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

Judul Jurnal Ilmiah (Artikel)	:	Effect of Surfactant HLB Value on Enzymatic Hydrolysis of Chitosan
Nama Penulis	:	**Nur Rokhati,** Tutuk Djoko Kusworo, Aji Prasetyaningrum, Nur 'Aini Hamada, Dani Puji Utomo dan Teguh Riyanto
Jumlah Penulis	:	6 orang
Status Pengusul	:	Penulis pertama~~/ penulis ke - 3~~/ penulis korespondensi
Identitas Jurnal Ilmiah	:	a. Nama Jurnal : Chemengineering b. Nomor ISSN : 2305-7084 c. Volume, nomor, bulan, tahun : Vol. 6 No. 1, February 2022 d. Penerbit : MDPI AG e. DOI Artikel : doi.org/10.3390/chemengineering6010017 f. Alamat web Jurnal : https://www.mdpi.com/journal/chemengineering Alamat artikel : https://www.mdpi.com/2305-7084/6/1/17/htm g. Terindeks : SCOPUS (Q2), Web of Science, PMC, PubMed, dan MEDLINE
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Hasil Penilaian Peer Review

Komponen yang Dinilai	Nilai Reviewer		Nilai Rata-rata
	Reviewer I	Reviewer II	
a. Kelengkapan unsur isi Artikel (10%)	4,0	4,0	4,0
b. Ruang lingkup dan kedalaman pembahasan (30%)	11,6	11	11,30
c. Kecukupan dan kemutakhiran data/ informasi dan metodologi (30%)	11,5	11	11.25
d. Kelengkapan unsur dan kualitas terbitan/ jurnal (30%)	11,5	11	11.25
Total = (100 %)	38,6	37	37,80
Nilai pengusul = (60% x nilai total) = ...	23,16	22,20	22,68

Semarang,

Reviewer II

Prof. Dr. Moh. Djaeni, S.T., M.Eng.
NIP. 197102071995121001
Unit Kerja : DepartemenTeknik Kimia FT UNDIP

Reviewer I

Prof. Dr. Ir. Bakti Jos, DEA.
NIP. 196005011986031 003
Unit Kerja : DepartemenTeknik Kimia FT UNDIP

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HASIL PENILAIAN SEJAWAT SEBIDANG ATAU *PEER REVIEW*
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Identitas Jurnal Ilmiah	:	a. Nama Jurnal : ChemEngineering b. Nomor ISSN : 2305-7084 c. Volume, nomor, bulan, tahun : Vol. 6 No. 1, February 2022 d. Penerbit : MDPI AG e. DOI Artikel : doi.org/10.3390/chemengineering6010017 f. Alamat web Jurnal : https://www.mdpi.com/journal/chemengineering Alamat artikel : https://www.mdpi.com/2305-7084/6/1/17/htm g. Terindeks : SCOPUS (Q2), Web of Science, PMC, PubMed, dan MEDLINE
Kategori Publikasi Jurnal Ilmiah (Beri ✓pada kategori yang tepat)	:	☑ Jurnal Ilmiah Internasional bereputasi ☐ Jurnal Ilmiah Nasional Terakreditasi ☐ Jurnal Ilmiah Nasional Tidak Terakreditasi

Hasil Penilaian *Peer Review*

Komponen yang dinilai	Nilai Maksimal Jurnal Ilmiah			Nilai Akhir yang diperoleh
	Internasional bereputasi ☑	Nasional Terakreditasi ☐	Nasional Tidak Terakreditasi ☐	
a. Kelengkapan unsur isi Artikel (10%)	4			4,0
b. Ruang lingkup dan kedalaman pembahasan (30%)	12			11,6
c. Kecukupan dan kemutakhiran data/ informasi dan metodologi (30%)	12			11,5
d. Kelengkapan unsur dan kualitas terbitan / jurnal (30%)	12			11,5
Total = (100%)	**40**			**38,6**
Nilai pengusul = 60% x 38,6				**23,16**

Catatan penilaian artikel oleh Reviewer:

1. Kesesuaian dan kelengkapan unsur isi artikel:
Kelengkapan unsur artikel tersaji dengan baik. Artikel ditulis lengkap sesuai dengan template jurnal ChemEngineering, terdiri dari Introduction, Materials and Methods, Results and Discussion, Conclusions, dan References.

