

REFERENCES

- Adachi, T. Experimental discussion on removal functions of SO₂ gas by a wet type electrostatic precipitator. IEEJ 97 (1977): 521-528.
- Awad, M. B., and Castle, G. S. P. Ozone generation in an electrostatic precipitator with a heated corona wire. JAPCA 25 (1975): 369-374.
- Caledonia, G. E. A survey of the gas-phase negative ion kinetics of inorganic molecules - Electron Attachment Reactions. Chem. Rev. 75 (1975): 333-351.
- Castle, G. S. P., Inculet, I. I., and Burgess, K. I. Ozone generation in positive corona electrostatic precipitators. IEEE Trans. Ind. and Gen. Appl. IGA-5 (1969): 489-496.
- Castle, P. M., Kanter, I. E., Lee, P. K., and Kline, L. E. Corona glow detoxification study. Final Rep., Westinghouse Co., Contract No. DAAA 09-82-C-5396, 1984.
- Chakarbarti, A., et al. Gas cleaning with semi-wet type plasma reactor. IEEE Trans. Ind. Appl. 31 (1995): 500-506.
- Chang, J. S. Corona discharge treatment of CO₂ gas in plasma enhanced electrofluidized bed filter. Proc. Int. Symp. High-Pressure Low-Temperature Plasma Process 2 (1987): 45-54.
- Chang, J. S., and Masuda S. Mechanism of pulse corona induced plasma chemical processes for removal of NO_x and SO_x from combustion gases. Conf. Rec. IEEE/IAS 1988 Meeting (1988): 1599-1635.
- Chang, J. S. The role of H₂O on the formation of NH₄NO₃ aerosol particles and De-NO_x under the corona discharge treatment of combustion flue gases. J. Aerosol Sci. 20 (1989): 1087-1090.
- Chang, J. S., Lawless, P. A., and Yamamoto, T. Corona discharge processes. IEEE Trans. Plasma Sci. 19 (December 1991): 1152-1166.

- Chang, M. B., Balbach, J. H., Rood, M. J., and Kushner, M. J. Gas-phase removal of SO₂ from gas streams using dielectric barrier discharge and combined plasma photolysis. J. Appl. Phys. 69 (1991): 4409-4417.
- Chang, M. B., Kushner, M. J., and Rood, M. J. Gas-phase removal of NO from gas streams via dielectric barrier discharges. Envir. Sci. and Tech. 26 (1992): 777-781.
- Chang, M. B. Removal of SO₂ and NO from gas streams with combined plasma photolysis. J. Envir. Eng. ASCE, 119 (1993): 414-423.
- Chang, M. B., and Tseng, T. D. Gas-phase removal of H₂S and NH₃ with dielectric barrier discharges. J. Envir. Eng. 122 (January 1996): 41-46.
- Civitano, L., et al. Flue gas simultaneous De-NO_x/De-SO_x by impulse corona energization. Int. Atomic Energy Agency Report No. TECDC-428, (1987): 55-84.
- Clements, J. S., Mizuno, A., Finney, W. C., and Davis, R. H. Combined removal of SO₂, NO_x and fly ash from flue gas using pulsed streamer corona. IEEE Trans. Ind. Appl. 25 (1989): 62-69.
- Dinelli, G., Civitano, L., and Rea, M. Industrial experiments on pulse simultaneous removal of NO_x and SO_x from flue gases. IEEE Trans. Ind. Appl. 25 (1990): 535-541.
- Dorsey, J. A., and Davidson, J. H. Ozone Production in electrostatic air cleaners with contaminated electrodes. IEEE Trans. Ind. Appl. 30 (1994): 370-376.
- Eliasson, B., Hirth, M., and Kogelschatz, U. Ozone synthesis from oxygen in dielectric barrier discharges. J. Phys. D: Applied Phys. 20 (1987): 1421-1437.

- Fuchs, P., Roth, B., and Schwing, U. Removal of NO_x and SO_2 by the electron beam process. Electron Beam Processing of Combustion Gases IAEA-TECDOC-428, (1987): 119-133.
- Hattori, H., Ito, T., Ehara, Y., and Miyata, Y. Superposition effect on ozone synthesis by two types of discharges. Trans. IEE Japan 112A (1992): 41-46.
- Helfritch, D. J., and Feldman, P. L. A pilot scale study of electron beam removal of SO_2 and NO_x from flue gas. Cottrel Envir. Sci. Somerville, N. J., Final Rep. to US DOE under Contract No. DE-FC22-81PC15079, 1985.
- Helfritch, D. J. Pulsed corona discharge for hydrogen sulfide decomposition. IEEE Trans. Ind. Appl. 29, 1993.
- Higashi, M., Sugaya, M., Ueki, K., and Fujii, K. Plasma processing of exhaust gas from a diesel engine vehicle. Proc. Int. Conf. on Plasma Chem. 2 (1985): 366-371.
- Higashi, M., Uchida, S., Suzuki, N., and Fujii, K. Simultaneous reduction of soot and NO_x in a diesel engine exhaust by discharge plasma. Trans. IEEE Japan III-A (1991): 457-473.
- Higashi, M. Soot elimination and NO_x and SO_x reduction in diesel engine exhaust by a combination of discharge plasma and oil dynamics. IEEE Trans. Plasma Sci. 20 (1992): 1-12.
- Horvath, M. Ozone. Amsterdam, The Netherlands: Elsevier Sci., 1980.
- Ito, T., Ehara, Y., Sakai, T., and Miyata, Y. Superposition effect on ozone synthesis by discharge. J. Jpn. Res. Group Elec. Discharges no. 127. (1990): 113-118.
- Jogan, K., Mizuno, A., Yamamoto, T., and Chang, J. S. The effect of residence time on the CO_2 reduction from combustion flue gases by an ac ferroelectric packed bed reactor. IEEE Trans. Ind. Appl. 29, 1993.

