sikarwar et al., 2016). The process includes a floating-fixed-bed reactor (FFBR) with a preceding pyrolysis step (Huber et al., 2016). Floating-fixed-bed gasification char (FFBGC) with a high carbon content and, depending on the process design, often highly porous structures is engendered as a by-product and is therefore qualified as biochar.

Another activation step is required after carbonization (Chen et al., 2011). With activation, the surface of the charcoal is getting more porous and therefore the surface area increases ( $1000\text{-}2500 \text{ m}^2\text{g}^{-1}$ ). This is an important and challenging step in the activation process. For the activation, there are two different approaches, a thermochemical one and an activation by means of chemical impregnation. In the thermochemical approach, the activation is caused by carbon dioxide, steam or both combined. This work is



# Production of Synthesis Gas from Biomass Residues by Staged Fixed-Bed Gasification - Results from Pilot Test Campaigns

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Fluidized-bed and entrained-flow gasification systems are developed for large-scale synthesis gas applications with at least 100 MW biomass input. However, there is also a market need for smaller-scale plants, which could be better integrated into energy production systems and local biomass logistics. The staged fixed-bed (SXB) gasifier described in this paper targets a size range of 10-50 MW of feedstock input. The primary gasification stage occurs in an updraft fixed bed. The tar-containing updraft gas is further processed in the secondary gasification zone, where gas temperature is raised from 200-500 °C to 750-900 °C by feeding secondary oxygen through a specially designed catalytic distributor zone. The composition and tar content of the resulting raw gas is similar to that of fluidized-bed gasifiers. Consequently, hot gas filtration, catalytic reforming and final gas cleaning technologies, similar to those recently developed and demonstrated for fluidized-bed gasifiers, can be applied. The results from the 0.5 MW pilot gasification tests carried out with wood, bark and sunflower husk pellets are presented in this paper.

## 1. Introduction

Advanced transportation biofuels have been the focus of intensive development in Europe since the early 2000s, but industrial deployment of developed technologies has been cancelled or postponed. One fundamental reason for this is the need for extremely large-scale plant concepts in order to exploit economies of scale, improve economic feasibility and attract investors. Large-scale plants also suffer from incomplete utilization of by-product heat, as it is difficult to find sufficiently large heat consumers that could exploit the heat supply to a large degree. Thus, the biomass utilization efficiency of stand-alone plants rarely exceeds 55 % (LHV), even with the best available technologies (Hannula I., Kurkela E., 2013). Although biomass gasification can be realized using many kinds of reactor types, all recent industrially developed Biomass-to-Liquids (BTL) concepts have been based either on entrained flow gasification of pre-treated biomass or fluidized-bed gasification followed by secondary treatment of tars and hydrocarbon gases (Hofbauer et al., 2019). These two basic alternatives aim at large-scale applications with at least 100 MW feedstock input. This paper concentrates on a fixed-bed gasification alternative aiming at 10-50 MW feedstock capacities. By using parallel gasifiers, larger plants can also be considered. Traditionally, fixed-bed biomass gasifiers are used to produce power in small-scale applications (downdraft gasifiers, < 1 MW) or to produce tar-containing gas (updraft, 1-10 MW), which cannot be cleaned for syngas applications (Sansaniwal et al., 2017). Usually, the feedstock basis of downdraft gasifiers is limited to lumpy biomass sources, which have low ash content or high ash melting temperature, as the basic design principle is to achieve efficient thermal tar breakdown in the hot central oxidation zone through which all tars and other pyrolysis products have to pass (Reed T.B & Das A., 1988). This design has several drawbacks: difficulty to scale-up to above 1 MW, ash sintering taking place in the hot oxidation zone and high carbon losses, since the final conversion depends on the char gasification reactions, which are significantly slower than oxidation reactions. The other basic fixed-bed gasifier type, the updraft (counter flow) gasifier, is a simple shaft furnace, in which air or oxygen and steam are introduced to the bottom of the fixed bed through a grate, and biomass is fed from the top. The main advantages of this reactor type are high chemical efficiency using gas and tar, high carbon conversion and fully oxidized ash