2. Ruang lingkup dan kedalaman pembahasan:
Ruang lingkup sesuai dengan bidang ilmu teknik kimia. Kebaruan artikel ini membahas tentang pengaruh nilai HLB surfaktan pada laju hidrolisis enzimatik kitosan. Hasil penelitian dibahas cukup detail dan komprehensif. Sitasi dalam pembahasan sebanyak 22 artikel dari 41 buah jumlah referensi atau 53,7 %. Pembahasan dilengkapi dengan 10 gambar.

3. Kecukupan dan kemutakhiran data/informasi dan metodologi:
Kemutahiran data informasi ini cukup baik. Hal ini ditunjukkan dengan jumlah referensi 10 tahun terakhir 33 buah dari 41 pustaka, atau 80,5 %. Metodologi disusun dengan lengkap dan terstruktur, instrumen-instrumen pengukur yang dipakai cukup memadai, sehingga pembaca bisa mencoba metode tersebut. Uji karakteristik produk meliputi deteksi aktifitas enzim selulasa, estimasi berat molekul, dan karakterisasi lain dengan FTIR, SEM, dan XRD.

4. Kelengkapan unsur dan kualitas terbitan:
Jurnal Chemengineering dengan publisher MDPI AG Switzerland, dikategorikan Jurnal Internasional bereputasi. Editorial board dari berbagai negara. Jurnal ChemEngineering mempunyai kategori ScimagoJR dengan SJR : 0,446 (2020), H index : 11, Quartiles (2020) : Q2. Nomor ISSN 2305-7084, Impact factor 2,29 Nilai similaritas artikel berdasarkan turnitin adalah 9 %.

Semarang,
Reviewer I

Prof. Dr. Ir. Bakti Jos, DEA.
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LEMBAR
HASIL PENILAIAN SEJAWAT SEBIDANG ATAU *PEER REVIEW*
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Identitas Jurnal Ilmiah	:	a. Nama Jurnal : Chemengineering b. Nomor ISSN : 2305-7084 c. Volume, nomor, bulan, tahun : Vol. 6 No. 1, February 2022 d. Penerbit : MDPI AG e. DOI Artikel : doi.org/10.3390/chemengineering6010017 f. Alamat web Jurnal : https://www.mdpi.com/journal/chemengineering Alamat artikel : https://www.mdpi.com/2305-7084/6/1/17/htm g. Terindeks : SCOPUS (Q2), Web of Science, PMC, PubMed, dan MEDLINE
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Komponen yang dinilai	Nilai Maksimal Jurnal Ilmiah			Nilai Akhir yang diperoleh
	Internasional bereputasi ✓	Nasional Terakreditasi	Nasional Tidak Terakreditasi	
a. Kelengkapan unsur isi Artikel (10%)	4			4,0
b. Ruang lingkup dan kedalaman pembahasan (30%)	12			11
c. Kecukupan dan kemutakhiran data/ informasi dan metodologi (30%)	12			11
d. Kelengkapan unsur dan kualitas terbitan / jurnal (30%)	12			11
Total = (100%)	40			37
Nilai pengusul = 60% x 37				22,20

Catatan penilaian artikel oleh Reviewer:

1. Kesesuaian dan kelengkapan unsur isi artikel:
Sistematika artikel sangat sesuai dimana terdiri dari Introduction, Materials and Methods, Results and Discussion, Conclusions, dan References.

2. Ruang lingkup dan kedalaman pembahasan:
Artikel ini menyajikan tentang pengaruh nilai HLB surfaktan pada hidrolisis enzimatik kitosan. Hasilnya menunjukkan bahwa semakin tinggi nilai HBL, maka laju alir reaksi semakin meningkat. Pembahasan sangat komprehensif dimana ada 22 referensi relevan yang dicitasi.

3. Kecukupan dan kemutakhiran data/informasi dan metodologi:
Nilai novelty artikel cukup baik, terdapat 33 referensi dalam 10 tahun terakhir dari 41 referensi yang ada (80,5 %). Metode yang disajikan dengan tahapan yang jelas dan terstruktur dengan baik, sehingga mudah diikuti. Data-data juga disajikan dengan detail.

4. Kelengkapan unsur dan kualitas terbitan:
Jurnal Chemengineering diterbitkan oleh MDPI AG Switzerland. Jurnal terindeks di : SCOPUS, dengan SJR : 0,446. H index : 11. Quartiles (2020) : Q2. Kualitas terbitan sangat baik. Artikel ini memiliki nilai similaritas berdasarkan turnitin sebesar 9%.