- Jordan, S., and Schikarski, W. Simultaneous DeSO_x and DeNO_x of flue gases by the EB-process in the agate pilot plant. Electron Beam Processing of Combustion Gases IAEA-TECDOC-428, (1987): 135-150.
- Kamase, Y., Nagahama, T., and Mizuno, A. Removal of ethylene by streamer corona discharge. Rec. 1991 IEEE/IAS Ann. Meet. (1991): 747-751.
- Kawamura, K., et al. Flue gas treatment of electron-beam irradiation. J. Atomic Energy Soc. Japan 20 (1978): 359-367.
- Kawamura, K., et al. Pilot plant experiment of NO_x and SO₂ removal from exhaust gases by electron beam irradiation. Radiat. Phys. Chem. 11 (1979): 5-12.
- Kawamura, K., et al. On the removal of NO_x and SO_x in exhaust gas from the sintering machine by electron beam irradiation. Radiat. Phys. Chem. 16 (1980): 133-138.
- Kawamura, K., and Shui, V. H. Pilot plant experience in electron beam treatment of iron-ore sintering flue gas cleanup. Radiat. Phys. Chem. 24 (1984): 117-127.
- Kawamura, K., et al. Development of electron beam dry flue gas treatment process (EB Process)- process demonstration operation in USA coal fired power station. EBAEA J1H00, no. 141. 1988.
- Kawamura, K., et al. Simultaneous removal of NO_x and SO_x by electron beam. Kagaku Kogaku 53 (1989): 820-821.
- Kohl, A. L., and Riesenfeld, F. C. Gas Purification. 3rd ed., Gulf Pub., Houston, 1979.
- Lagarias, J. S. Discharge electrodes and electrostatic precipitators. JAPCA 10 (1960): 271-274.
- Larpsuriyakul, K., Sano, N., Tamon, H., Tanthapanichakoon, W., and Okazaki, M. Influence of structure of corona-discharge reactor on removal of dilute gases using electron attachment. Proc. Himeji Conf. Soc. Chem. Engrs. Japan (1996): 270-271.

- Larpsuriyakul, K., Charinpanitkul, T., Tanthapanichakoon, W., Sano, N., Tamon, H., and Okazaki, M. Removal of dilute gaseous impurities by electron attachment reaction using corona-discharge reactors of different structures. 7th National Conf. Chem. Eng. and Appl. Chemistry 24-25 October 1997.
- Lawless, P. A., McLean, K. J., Sparks, L. E., and Ramsey, G. H. Negative corona in wire-plate electrostatic precipitators. Part I: Characteristics of individual tuft-corona discharge. J. Electrostatics 18 (1986): 199-217.
- Maezono, I. Flow enhanced corona discharge-corona torch. J. Appl. Phys. 59 (1988): 2322-2324.
- Maezono, I., and Chang, J. S. Reduction of CO₂ from combustion gases by dc corona torchers. IEEE Trans. Ind. Appl. 26 (1990): 651-655.
- Massay, S. H. Negative Ions. Cambridge Univ. Press, Cambridge, England, 1976.
- Massay, S. H. Atomic and Molecular Collisions. Taylor & Francis, London, 1979.
- Masuda, S., et al. Basic research on electron beam process for removal of gaseous pollutants. Ministry of Education Japan, Special Research Project on Detection and Control of Environmental Pollution Res. Rep. 011903, 2 (1978): 8-36.
- Masuda, S., Hirano, M., and Akutsu, K. Enhancement of electron beam denitritization process by means of electric field. Radiat. Phys. Chem. 17 (1981): 223-228.
- Masuda, S., Sato, M., and Seki, T. High efficiency ozonizer using traveling wave pulse voltage. Conf. Rec. IEEE/IAS 1984 Ann. Meet. Chicago, IL, (1984): 978-985.

- Masuda, S., and Nakao, H. Control of NO_x by positive and negative pulsed corona discharges. Conf. Rec. IEEE/IAS Ann. Mect. (1986): 1173-1182.
- Masuda, S., Wu, Y., Urabe, T., and Ono, Y. Pulse corona induced plasma chemical process for De- NO_x , De- SO_x and mercury vapor control of combustion gas. Proc. 3rd Int. Conf. on Electrostatic Precipitation (1988): 667-676.
- Masuda, S., Akutsu, K., Kuroda, M., Awatsu, Y., and Shibuya, Y. A ceramic-based ozonizer using high-frequency surface discharge. IEEE Trans. Ind. Appl. IA-24 (1988): 223-231.
- Masuda, S., Pulse corona induced plasma chemical process. Pure Applied Chem. 60 (1988): 727-731.
- Masuda, S., and Nakao, H. Control of NO_x by positive and negative pulsed corona discharges. IEEE Trans. Ind. Appl. 26 (1990): 374-383.
- Masuda, S., and Wang, J. De NO_x and De SO_x by PPCP and SPCP. Proc. 8th EPA/EPRI Symp. Transfer Utilization Particulate Contr. Tech. March 1990.
- Masuda, S., et al. Destruction of gaseous pollutants by surface-induced plasma chemical process (SPCP). IEEE Trans. Ind. Appl. 29 (1993): 781-786.
- McLean, K. J., Lawless, P. A., Sparks, L. E., and Ramsey, G. H. Negative corona in wire-plate electrostatic precipitators. Part II: Calculation of electrical characteristics of contaminated discharge electrodes. J. Electrostatics 18 (1986): 219-231.
- Mizuno, A., Clements, J. S., and Davis, R. H. The use of energetic electrons in a particle precharger and in a sulfur dioxide reactor. Proc. 2nd Int. Conf. on Electrostatic Precipitation (1984): 498-512.

