

**ETHYLENE EPOXIDATION IN A LOW-TEMPERATURE
DIELECTRIC BARRIER DISCHARGE SYSTEM:
EFFECT OF ELECTRODE GEOMETRY**



Natthaworanan Permsin

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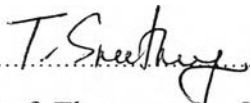
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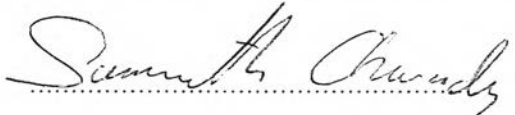
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By: Natthaworanan Permsin
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Assoc. Prof. Sumaeth Chavadej


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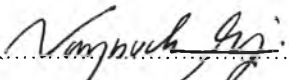

..... Dean
(Asst. Prof. Pomthong Malakul)

Thesis Committee:


.....
(Asst. Prof. Thammanoon Sreethawong)


.....
(Assoc. Prof. Sumaeth Chavadej)


.....
(Assoc. Prof. Thirasak Rirksomboon)


.....
(Dr. Nongnuch Rueangjitt)

ABSTRACT

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Ethylene oxide is a valuable chemical feedstock in producing many industrial chemicals, such as ethylene glycol, solvents, antifreezes, and adhesives. Hence, the partial oxidation of ethylene to ethylene oxide, so-called ethylene epoxidation, has been of great interest in many global research studies. In this work, the epoxidation of ethylene under a cylindrical dielectric barrier discharge (DBD) reactor was initially studied to find the optimum operating conditions and then was compared with that under a parallel DBD reactor. For the cylindrical DBD system, it was found that the ethylene oxide yield increased with decreasing O_2/C_2H_4 molar ratio, under the O_2 -lean condition, and decreasing feed flow rate; however, there were optimum applied voltage and input frequency to obtain the highest ethylene oxide yield. The highest ethylene oxide yield of 2.41% was achieved when an O_2/C_2H_4 molar ratio of 0.25:1 (1:4), an applied voltage of 15 kV, an input frequency of 500 Hz, a feed flow rate of $50\text{ cm}^3/\text{min}$, and electrode gap distance of 5 mm were used. Under these optimum conditions, the power consumption was found to be 12.72×10^{-16} Ws/molecule of ethylene oxide produced. The optimum conditions were used to comparatively investigate the epoxidation performance with the parallel DBD system. It was found that at the optimum conditions, the cylindrical DBD system still exhibited higher epoxidation performance. Therefore, the cylindrical DBD system was found to exhibit a high potential to produce ethylene oxide from ethylene epoxidation reaction.

บทคัดย่อ

ณัฐวรรณท์ เพิ่มสิน: การอีพอกซิเดชันของเอธิลีนภายใต้ระบบพลาสมาอุณหภูมิต่ำชนิดไดอิเล็กทริกแบริเออร์ดีสชาร์จ: ผลของการวางตัวของขั้วไฟฟ้า (Ethylene Epoxidation in a Low-Temperature Dielectric Barrier Discharge System: Effect of Electrode Geometry) อ. ที่ปรึกษา : ผศ. ดร. ธรรมบุญ ศรีทะวงศ์ และ รศ. ดร. สุเมธ ชวเดช 70 หน้า