Semarang,
Reviewer II

Prof. Dr. Moh. Djaeni, S.T., M.Eng.
NIP. 197102071995121001
Unit Kerja : DepartemenTeknik Kimia FT UNDIP

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Effect of Surfactant HLB Value on Enzymatic Hydrolysis of Chitosan

Rokhati N.[a, b], Kusworo T.D.[a], Prasetyaningrum A.[a], Hamada N.A.[b], Utomo D.P.[a], Riyanto T.[a]

Save all to author list

[a] Department of Chemical Engineering, Faculty of Engineering, Diponegoro University, Jl. Prof. Soedarto S.H., Tembalang, Semarang, 50275, Indonesia

[b] Membrane Research Center, Integrated Laboratory for Research and Services, Diponegoro University, Jl. Prof. Soedarto S.H., Tembalang, Semarang, 50275, Indonesia

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Abstract

Author keywords

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Abstract

Nonionic surfactants are reported as being able to enhance enzyme stability and increase the conversion of enzymatic reactions. Surfactant-assisted enzymatic hydrolysis conversion is affected by surfactant HLB values. This work investigated the influence of nonionic surfactants with different HLB values on chitosan enzymatic hydrolysis using cellulase enzyme by measuring the reducing sugars formation, viscosity, and molecular weight of hydrolyzed chitosan. A characterization analysis of hydrolyzed products was also carried out. A higher HLB value exhibits a better enzymatic chitosan hydrolysis performance, shown by the decrease in a solution's viscosity and the increase in reducing sugar formation. Increasing the surfactant concentration will also increase the hydrolysis rate.

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ChemEngineering **2022**, *6*(2), 27; **https://doi.org/10.3390/chemengineering6020027 (https://doi.org/10.3390/chemengineering6020027)** - 28 Mar 2022

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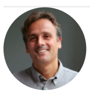

Prof. Dr. Luca Brandt

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Prof. Dr. José P. Coelho

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Interests: chemical engineering; supercritical fluids; antioxidants; thermodynamics; modelling; food technology

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ChemEngineering, Volume 6, Issue 1 (February 2022) – 19 articles

Cover Story (**view full-size image (/files/uploaded/covers/ChemEngineering/big_cover-ChemEngineering-v6-i1.png)**) Power-to-X (PtX) products are recognized as major levers to allow the ramping up of renewable energy capacities and the consequent use of green electrons in

different sectors. Importantly, the boundary conditions to implement PtX processes at remote areas with abundant renewable resources differ significantly from conventional processes due to the dynamics of renewable energy-driven hydrogen production. Process intensification (PI) approaches in that context offer, on one hand, maximum utilization of the valuable renewable feedstock and, on the other, simpler production processes. In this work, the challenges for the PtX processes are addressed and different PI strategies and their potential to overcome those challenges are discussed for three exemplary, major PtX products. **View this paper (https://www.mdpi.com/2305-7084/6/1/13)**

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Electrocatalysts for the Oxygen Reduction Reaction: From Bimetallic Platinum Alloys to Complex Solid Solutions (/2305-7084/6/1/19)

by **Ricardo Martínez-Hincapié (https://sciprofiles.com/profile/1956827)** and **Viktor Čolić (https://sciprofiles.com/profile/1125036)**

ChemEngineering **2022**, *6*(1), 19; **https://doi.org/10.3390/chemengineering6010019 (https://doi.org/10.3390/chemengineering6010019)** - 16 Feb 2022

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Abstract The oxygen reduction reaction has been the object of intensive research in an attempt to improve the sluggish kinetics that limit the performance of renewable energy storage and utilization systems. Platinum or platinum bimetallic alloys are common choices as the electrode material, but **[...] Read more.**

(This article belongs to the Special Issue **New Insights into Electrocatalysis (/journal/ChemEngineering/special_issues/Insights_into_Electrocatalysis)**)

