CHAPTER V
CONCLUSIONS AND RECOMMENDATIONS

5.1 Conclusions

In this work, the epoxidation reaction of ethylene was investigated in the low-temperature dielectric barrier discharge (DBD) systems with two different electrode geometries, i.e. cylindrical DBD and parallel DBD. For the cylindrical DBD system, the effects of various operating parameters, including O_2/C_2H_4 molar ratio, applied voltage, input frequency, and feed flow rate, on the epoxidation activity were initially studied in order to achieve the optimum conditions, which were then used to comparatively study the effect of electrode geometry with the parallel DBD system. In order to obtain the highest ethylene oxide yield of 2.41% and the ethylene oxide selectivity of 12.75%, the cylindrical DBD system had to be operated at an O_2/C_2H_4 molar ratio of 0.25:1, an applied voltage of 15 kV, an input frequency of 500 Hz, a feed flow rate of 50 cm^3/min, and an electrode gap distance of 5 mm. At these optimum conditions, the power consumptions to break down each C_2H_4 molecule and to create each C_2H_4O molecule were found to be 1.62×10^{-16} Ws/molecule of C_2H_4 converted and 12.72×10^{-16} Ws/molecule of C_2H_4O produced, respectively. For the comparative investigation of the epoxidation performance between the two DBD systems, it was found that at the optimum conditions, the cylindrical DBD system still exhibited higher epoxidation performance, as shown in Table 5.1. Therefore, the cylindrical DBD system was found to have a high capability of producing ethylene oxide from ethylene epoxidation reaction.

Table 5.1 Summary of the obtained optimum conditions between the cylindrical DBD and the parallel DBD reactors.

Reactor / Parameter	Cylindrical DBD reactor	Parallel DBD reactor
O_2/C_2H_4 molar ratio	0.25:1	0.25:1
Applied voltage (kV)	15	19
Input frequency (Hz)	500	500
Feed flow rate (cm^3/min)	50	50
Electrode gap distance (mm)	5	5
Ethylene oxide selectivity (%)	12.75	10.37
Ethylene oxide yield (%)	2.41	2.20
Power consumption per C_2H_4 converted (Ws/molecule)	1.62×10^{-16}	1.46×10^{-16}
Power consumption per C_2H_4O produced (Ws/molecule)	12.72×10^{-16}	14.06×10^{-16}

5.2 Recommendations

The optimum conditions for ethylene epoxidation under the cylindrical DBD system should be applied with a reported catalytically active catalyst, i.e. 12.5 wt.% Ag/(low-surface-area)α-Al_2O_3, in order to further enhance the epoxidation performance. Moreover, the addition of promoters, such as Au, Cs, and Cu, on the 12.5 wt.% Ag/(LSA)α-Al_2O_3 catalyst, should be studied to evaluate the epoxidation performance of the cylindrical DBD system.