- Mizuno, A. An electrostatic precipitator using a ferroelectric pellet layer for particle collection. Proc. IEEE/IES 1986 Ann. Conf. (Denver, Co.) (October 1986): 1106-1112.
- Mizuno, A., Clements, J. S., and Davis, R. H. A method for the removal of sulfur dioxide from exhaust gas utilizing pulsed streamer corona for electron energization. IEEE Trans. Ind. Appl. IA-22 (1986): 516-522.
- Mizuno, A., and Ito, H. An electrostatic precipitator using a ferroelectric pellet layer for particle collection. Proc. 3rd Int. Conf. on Electrostatic Precipitation (1988): 617-624.
- Mizuno, A., et al. Effect of voltage waveform on partial discharge in ferroelectric pellet layer for gas cleaning. Conf. Rec. IEEE Ind. Appl. Soc. Ann. Meeting (1990): 815-821.
- Mizuno, A., Yamazaki, Y., Ito, H., and Yoshida, H. Ac energized ferroelectric pellet bed gas cleaner. IEEE Trans. Ind. Appl. 28 (1992).
- Mizuno, A., Chakrabarti, A., and Okazaki, K. Application of corona technology in the reduction of greenhouse gases and other gaseous pollutants. Nonthermal Plasma Tech. Pollution Contr. B. M. Penetrante and S. E. Schultheis, Ed., Berlin: Springer-Verlag, NATO ASI Series, 34 (1993): 165-185.
- Mizuno, A., et al. NO_x removal process using pulsed discharge plasma. IEEE Trans. Ind. Appl. 3 (1995): 957-963.
- Moruzzi, J. L., and Phelps, A. V. Survey of negative-ion-molecule reactions in O₂, CO₂, H₂O, CO, and mixtures of these gases at high pressures. J. Chem. Phys. 45 (December 1966): 4617-4627.
- Nashimoto, K. The effect of electrode materials on O₃ and NO_x emissions by corona discharging. J. Imaging Sci. 32 (1988): 205-210.

- Nomoto, Y. Improvement of ozone generation efficiency in a parallel plate ozonizer with a rotating plate electrode. Proc. Inst. Electrostatic Japan 13 (1989): 308-311.
- Nomoto, Y., et al. Ozone generation characteristics of a hybrid discharge ozonizer. Proc. 5th Asian Conf. Elec. Discharge Singapore (1992): 45-48.
- Nomoto, Y., Ohkubo, T., Kanazawa, S., and Adachi, T. Improvement of ozone yield by a silent-surface hybrid discharge ozonizer. IEEE Trans. Ind. Appl. 31 (1995): 1458-1462.
- Oda, T., Takahashi, T., Nakano, H., Masuda, S. Decomposition of fluorocarbon gaseous contaminants by surface discharge induced plasma chemical process. Rec. IEEE/IAS 1991 Ann. Conf. (October 1991): 734-739.
- Oda, T., Takahashi, T., Nakano, H., Masuda, S. Decomposition of fluorocarbon gaseous contaminants by surface discharge induced plasma chemical process. IEEE Trans. Ind. Appl. 29 (1993): 787-792.
- Oda, T., et al. Decomposition of gaseous organic contaminants by surface discharge induced plasma chemical process-SPCP. IEEE Trans. Ind. Appl. 32 (1996): 118-124.
- Oda, T., Yamashita, R., Takahashi, T., and Masuda, S. Atmospheric pressure discharge plasma decomposition for gaseous air contaminants-Trichlorotrifluoroethane and Trichloroethylene. IEEE Trans. Ind. Appl. 32 (1996): 227-232.
- Oglesby, S., and Nichols, G. B. Electrostatic Precipitation. Marcel Dekker, New York, 1978.
- Ohkubo, T., et al. NO_x removal by a pipe with nozzle-plate electrode corona discharge system. IEEE Trans. Ind. Appl. 30 (1994): 856-861.

- Okazaki, K., Mizuno, A., Shimizu, K., and Niwa, T. Application of semi-wet type corona discharge reactor to the simultaneous removal of NO_x , SO_x and fly ash in pulverized coal combustion. Int. Conf. on Power Eng. 1993 Tokyo, Japan, 1993.
- Palotiai, T., and Chang, J. S. Reduction of CO_2 from Ar- CO_2 mixture gas by capillary tube reactor with repeated spark discharges. Proc. 2nd Int. Symp. on High Pressure Low Temperature Plasma Chemistry in press.
- Palumbo, F. J., and Fraas, F. The removal of sulfur from stack gases by an electric discharge. J. Air Pollution Contr. Assoc. 21 (1971): 143-144.
- Penny, G. W., and Hewitt, J. G. Some measurements of abnormal corona. AIEE (1953): 319-327.
- Penny, G. W., and Craig, S. E. Sparkover as influenced by surface conditions in dc corona. AIEE (1960): 112-118.
- Peyrous, R., and Lapeyre, R. M. Gaseous products created by electrical discharges in the atmosphere and condensation nuclei resulting from gaseous phase reactions. Atmospheric Envir. 16 (1982): 959-968.
- Sano, N., Nagamoto, T., Tamon, H., and Okazaki, M. Removal of iodine and methyl iodide in gas by wetted-wall reactor based on selective electron attachment. J. Chem. Eng. Japan 29 (1996): 59-64.
- Sano, N. Development of Gas Purification Technology by Selective Electron Attachment. Doctoral Dissertation, Kyoto Univ., Japan, 1997.
- Tamaki, K., et al. Oxidation of nitrogen monoxide by corona discharge - Effect of discharge conditions. Proc. Chem. Soc. Japan 11 (1979): 1582.
- Tamon, H., Yano, H., and Okazaki, M. A new method of gas mixture separation based on selective electron attachment. Kagaku Kogaku Ronbunshu 15 (1989): 663-668.