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A Detailed Hydrodynamic Study of the Split-Plate Airlift Reactor by Using Non-Invasive Gamma-Ray Techniques (/2305-7084/6/1/18)

by **Laith S. Sabri (https://sciprofiles.com/profile/1959515)**, **Abbas J. Sultan (https://sciprofiles.com/profile/2151930)**, **Hasan Shakir Majdi (https://sciprofiles.com/profile/author/QS90VnZ4bFc5SDhHSHNOazR4azJGUU5RZGl5M2hwY3RtSVZXWFYrSSttenBoVmNDd3lpVkxwcWFvWHVHNmRYT**
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Shadha K. Jebur (https://sciprofiles.com/profile/author/U211ZXFXQ1lRVGQrYloyT01VUHZyS3AwUjRNVWNZdXFORUo1c2tZd1pWcz0=) and **Muthanna H. Al-Dahhan (https://sciprofiles.com/profile/author/RGhGMFF6emxFOUE2OUZiQjc2MHVydSsvRzB3K1N4TFlqMFVtRzJQSlNaQT0=)**

ChemEngineering **2022**, *6*(1), 18; **https://doi.org/10.3390/chemengineering6010018 (https://doi.org/10.3390/chemengineering6010018)** - 10 Feb 2022

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Abstract This study focused on detailed investigations of selected local hydrodynamics in split airlift reactor by using an unconventional measurements facility: computed tomography (CT) and radioactive particle tracking (RPT). The local distribution in a cross-sectional manner with its radial's profiles for gas holdup, liquid **[...] Read more.**

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Effect of Surfactant HLB Value on Enzymatic Hydrolysis of Chitosan (/2305-7084/6/1/17)

by Nur Rokhati (https://sciprofiles.com/profile/2011604), Tutuk Djoko Kusworo (https://sciprofiles.com/profile/1189919), Aji Prasetyaningrum (https://sciprofiles.com/profile/author/RkRlRkRtVjkyWEU4Q2NkL00rdUNVQmNWNlhzSzVyaWZJVzFWblNWWmV3MD0=), Nur 'Aini Hamada (https://sciprofiles.com/profile/2011697), Dani Puji Utomo (https://sciprofiles.com/profile/1297707) and Teguh Riyanto (https://sciprofiles.com/profile/1286458)

ChemEngineering **2022**, *6*(1), 17; https://doi.org/10.3390/chemengineering6010017 (https://doi.org/10.3390/chemengineering6010017) - 08 Feb 2022

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Abstract Nonionic surfactants are reported as being able to enhance enzyme stability and increase the conversion of enzymatic reactions. Surfactant-assisted enzymatic hydrolysis conversion is affected by surfactant HLB values. This work investigated the influence of nonionic surfactants with different HLB values on chitosan enzymatic [...] Read more.

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Chemical Model for Thermal Treatment of Sewage Sludge (/2305-7084/6/1/16)

by Corinna Netzer (https://sciprofiles.com/profile/1705515) and Terese Løvås (https://sciprofiles.com/profile/21059)

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Abstract Sewage sludge is here studied as a valuable source for processing or energy conversation thanks to its high nutrition and energy content. However, various origins of the wastewater, different water cleaning technologies, and seasonal and regional dependencies lead to the high variability of [...] Read more.

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Reliability of Biodegradation Measurements for Inhibitive Industrial Wastewaters (/2305-7084/6/1/15)

by Hanna Prokkola (https://sciprofiles.com/profile/1135364), Anne Heponiemi (https://sciprofiles.com/profile/783354), Janne Pesonen (https://sciprofiles.com/profile/651245), Toivo Kuokkanen (https://sciprofiles.com/profile/author/eHdUdktaTFBJczBWMlNNeThob3NVNCszdzRGMlplbUJJVG9iMmVXTW9SOD0=) and Ulla Lassi (https://sciprofiles.com/profile/633593)

ChemEngineering **2022**, *6*(1), 15; https://doi.org/10.3390/chemengineering6010015 (https://doi.org/10.3390/chemengineering6010015) - 03 Feb 2022

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Abstract Industrial wastewaters may contain toxic or highly inhibitive compounds, which makes the measurement of biological oxygen demand (BOD) challenging. Due to the high concentration of organic compounds within them, industrial wastewater samples must be diluted to perform BOD measurements. This study focused on [...] Read more.