เอธิลีนออกไซด์เป็นผลิตภัณฑ์ปิโตรเคมีชั้นกลางที่มีบทบาทสำคัญอย่างยิ่งในการผลิตผลิตภัณฑ์อุตสาหกรรมหลากหลายชนิด เช่น เอธิลีนไกลคอล, ตัวทำละลาย, สารต้านการเยือกแข็ง, และสารที่ใช้สำหรับการเชื่อมติด ด้วยเหตุนี้กระบวนการอีพอกซิเดชันของเอธิลีนไปเป็นเอธิลีนออกไซด์ซึ่งเป็นกระบวนการออกซิเดชันที่ไม่สมบูรณ์ของสารอินทรีย์ จึงเป็นกระบวนการที่น่าสนใจอย่างยิ่งสำหรับการศึกษาเพื่อผลิตเอธิลีนออกไซด์อย่างกว้างขวาง ในงานวิจัยนี้กระบวนการอีพอกซิเดชันของเอธิลีนไปเป็นเอธิลีนออกไซด์ถูกทำการทดลองในเครื่องปฏิกรณ์พลาสมาชนิดไดอิเล็กทริกแบริเออร์ดีสชาร์จแบบทรงกระบอกเพื่อศึกษาสภาวะต่างๆที่เหมาะสมในการเกิดปฏิกิริยาเป็นลำดับแรก และทำการเปรียบเทียบประสิทธิภาพกับเครื่องปฏิกรณ์พลาสมาชนิดไดอิเล็กทริกแบริเออร์ดีสชาร์จแบบทรงสี่เหลี่ยมด้านขนาน จากการทดลองพบว่า สำหรับระบบพลาสมาชนิดไดอิเล็กทริกแบริเออร์ดีสชาร์จแบบทรงกระบอก ผลได้ของเอธิลีนออกไซด์เพิ่มขึ้นเมื่อทำการลดอัตราส่วนของออกซิเจนต่อเอธิลีนภายใต้สภาวะขาดแคลนออกซิเจน และลดอัตราการไหลของสารตั้งต้น อย่างไรก็ตาม จากผลทดลองพบอีกว่าค่าความต่างศักย์และค่าความถี่ที่เหมาะสมที่ทำให้ได้ค่าผลผลิตของเอธิลีนออกไซด์สูงที่สุด ซึ่งผลได้ของเอธิลีนออกไซด์มากที่สุดคือ 2.41 เปอร์เซ็นต์ เมื่อใช้อัตราส่วนของออกซิเจนต่อเอธิลีนเป็น 0.25:1 (1:4), ความต่างศักย์ 15 กิโลโวลต์ ค่าความถี่ 500 เฮิร์ตซ์ ด้วยอัตราไหลของสารตั้งต้นเป็น 50 ลูกบาศก์เซนติเมตรต่อนาที และระยะห่างระหว่างขั้วไฟฟ้า 5 มิลลิเมตร ภายใต้สภาวะที่เหมาะสมดังกล่าว พลังงานที่ใช้ในการผลิตเอธิลีนออกไซด์เท่ากับ 12.72×10^{-16} วัตต์วินาทีต่อโมเลกุล นอกจากนี้ เมื่อทำการเปรียบเทียบประสิทธิภาพการเกิดปฏิกิริยาอีพอกซิเดชันกับระบบพลาสมาชนิดไดอิเล็กทริกแบริเออร์ดีสชาร์จแบบทรงสี่เหลี่ยมด้านขนาน ผลการทดลองพบว่า ภายใต้สภาวะที่เหมาะสมเครื่องปฏิกรณ์พลาสมาอุณหภูมิต่ำชนิดไดอิเล็กทริกแบริเออร์ดีสชาร์จแบบทรงกระบอกให้ประสิทธิภาพการเกิดปฏิกิริยาอีพอกซิเดชันดีกว่า ดังนั้น ระบบพลาสมาชนิดไดอิเล็กทริกแบริเออร์ดีสชาร์จแบบทรงกระบอกจึงมีศักยภาพสูงสำหรับการใช้ในการผลิตเอธิลีนออกไซด์จากปฏิกิริยาอีพอกซิเดชันของเอธิลีน

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TABLE OF CONTENTS

	PAGE
Title Page	i
Abstract (in English)	iii
Abstract (in Thai)	iv
Acknowledgements	v
Table of Contents	vi
List of Tables	viii
List of Figures	ix
 CHAPTER	
I INTRODUCTION	1
II LITERATURE REVIEW	3
2.1 Basic Principles of Plasma	3
2.2 Applications of Non-Thermal Plasma in Chemical Synthesis	14
2.3 Catalytic Plasma Processing	15
2.4 Catalysts Used in Epoxidation of Ethylene	17
III EXPERIMENTAL	20
3.1 Materials	20
3.2 Reaction Activity Measurement	20
3.3 Power Supply Unit	25
3.4 Studied Conditions	25
IV RESULTS AND DISCUSSION	29
4.1 Effect of O ₂ /C ₂ H ₄ Molar Ratio	29
4.2 Effect of Applied Voltage	37
4.3 Effect of Input Frequency	46
4.4 Effect of Residence Time	54

CHAPTER		PAGE
V	CONCLUSIONS AND RECOMMENDATIONS	64
	5.1 Conclusions	64
	5.2 Recommendations	65
	REFERENCES	66
	CURRICULUM VITAE	72

LIST OF TABLES

TABLE		PAGE
2.1	Collision mechanisms in the plasma	5
3.1	The important dimensions in both DBD reactors configuration	25
5.1	Summary of the obtained optimum conditions between the cylindrical DBD and the parallel DBD reactors	65