- Tamon, H., et al. New concept of gas purification by electron attachment. AICHE J. 41 (1995): 1701-1711.
- Tamon, H., Sano, N., Okazaki, M. Influence of oxygen and water vapor on removal of sulfur compounds by electron attachment. AICHE J. 42 (1996): 1481-1486.
- Tanthapanichakoon, W., Larpsuriyakul, K., Sano, N., Tamon, H., and Okazaki, M. Effect of reactor structure on removal of methyl iodide and chlorofluorocarbon in gas using selective electron attachment. Proc. Regional Sym. Chem. Eng. 1996 Jakarta, Indonesia, (October 1996): 3.2.1-3.2.14.
- Tanthapanichakoon, W., Larpsuriyakul, K., Charinpanitkul, T., Sano, N., Tamon, H., and Okazaki, M. Effect of structure of corona-discharge reactor on removal of dilute gaseous pollutants using selective electron attachment. J. Chem. Eng. Japan (in press).
- Urabe, T., et al. Removal of Hg vapor by the pulse energization. Proc. Chem. Eng. Conf. Japan (in Japanese) July 1986.
- Viner, A. S., Lawless, P. A., and Ensor, D. S. Ozone generation in dc-energized electrostatic precipitators. Proc. 1989 IEEE/IAS (1989): 2167-2174.
- Weiss, H. R. Plasma induced dissociation of carbon dioxide. Proc. Int. Conf. on Plasma Chem. 2 (1985): 383-388.
- White, H. J., and Cole, W. H. Design and performance of high-velocity, high-efficiency air cleaning precipitators. JAPCA 10 (1960): 239-245.
- Yamamoto, T., Lawless, P. A., and Sparks, L. E. Narrow-gap point-to-plane corona with high velocity flows. IEEE Trans. Ind. Appl. 24 (1988): 934-939.
- Yamamoto, T., Lawless, P. A., and Sparks, L. E. Triangle-shaped dc corona discharge device for molecular decomposition. IEEE Trans. Ind. Appl. 25 (1989): 743-749.

- Yamamoto, T., et al. Control of volatile organic compounds by an ac energized ferroelectric pellet reactor and a pulsed corona reactor. IEEE Trans. Ind. Appl. 28 (1992): 528-534.
- Yamamoto, T., Shioji, S., and Masuda, S. Synthesis of ultra-fine particles by surface discharge induced plasma chemical process (SPCP) and its application. IEEE Trans. Ind. Appl. 28 (1992): 1189-1193.
- Yamamoto, T., et al. Catalysis-assisted plasma technology for carbon tetrachloride destruction. IEEE Trans. Ind. Appl. 32 (1996): 100-105.
- Zhang, R., Yamamoto, T., and Bundy, D. S. Control of ammonia and odors in animal house by a ferroelectric plasma reactor. IEEE Trans. Ind. Appl. 32 (1996): 113-117.



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APPENDICES

สถาบันวิทยบริการ
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APPENDIX A**EXPERIMENTAL DATA OF INITIAL TEST RUNS****Notation for the following data sheets**

- GC** = peak area of chromatogram [-]
C_{out} = outlet concentration [ppm]
I = discharge current [mA]
V = applied voltage [kV]
P = electric power [W]
Eff = removal efficiency [-]
E/p = ratio of electric field strength to pressure [$\text{Vm}^{-1}\text{Pa}^{-1}$]

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Date:	7/16/1997		
Subject:	CH ₃ CHO Removal from N ₂		
Cathode diameter:	0.5 mm		
Anode diameter and length:	40 mm x 370 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	-	cc/min
	CH ₃ CHO	100.0	cc/min [500 ppm]
	Total	100.0	cc/min
Temperature:	25.0	c	
Inlet concentration (C_{in}):	498.55	ppm	

GC	C _{out}	I	V	P	Eff
14729	494.26	0.00	-	-	0.00
14979	502.65	0.00	-	-	0.00
14862	498.72	0.00	-	-	0.00
9309	312.38	0.05	8.0	0.40	0.37
9316	312.62	0.05	8.0	0.40	0.37
7540	253.02	0.10	9.1	0.91	0.49
7445	249.83	0.10	9.1	0.91	0.50
7218	242.21	0.10	9.1	0.91	0.51
3601	120.84	0.20	9.8	1.96	0.76
3594	120.60	0.20	9.8	1.96	0.76
888	29.80	0.30	10.7	3.21	0.94
852	28.59	0.30	10.7	3.21	0.94
742	24.90	0.30	10.7	3.21	0.95
251	8.42	0.50	11.5	5.75	0.98
262	8.79	0.50	11.5	5.75	0.98
241	8.09	0.50	11.5	5.75	0.98
90	3.02	1.00	12.7	12.70	0.99
97	3.26	1.00	12.7	12.70	0.99

Date:	7/15/1997				
Subject:	CH ₃ CHO Removal from N ₂				
Cathode diameter:	0.5 mm				
Anode diameter and length:	40 mm x 370 mm				
Number of cathodes:	1 cathode				
Gas flow rate:	N ₂	59.4	cc/min		
	CH ₃ CHO	40.6	cc/min	[200 ppm]	
	Total	100.0	cc/min		
Temperature:	27.0	c			
Inlet concentration (C_{in}):	199.89	ppm			

GC	C _{out}	I	V	P	Eff
3728	197.98	0.00	-	-	0.00
3739	198.57	0.00	-	-	0.00
3825	203.13	0.00	-	-	0.00
970	51.51	0.05	8.2	0.41	0.74
836	44.40	0.05	8.2	0.41	0.78
296	15.72	0.10	8.4	0.84	0.92
287	15.24	0.10	8.4	0.84	0.92
75	3.98	0.20	8.90	1.78	0.98
0	0.00	0.30	9.40	2.82	1.00
0	0.00	0.50	10.40	5.20	1.00

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Date:	7/14/1997		
Subject:	CH ₃ CHO Removal from N ₂		
Cathode diameter:	0.5 mm		
Anode diameter and length:	40 mm x 370 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	90.0	cc/min
	CH ₃ CHO	10.0	cc/min [50 ppm]
	Total	100.0	cc/min
Temperature:	25.0	c	
Inlet concentration (C_{in}):	49.93	ppm	