(This article belongs to the Special Issue Feature Papers in Chemical Engineering (/journal/ChemEngineering/special_issues/FP_in_ChE))

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Article

Effect of Surfactant HLB Value on Enzymatic Hydrolysis of Chitosan

Nur Rokhati [1,2,*], Tutuk Djoko Kusworo [1], Aji Prasetyaningrum [1], Nur 'Aini Hamada [2], Dani Puji Utomo [1] and Teguh Riyanto [1]

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Abstract: Nonionic surfactants are reported as being able to enhance enzyme stability and increase the conversion of enzymatic reactions. Surfactant-assisted enzymatic hydrolysis conversion is affected by surfactant HLB values. This work investigated the influence of nonionic surfactants with different HLB values on chitosan enzymatic hydrolysis using cellulase enzyme by measuring the reducing sugars formation, viscosity, and molecular weight of hydrolyzed chitosan. A characterization analysis of hydrolyzed products was also carried out. A higher HLB value exhibits a better enzymatic chitosan hydrolysis performance, shown by the decrease in a solution's viscosity and the increase in reducing sugar formation. Increasing the surfactant concentration will also increase the hydrolysis rate. Nonionic surfactants can protect cellulase enzyme from the denaturation of temperature and stirring influence. The higher the HLB value, the lower the molecular weight of the hydrolyzed chitosan. The result of UV–Vis demonstrated aldehyde groups formation during hydrolysis. The SEM analysis showed that the chitosan, hydrolyzed using different HLB values of surfactants, had different surface morphologies. However, it did not change the chemical structure of the hydrolysis product seen by the FTIR analysis. The XRD patterns showed that the relative crystallinity of raw chitosan decreased when hydrolyzed with surfactants.

Keywords: nonionic surfactant; HLB value; enzymatic hydrolysis; chitosan; cellulase

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Citation: Rokhati, N.; Kusworo, T.D.; Prasetyaningrum, A.; Hamada, N.'A.; Utomo, D.P.; Riyanto, T. Effect of Surfactant HLB Value on Enzymatic Hydrolysis of Chitosan. *ChemEngineering* **2022**, *6*, 17. https://doi.org/10.3390/chemengineering6010017

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1. Introduction

Chitosan is a polycationic natural derivative of chitin, which is considered the main building component of crustacean shells [1,2]. This biopolymer comprises two common sugars: glucosamine and N-acetylglucosamine [3]. Chemically, chitosan is a linear copolymer of (1→4)-linked 2-acetamido-2-deoxy-β-D-glucan and 2-amino- 2-deoxy-β- D-glucan units in varying proportions [2]. Chitosan is nontoxic, biocompatible, and biodegradable. It also has a high tensile strength and antimicrobial activity. These advantageous properties make possible the use of chitosan in many applications, especially in the food, biomedical, and pharmaceutical industries [1,4–6]. However, the high molecular weight of chitosan results in its high viscosity and low aqueous solubility at a neutral pH, which limits its potential application [5,7].

Several methods to produce a water-soluble, low-molecular-weight chitosan have been attempted, in order to improve its solubility and applicability. Usually, a chemical or enzymatic hydrolysis of the chitosan polymers is used to prepare low-molecular-weight chitosan. Chemical hydrolysis is preferred because it is simple, practical, and gives a high yield [4]. The drawbacks of this method are the extreme reaction condition requirements (high temperature and pressure, extreme pH condition, etc.) and a composition of the

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Review

Electrocatalysts for the Oxygen Reduction Reaction: From Bimetallic Platinum Alloys to Complex Solid Solutions

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Abstract: The oxygen reduction reaction has been the object of intensive research in an attempt to improve the sluggish kinetics that limit the performance of renewable energy storage and utilization systems. Platinum or platinum bimetallic alloys are common choices as the electrode material, but prohibitive costs hamper their use. Complex alloy materials, such as high-entropy alloys (HEAs), or more generally, multiple principal component alloys (MPCAs), have emerged as a material capable of overcoming the limitations of platinum and platinum-based materials. Theoretically, due to the large variety of active sites, this new kind of material offers the opportunity to identify experimentally the optimal binding site on the catalyst surface. This review discusses recent advances in the application of such alloys for the oxygen reduction reaction and existing experimental challenges in the benchmarking of the electrocatalytic properties of these materials.

Keywords: oxygen reduction; platinum; platinum alloy; MPCA; HEA

Citation: Martínez-Hincapié, R.; Čolić, V. Electrocatalysts for the Oxygen Reduction Reaction: From Bimetallic Platinum Alloys to Complex Solid Solutions. *ChemEngineering* **2022**, *6*, 19. https://doi.org/10.3390/chemengineering6010019

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1. Introduction

The need for the proliferation of renewable energy sources, motivated by the demand for the mitigation of climate change, has triggered a widespread interest in the research of electrochemical devices for energy conversion and storage. Along with Li-ion batteries, proton exchange membrane fuel cells (PEMFC) have been a prime candidate for mid- and long-term energy storage and utilization devices [1–6]. It is expected that PEMFC technology plays an important role in mass transport systems, a recent example being the Coradia iLint, the world's first passenger train powered by a hydrogen fuel cell [7]. In a PEMFC, green hydrogen expected to be gained from water electrolysis, is oxidized at the anode and oxygen is reduced at the cathode. In the development of PEMFCs and other related technologies the high overpotential for the oxygen reduction reaction (ORR) is the bottleneck for the improvement of the efficiency and cost-effectiveness and, in turn, the widespread use of these technologies [8].