LIST OF FIGURES

FIGURE		PAGE
2.1	Phase of matter consists of solid, liquid, gas, and the forth state named “plasma”.	3
2.2	The various types of discharge classified according to temporal behaviour, pressure, and geometric electrode.	7
2.3	Common dielectric barrier discharge configurations.	9
2.4	Schematic for dielectric barrier discharge reactor.	10
2.5	The corona discharge generated by inhomogeneous electrodes.	11
2.6	Schematic of various forms of corona discharge depending upon applied voltage at constant electrode geometrical configuration.	12
3.1	Schematics of experimental setup for ethylene epoxidation reaction using (a) parallel DBD and (b) cylindrical DBD.	23
3.2	Schematics of reactor setup for (a) parallel DBD and (b) cylindrical DBD.	24
3.3	Block diagram of the power supply unit.	28
4.1	Conversions of ethylene and oxygen and yield of ethylene oxide as a function of O_2/C_2H_4 molar ratio by using the cylindrical DBD reactor (applied voltage = 19 kV; input frequency = 500 Hz; feed flow rate = 50 cm ³ /min; residence time = 25.12 sec; and electrode gap distance = 5 mm).	30
4.2	Comparison of ethylene and oxygen conversions between the parallel DBD and the cylindrical DBD reactors as a function of O_2/C_2H_4 molar ratio (applied voltage = 19 kV; input frequency = 500 Hz; feed flow rate = 50 cm ³ /min; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	31

FIGURE		PAGE
4.3	Comparison of ethylene oxide selectivity and ethylene oxide yield between the parallel DBD and the cylindrical DBD reactors as a function of O_2/C_2H_4 molar ratio (applied voltage = 19 kV; input frequency = 500 Hz; feed flow rate = $50\text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	32
4.4	By-product selectivities as a function of O_2/C_2H_4 molar ratio by using the cylindrical DBD reactor (applied voltage = 19 kV; input frequency = 500 Hz; feed flow rate = $50\text{ cm}^3/\text{min}$; residence time = 25.12 sec; and electrode gap distance = 5 mm).	33
4.5	Comparison of hydrogen selectivity and hydrogen yield between the parallel DBD and the cylindrical DBD reactors as a function of O_2/C_2H_4 molar ratio (applied voltage = 19 kV; input frequency = 500 Hz; feed flow rate = $50\text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	34
4.6	Comparison of by-product selectivities between the parallel DBD and the cylindrical DBD reactors as a function of O_2/C_2H_4 molar ratio: (a) carbon monoxide, (b) carbon dioxide, (c) acetylene, (d) methane, (e) ethane, and (f) propane (applied voltage = 19 kV; input frequency = 500 Hz; feed flow rate = $50\text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	35
4.8	Comparison of specific power consumptions between the parallel DBD and the cylindrical DBD reactors as a function of O_2/C_2H_4 molar ratio (applied voltage = 19 kV; input frequency = 500 Hz; feed flow rate = $50\text{ cm}^3/\text{min}$; residence time = 25.12 sec; and electrode gap distance = 5 mm).	37

FIGURE		PAGE
4.9	Conversions of ethylene and oxygen and yield of ethylene oxide as a function of applied voltage by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 25.12 sec; and electrode gap distance = 5 mm).	39
4.10	Effect of applied voltage on generated current by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 25.12 sec; and electrode gap distance = 5 mm).	39
4.11	Comparison of ethylene and oxygen conversions between the parallel DBD and the cylindrical DBD reactors as a function of applied voltage (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	40
4.12	Comparison of ethylene oxide selectivity and ethylene oxide yield between the parallel DBD and the cylindrical DBD reactors as a function of applied voltage (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	41
4.13	By-product selectivities as a function of applied voltage by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 25.12 sec; and electrode gap distance = 5 mm).	42

FIGURE		PAGE
4.14	Comparison of hydrogen selectivity and hydrogen yield between the parallel DBD and the cylindrical DBD reactors as a function of applied voltage (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	43
4.15	Comparison of by-product selectivity between the parallel DBD and the cylindrical DBD reactors as a function of input frequency: (a) carbon monoxide, (b) carbon dioxide, (c) acetylene, (d) methane, (e) ethane, and (f) propane (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	44
4.16	Comparison of specific power consumptions for different applied voltages by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	45
4.17	Comparison of specific power consumptions between the parallel DBD and the cylindrical DBD reactors as a function of applied voltage (molar ratio of $O_2/C_2H_4 = 0.25:1$; input frequency = 500 Hz; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	46