GC	C _{out}	I	V	P	Eff
1202	49.83	0.00	-	-	0.00
1214	50.33	0.00	-	-	0.00
1197	49.63	0.00	-	-	0.00
31	1.29	0.05	8.40	0.42	0.97
29	1.20	0.05	8.40	0.42	0.98
33	1.37	0.05	8.40	0.42	0.97
0	0.00	0.10	8.50	0.85	1.00
0	0.00	0.20	8.80	1.76	1.00
0	0.00	0.30	9.20	2.76	1.00
0	0.00	0.50	9.60	4.80	1.00

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APPENDIX B**EXPERIMENTAL DATA OF EFFECT OF CATHODE DIAMETER****Notation for the following data sheets**

- GC = peak area of chromatogram [-]
C_{out} = outlet concentration [ppm]
I = discharge current [mA]
V = applied voltage [kV]
P = electric power [W]
Eff = removal efficiency [-]
E/p = ratio of electric field strength to pressure [$\text{Vm}^{-1}\text{Pa}^{-1}$]

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Date:	1/18/96					
Subject:	CH3I Removal from air					
Cathode diameter:	0.1 mm					
Anode diameter and length:	38 mm x 280 mm					
Number of cathodes:	1 cathode					
Gas flow rate:	N2	131.9	cc/min			
	O2	49.1	cc/min	[20%]		
	CH3I	64.0	cc/min	[80 ppm]		
	Total	245.0	cc/min			
Temperature:	13.0	c				
Inlet concentration (Cin):	77.85	ppm				
GC	Cout	I	V	P	Eff	E/p
260478	78.50	0.00	-	-	0.00	-
255907	77.13	0.00	-	-	0.00	-
257186	77.51	0.00	-	-	0.00	-
254769	76.78	0.00	-	-	0.00	-
262462	79.10	0.00	-	-	0.00	-
259092	78.09	0.00	-	-	0.00	-
157744	47.54	0.05	5.90	0.30	0.39	1.03
155923	46.99	0.05	5.90	0.30	0.40	1.03
160252	48.30	0.05	5.90	0.30	0.38	1.03
77021	23.21	0.10	6.80	0.68	0.70	1.19
79038	23.82	0.10	6.80	0.68	0.69	1.19
80604	24.29	0.10	6.80	0.68	0.69	1.19
24466	7.37	0.20	7.90	1.58	0.91	1.38
30064	9.06	0.20	7.90	1.58	0.88	1.38
24398	7.35	0.20	7.90	1.58	0.91	1.38
11930	3.60	0.30	9.00	2.70	0.95	1.57
8142	2.45	0.30	9.00	2.70	0.97	1.57
12995	3.92	0.30	9.00	2.70	0.95	1.57
0	0.00	0.50	10.50	5.25	1.00	1.83
0	0.00	0.50	10.50	5.25	1.00	1.83
0	0.00	0.50	10.50	5.25	1.00	1.83

Date:	3/30/96			
Subject:	CH3I Removal from air			
Cathode diameter:	0.3 mm			
Anode diameter and length:	38 mm x 280 mm			
Number of cathodes:	1 cathode			
Gas flow rate:	N2	131.9	cc/min	
	O2	49.1	cc/min	[20%]
	CH3I	64.0	cc/min	[80 ppm]
	Total	245.0	cc/min	
Temperature:	19.0	c		
Inlet concentration (Cin):	77.87	ppm		

GC	Cout	I	V	P	Eff	E/p
255311	76.95	0.00	-	-	0.00	-
257528	77.62	0.00	-	-	0.00	-
262227	79.03	0.00	-	-	0.00	-
132487	39.93	0.05	8.80	0.44	0.49	1.87
136455	41.13	0.05	8.80	0.44	0.47	1.87
135926	40.97	0.05	8.80	0.44	0.47	1.87
74832	22.55	0.10	9.30	0.93	0.71	1.98
68679	20.70	0.10	9.30	0.93	0.73	1.98
75020	22.61	0.10	9.30	0.93	0.71	1.98
20539	6.19	0.20	10.00	2.00	0.92	2.13
17400	5.24	0.20	10.00	2.00	0.93	2.13
15981	4.82	0.20	10.00	2.00	0.94	2.13
0	0.00	0.30	10.60	3.18	1.00	2.26
0	0.00	0.30	10.60	3.18	1.00	2.26
0	0.00	0.30	10.60	3.18	1.00	2.26
0	0.00	0.50	11.70	5.85	1.00	2.49

Date:	2/20/96		
Subject:	CH3I Removal from air		
Cathode diameter:	0.8 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	132.0	cc/min
	O2	49.0	cc/min [20%]
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	14.5	c	
Inlet concentration (Cin):	75.57	ppm	

GC	Cout	I	V	P	Eff	E/p
250641	75.54	0.00	-	-	0.00	-
251516	75.80	0.00	-	-	0.00	-
249713	75.26	0.00	-	-	0.00	-
249827	75.29	0.00	-	-	0.00	-
249739	75.27	0.00	-	-	0.00	-
253099	76.28	0.00	-	-	0.00	-
80649	24.31	0.05	13.00	0.65	0.68	3.43
87882	26.49	0.05	13.00	0.65	0.65	3.43
84818	25.56	0.05	13.00	0.65	0.66	3.43
12197	3.68	0.10	13.10	1.31	0.95	3.45
11307	3.41	0.10	13.10	1.31	0.95	3.45
12159	3.66	0.10	13.10	1.31	0.95	3.45
0	0.00	0.20	13.40	2.68	1.00	3.53
0	0.00	0.20	13.40	2.68	1.00	3.53
0	0.00	0.20	13.40	2.68	1.00	3.53
0	0.00	0.30	14.00	4.20	1.00	3.69
0	0.00	0.50	14.90	7.45	1.00	3.93