Few reactions have received as much attention in the last 50 years in both fundamental and applied research as the ORR. The ORR also has a key role in other important processes such as corrosion, enzymatic reactions, and metal–air batteries, among others [9–12]. In acidic media, the best know catalyst for the ORR is platinum (Pt), but even on Pt, the overpotential for the ORR is around 0.3 V [8,13,14]. Pt is also one of the few materials displaying sufficient stability under harsh ORR reaction conditions [15]. However, platinum is scarce, expensive, and 77% of its production is concentrated in only one country [16].

In fuel cells the noble metal (generally Pt) loading of the cathode, for the catalysis of ORR, is considerably higher than of the anode (0.2 vs. 0.05 mg·cm^{-2}) [17,18]. This contributes significantly to the cost of fuel cell stack and inhibits their proliferation [18], since the platinum price is around 35$/g (November 2021), the price of the platinum catalyst is about 20% of the total stack cost [19,20]. Therefore, to accelerate the application

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Article

A Detailed Hydrodynamic Study of the Split-Plate Airlift Reactor by Using Non-Invasive Gamma-Ray Techniques

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Abstract: This study focused on detailed investigations of selected local hydrodynamics in split airlift reactor by using an unconventional measurements facility: computed tomography (CT) and radioactive particle tracking (RPT). The local distribution in a cross-sectional manner with its radial's profiles for gas holdup, liquid velocity flow field, shear stresses, and turbulent kinetic energy were studied under various gas velocity 1, 2 and 3 cm/s with various six axial level z = 12, 20, 40, 60, 90 and 112 cm. The distribution in gas–liquid phases in the whole split reactor column, the riser and downcomer sides, including their behavior at the top and bottom sections of the split plate was also described. The outcomes of this study displayed an exemplary gas–liquid phases dispersion approximately in all reactor's zones and had large magnitude over the ring of the sparger as well as upper the split plate. Furthermore, the outcomes pointed out that the distribution of this flow may significantly impacts the performance of the split reactor, which may have essential influence on its performance particularly for microorganisms culturing applications. These outcomes are dependable as benchmark information to validate computational fluid dynamics (CFD) simulations and other models.

Keywords: split-plate airlift reactor; hydrodynamics parameters; non-invasive gamma-ray techniques

Citation: Sabri, L.S.; Sultan, A.J.; Majdi, H.S.; Jebur, S.K.; Al-Dahhan, M.H. A Detailed Hydrodynamic Study of the Split-Plate Airlift Reactor by Using Non-Invasive Gamma-Ray Techniques. *ChemEngineering* **2022**, *6*, 18. https://doi.org/10.3390/chemengineering6010018

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1. Introduction

A split airlift reactor is a multiphase contactor for many industrial processes involving gas–liquid or gas–solid–liquid systems [1,2]. It consists of three distinct regions, riser, degassing, and the downcomer region. These distinguish regions are created by placing a separating plate at the center of this reactor, which forms a path for circulating the liquid inside the reactor.

This split airlift reactor is characterized by a natural circulation flow pattern, which occurs by bubbling air or gas into the liquid by using a gas sparger located at the bottom of the riser section [3]. These formed bubbles (i.e., gassed liquid) move up in the riser section and once they reach the degassing region (i.e., sudden widening), the air bubbles velocity reduce and thus the bubbles escape from the liquid at the top [4]. As a result, the degassed liquid (i.e., denser liquid) flows downward to the downcomer section. This happens as a result of the presence of a difference between their densities (i.e., gassed and degassed liquids) [5].

This natural liquid circulation, low shear stress environment, high heat and mass transfer rates, and low energy consumption features make the split airlift reactor a preferred option over other reactors in many processes such as fermentation process, microorganisms cell cultures, and wastewater treatment [6–10]. However, the split airlift reactor delivers a