FIGURE	PAGE	
4.18	Conversions of ethylene and oxygen and yield of ethylene oxide as a function of input frequency by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 15 kV; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 25.12 sec; and electrode gap distance = 5 mm).	47
4.19	Effect of input frequency on generated current by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 15 kV; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 25.12 sec; and electrode gap distance = 5 mm).	48
4.20	Comparison of ethylene and oxygen conversions between the parallel DBD and the cylindrical DBD reactors as a function of input frequency (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), 15 kV (cylindrical DBD); feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	49
4.21	Comparison of ethylene oxide selectivity and ethylene oxide yield between the parallel DBD and the cylindrical DBD reactors as a function of input frequency (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), 15 kV (cylindrical DBD); feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	49
4.22	By-product selectivities as a function of input frequency by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 25.12 sec; electrode gap distance = 5 mm; and applied voltage = 15 kV).	50

FIGURE		PAGE
4.23	Comparison of hydrogen selectivity and hydrogen yield between the parallel DBD and the cylindrical DBD reactors as a function of input frequency (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), 15 kV (cylindrical DBD); feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	51
4.24	Comparison of by-product selectivities between the parallel DBD and the cylindrical DBD reactors as a function of input frequency: (a) carbon monoxide, (b) carbon dioxide, (c) acetylene, (d) methane, (e) ethane, and (f) propane (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), 15 kV (cylindrical DBD); feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	52
4.25	Comparison of specific power consumptions as a function of input frequency by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 15 kV; feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 25.12 sec; and electrode gap distance = 5 mm).	53
4.26	Comparison of specific power consumptions between the parallel DBD and the cylindrical DBD reactors as a function of input frequency (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), 15 kV (cylindrical DBD); feed flow rate = $50 \text{ cm}^3/\text{min}$; residence time = 17.1 sec (parallel DBD), 25.12 sec (cylindrical DBD); and electrode gap distance = 5 mm).	54

FIGURE		PAGE
4.27	Conversions of ethylene and oxygen and yield of ethylene oxide as a function of residence time (feed flow rate) by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 15 kV; input frequency = 500 Hz; and electrode gap distance = 5 mm).	55
4.28	Effect of residence time (feed flow rate) on generated current by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 15 kV; input frequency = 500 Hz; and electrode gap distance = 5 mm).	56
4.29	Comparison of ethylene and oxygen conversions between the parallel DBD and the cylindrical DBD reactors as a function of residence time (feed flow rate) (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), = 15 kV (cylindrical DBD); input frequency = 500 Hz; and electrode gap distance = 5 mm).	57
4.30	Comparison of ethylene oxide selectivity and ethylene oxide yield between the parallel DBD and the cylindrical DBD reactors as a function of residence time (feed flow rate) (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), = 15 kV (cylindrical DBD); input frequency = 500 Hz; and electrode gap distance = 5 mm).	58
4.31	By-product selectivities as a function of residence time (feed flow rate) by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 15 kV; input frequency = 500 Hz; and electrode gap distance = 5 mm).	59

FIGURE		PAGE
4.32	Comparison of hydrogen selectivity and hydrogen yield between the parallel DBD and the cylindrical DBD reactors as a function of residence time (feed flow rate) (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), = 15 kV (cylindrical DBD); input frequency = 500 Hz; and electrode gap distance = 5 mm).	60
4.33	Comparison of by-product selectivities between the parallel DBD and the cylindrical DBD reactors as a function of residence time (feed flow rate): (a) carbon monoxide, (b) carbon dioxide, (c) acetylene, (d) methane, (e) ethane, and (f) propane (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), = 15 kV (cylindrical DBD); input frequency = 500 Hz; and electrode gap distance = 5 mm).	61
4.34	Comparison of specific power consumptions as a function of residence time (feed flow rate) by using the cylindrical DBD reactor (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 15 kV; input frequency = 500 Hz; and electrode gap distance = 5 mm).	62
4.35	Comparison of specific power consumptions between the parallel DBD and the cylindrical DBD reactors as a function of residence time (feed flow rate) (molar ratio of $O_2/C_2H_4 = 0.25:1$; applied voltage = 19 kV (parallel DBD), = 15 kV (cylindrical DBD); input frequency = 500 Hz; and electrode gap distance = 5 mm).	63