Date:	2/23/96		
Subject:	CH3I Removal from air		
Cathode diameter:	1.0 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	132.0	cc/min
	O2	49.0	cc/min [20%]
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	14.5	c	
Inlet concentration (Cin):	78.91	ppm	

GC	Cout	I	V	P	Eff	E/p
257110	77.49	0.00	-	-	0.00	-
259997	78.36	0.00	-	-	0.00	-
262433	79.09	0.00	-	-	0.00	-
264009	79.57	0.00	-	-	0.00	-
265455	80.00	0.00	-	-	0.00	-
261948	78.95	0.00	-	-	0.00	-
51697	15.58	0.05	13.30	0.67	0.80	3.70
52036	15.68	0.05	13.30	0.67	0.80	3.70
55533	16.74	0.05	13.30	0.67	0.79	3.70
0	0.00	0.10	13.70	1.37	1.00	3.81
0	0.00	0.10	13.70	1.37	1.00	3.81
0	0.00	0.10	13.70	1.37	1.00	3.81
0	0.00	0.20	14.00	2.80	1.00	3.90
0	0.00	0.30	14.80	4.44	1.00	4.12
0	0.00	0.50	15.70	7.85	1.00	4.37

Date:	3/13/96					
Subject:	CH3I Removal from air					
Cathode diameter:	1.6 mm					
Anode diameter and length:	38 mm x 280 mm					
Number of cathodes:	1 cathode					
Gas flow rate:	N2	132.0	cc/min			
	O2	49.0	cc/min	[20%]		
	CH3I	64.0	cc/min	[80 ppm]		
	Total	245.0	cc/min			
Temperature:	14.0	c				
Inlet concentration (Cin):	77.52	ppm				
GC	Cout	I	V	P	Eff	E/p
251441	75.78	0.00	-	-	0.00	-
254528	76.71	0.00	-	-	0.00	-
254694	76.76	0.00	-	-	0.00	-
260688	78.57	0.00	-	-	0.00	-
261598	78.84	0.00	-	-	0.00	-
260275	78.44	0.00	-	-	0.00	-
0	0.00	0.05	17.30	0.87	1.00	5.44
0	0.00	0.05	17.30	0.87	1.00	5.44
0	0.00	0.05	17.30	0.87	1.00	5.44
0	0.00	0.10	17.40	1.74	1.00	5.48
0	0.00	0.20	17.70	3.54	1.00	5.57
0	0.00	0.30	18.00	5.40	1.00	5.66
0	0.00	0.50	18.50	9.25	1.00	5.82

Date:	2/13/96		
Subject:	CH3I Removal from N2		
Cathode diameter:	0.05 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	181.0	cc/min
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	18.0	c	
Inlet concentration (Cin):	78.60	ppm	

GC	Cout	I	V	P	Eff	E/p
261436	78.80	0.00	-	-	0.00	-
259921	78.30	0.00	-	-	0.00	-
264406	79.70	0.00	-	-	0.00	-
259570	78.20	0.00	-	-	0.00	-
260222	78.40	0.00	-	-	0.00	-
259633	78.20	0.00	-	-	0.00	-
214302	64.60	0.10	5.20	0.52	0.18	0.81
219100	66.00	0.10	5.20	0.52	0.16	0.81
221413	66.70	0.10	5.20	0.52	0.15	0.81
201574	60.80	0.30	5.80	1.74	0.23	0.91
201119	60.60	0.30	5.80	1.74	0.23	0.91
200098	60.30	0.30	5.80	1.74	0.23	0.91
182825	55.10	0.50	6.80	3.40	0.30	1.06
181243	54.60	0.50	6.80	3.40	0.31	1.06
182371	55.00	0.50	6.80	3.40	0.30	1.06
165731	49.90	0.70	7.00	4.90	0.37	1.09
166848	50.30	0.70	7.00	4.90	0.36	1.09
167671	50.50	0.70	7.00	4.90	0.36	1.09
166283	50.10	1.00	7.20	7.20	0.36	1.13
165188	49.80	1.00	7.20	7.20	0.37	1.13
163001	49.10	1.00	7.20	7.20	0.38	1.13
148219	44.70	1.50	7.20	10.80	0.43	1.13
148295	44.70	1.50	7.20	10.80	0.43	1.13
150975	45.50	1.50	7.20	10.80	0.42	1.13
135523	40.80	2.00	7.00	14.00	0.48	1.09
136154	41.00	2.00	7.00	14.00	0.48	1.09
135817	40.90	2.00	7.00	14.00	0.48	1.09

Date:	3/14/96		
Subject:	CH3I Removal from N2		
Cathode diameter:	0.1 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	181.0	cc/min
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	18.0	c	
Inlet concentration (Cin):	78.90	ppm	

GC	Cout	I	V	P	Eff	E/p
259263	78.10	0.00	-	-	0.00	-
260791	78.60	0.00	-	-	0.00	-
262733	79.20	0.00	-	-	0.00	-
260526	78.50	0.00	-	-	0.00	-
263840	79.50	0.00	-	-	0.00	-
263729	79.50	0.00	-	-	0.00	-
223295	67.30	0.10	5.90	0.59	0.15	1.03
222977	67.20	0.10	5.90	0.59	0.15	1.03
225732	68.00	0.10	5.90	0.59	0.14	1.03
186933	56.30	0.30	7.10	2.13	0.29	1.24
185985	56.10	0.30	7.10	2.13	0.29	1.24
186369	56.20	0.30	7.10	2.13	0.29	1.24
160665	48.40	0.50	8.00	4.00	0.39	1.40
162676	49.00	0.50	8.00	4.00	0.38	1.40
161486	48.70	0.50	8.00	4.00	0.38	1.40
148661	44.80	0.70	8.70	6.09	0.43	1.52
152179	45.90	0.70	8.70	6.09	0.42	1.52
157093	47.30	0.70	8.70	6.09	0.40	1.52
140281	42.30	1.00	9.20	9.20	0.46	1.60
141320	42.60	1.00	9.20	9.20	0.46	1.60
143576	43.30	1.00	9.20	9.20	0.45	1.60
124055	37.40	1.50	9.90	14.85	0.53	1.73
120072	36.20	1.50	9.90	14.85	0.54	1.73
121343	36.60	1.50	9.90	14.85	0.54	1.73
101218	30.50	2.00	10.30	20.60	0.61	1.80
98730	29.80	2.00	10.30	20.60	0.62	1.80
96366	29.00	2.00	10.30	20.60	0.63	1.80

Date:	3/29/96		
Subject:	CH3I Removal from N2		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	181.0	cc/min
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	19.5	c	
Inlet concentration (Cin):	75.95	ppm	

GC	Cout	I	V	P	Eff	E/p
253557	75.17	0.00	-	-	0.00	-
257813	76.43	0.00	-	-	0.00	-
257168	76.24	0.00	-	-	0.00	-
182461	54.99	0.10	8.90	0.89	0.28	1.89
184861	55.71	0.10	8.90	0.89	0.27	1.89
185726	55.98	0.10	8.90	0.89	0.26	1.89
130152	39.23	0.30	9.60	2.88	0.48	2.04
137052	41.31	0.30	9.60	2.88	0.46	2.04
138262	41.67	0.30	9.60	2.88	0.45	2.04
118809	35.81	0.50	10.10	5.05	0.53	2.15
113725	34.28	0.50	10.10	5.05	0.55	2.15
117865	35.52	0.50	10.10	5.05	0.53	2.15
73757	22.23	1.00	10.60	10.60	0.71	2.26
73661	22.20	1.00	10.60	10.60	0.71	2.26
85682	25.82	1.00	10.60	10.60	0.66	2.26
59119	17.82	1.50	10.90	16.35	0.77	2.32
61290	18.47	1.50	10.90	16.35	0.76	2.32
58581	17.66	1.50	10.90	16.35	0.77	2.32

Date:	4/12/96		
Subject:	C2Cl3F3 Removal from air		
Cathode diameter:	0.05 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	40.2	cc/min
	O2	20.0	cc/min [20%]
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	9.5	c	
Inlet concentration (Cin):	396.63	ppm	

GC	Cout	I	V	P	Eff	E/p
2374805	398.10	0.00	-	-	0.00	-
2361076	395.80	0.00	-	-	0.00	-
2362164	396.00	0.00	-	-	0.00	-
2229608	373.80	0.10	5.80	0.58	0.06	0.91
2248997	377.00	0.10	5.80	0.58	0.05	0.91
2222948	372.70	0.10	5.80	0.58	0.06	0.91
2141189	359.00	0.20	7.10	1.42	0.09	1.11
2144890	359.60	0.20	7.10	1.42	0.09	1.11
2144870	359.60	0.20	7.10	1.42	0.09	1.11
2040419	342.10	0.30	8.30	2.49	0.14	1.30
2047206	343.20	0.30	8.30	2.49	0.13	1.30
2048670	343.40	0.30	8.30	2.49	0.13	1.30
1914641	321.00	0.50	9.80	4.90	0.19	1.53
1923908	322.50	0.50	9.80	4.90	0.19	1.53
1896897	318.00	0.50	9.80	4.90	0.20	1.53
1637280	274.50	1.00	12.10	12.10	0.31	1.89
1662830	278.80	1.00	12.10	12.10	0.30	1.89
1659528	278.20	1.00	12.10	12.10	0.30	1.89
1489509	249.70	1.50	13.30	19.95	0.37	2.08
1487079	249.30	1.50	13.30	19.95	0.37	2.08

Date:	4/8/96		
Subject:	C2Cl3F3 Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	40.2	cc/min
	O2	20.0	cc/min [20%]
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	16.0	c	
Inlet concentration (Cin):	394.30	ppm	

GC	Cout	I	V	P	Eff	E/p
2372688	397.80	0.00	-	-	0.00	-
2323368	392.90	0.00	-	-	0.00	-
2339291	392.20	0.00	-	-	0.00	-
2172907	364.30	0.10	9.20	0.92	0.08	1.96
2185728	366.40	0.10	9.20	0.92	0.07	1.96
2181289	365.70	0.10	9.20	0.92	0.07	1.96
2044749	342.80	0.20	10.10	2.02	0.13	2.15
2038428	341.70	0.20	10.10	2.02	0.13	2.15
1912422	320.60	0.30	10.90	3.27	0.19	2.32
1912542	320.60	0.30	10.90	3.27	0.19	2.32
1911332	320.40	0.30	10.90	3.27	0.19	2.32
1721591	288.60	0.50	12.00	6.00	0.27	2.55
1714520	287.40	0.50	12.00	6.00	0.27	2.55
1726905	289.50	0.50	12.00	6.00	0.27	2.55
1374242	230.40	1.00	14.00	14.00	0.42	2.98
1367191	229.20	1.00	14.00	14.00	0.42	2.98
1372952	230.20	1.00	14.00	14.00	0.42	2.98
1188971	199.30	1.50	15.20	22.80	0.49	3.24
1214732	203.60	1.50	15.20	22.80	0.48	3.24
1235021	207.00	1.50	15.20	22.80	0.48	3.24

Date:	4/19/96		
Subject:	C2Cl3F3 Removal from air		
Cathode diameter:	0.8 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	40.2	cc/min
	O2	20.0	cc/min [20%]
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	14.0	c	
Inlet concentration (Cin):	394.17	ppm	

GC	Cout	I	V	P	Eff	E/p
2353576	394.60	0.00	-	-	0.00	-
2343512	392.90	0.00	-	-	0.00	-
2356445	395.00	0.00	-	-	0.00	-
2135942	358.10	0.10	13.40	1.34	0.09	3.53
2151798	360.70	0.10	13.40	1.34	0.08	3.53
2143442	359.30	0.10	13.40	1.34	0.09	3.53
1979078	331.80	0.20	13.80	2.76	0.16	3.64
1987934	333.30	0.20	13.80	2.76	0.15	3.64
1980768	332.10	0.20	13.80	2.76	0.16	3.64
1866175	312.90	0.30	14.20	4.26	0.21	3.74
1860966	312.00	0.30	14.20	4.26	0.21	3.74
1860288	311.90	0.30	14.20	4.26	0.21	3.74
1646872	276.10	0.50	14.90	7.45	0.30	3.93
1659239	278.20	0.50	14.90	7.45	0.29	3.93
1649753	276.60	0.50	14.90	7.45	0.30	3.93
1281253	214.80	1.00	15.90	15.90	0.46	4.19
1293644	216.90	1.00	15.90	15.90	0.45	4.19
1287653	215.90	1.00	15.90	15.90	0.45	4.19

Date:	4/17/96		
Subject:	C2Cl3F3 Removal from air		
Cathode diameter:	1.26 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	40.2	cc/min
	O2	20.0	cc/min [20%]
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	17.0	c	
Inlet concentration (Cin):	394.50	ppm	

GC	Cout	I	V	P	Eff	E/p
2345576	393.20	0.00	-	-	0.00	-
2353048	394.50	0.00	-	-	0.00	-
2360944	395.80	0.00	-	-	0.00	-
2110056	353.70	0.10	16.10	1.61	0.10	4.75
2120580	355.50	0.10	16.10	1.61	0.10	4.75
2102754	352.50	0.10	16.10	1.61	0.11	4.75
1925600	322.80	0.20	16.20	3.24	0.18	4.78
1926958	323.00	0.20	16.20	3.24	0.18	4.78
1923580	322.50	0.20	16.20	3.24	0.18	4.78
1795176	301.00	0.30	16.30	4.89	0.24	4.81
1806886	302.90	0.30	16.30	4.89	0.23	4.81
1820917	305.30	0.30	16.30	4.89	0.23	4.81
1569544	263.10	0.50	16.80	8.40	0.33	4.96
1571471	263.40	0.50	16.80	8.40	0.33	4.96
1572899	263.70	0.50	16.80	8.40	0.33	4.96
1194358	200.20	1.00	17.30	17.30	0.49	5.11
1193027	200.00	1.00	17.30	17.30	0.49	5.11
1192644	199.90	1.00	17.30	17.30	0.49	5.11

Date:	4/11/96					
Subject:	C2Cl3F3 Removal from N2					
Cathode diameter:	0.05 mm					
Anode diameter and length:	38 mm x 280 mm					
Number of cathodes:	1 cathode					
Gas flow rate:	N2	60.2	cc/min			
	C2Cl3F3	39.8	cc/min	[400 ppm]		
	Total	100.0	cc/min			
Temperature:	12.5	c				
Inlet concentration (Cin):	397.63	ppm				

GC	Cout	I	V	P	Eff	E/p
2351173	394.20	0.00	-	-	0.00	-
2370875	397.50	0.00	-	-	0.00	-
2392916	401.20	0.00	-	-	0.00	-
1797524	301.30	0.10	5.80	0.58	0.24	0.91
1785256	299.30	0.10	5.80	0.58	0.25	0.91
1810933	303.60	0.10	5.80	0.58	0.24	0.91
1561335	261.70	0.20	7.10	1.42	0.34	1.11
1561564	261.80	0.20	7.10	1.42	0.34	1.11
1529369	256.40	0.20	7.10	1.42	0.36	1.11
1340807	224.80	0.30	8.20	2.46	0.43	1.28
1335760	223.90	0.30	8.20	2.46	0.44	1.28
1339055	224.50	0.30	8.20	2.46	0.44	1.28
1103015	184.90	0.50	9.80	4.90	0.53	1.53
1128270	189.10	0.50	9.80	4.90	0.52	1.53
1135659	190.40	0.50	9.80	4.90	0.52	1.53
784980	131.60	1.00	12.10	12.10	0.67	1.89
753029	126.20	1.00	12.10	12.10	0.68	1.89
770947	129.20	1.00	12.10	12.10	0.68	1.89
562394	94.30	1.50	13.30	19.95	0.76	2.08
575526	96.50	1.50	13.30	19.95	0.76	2.08
579118	97.10	1.50	13.30	19.95	0.76	2.08

Date:	4/4/96					
Subject:	C2Cl3F3 Removal from N2					
Cathode diameter:	0.3 mm					
Anode diameter and length:	38 mm x 280 mm					
Number of cathodes:	1 cathode					
Gas flow rate:	N2	60.2	cc/min			
	C2Cl3F3	39.8	cc/min	[400 ppm]		
	Total	100.0	cc/min			
Temperature:	8.0	c				
Inlet concentration (Cin):	398.31	ppm				
GC	Cout	I	V	P	Eff	E/p
2380846	399.14	0.00	-	-	0.00	-
2368644	397.09	0.00	-	-	0.00	-
2378182	398.69	0.00	-	-	0.00	-
1465774	245.73	0.10	9.60	0.96	0.38	2.04
1458771	244.56	0.10	9.60	0.96	0.39	2.04
1451577	243.35	0.10	9.60	0.96	0.39	2.04
1110451	186.16	0.20	10.10	2.02	0.53	2.15
1117512	187.34	0.20	10.10	2.02	0.53	2.15
1121322	187.98	0.20	10.10	2.02	0.53	2.15
945821	158.56	0.30	10.60	3.18	0.60	2.26
950016	159.27	0.30	10.60	3.18	0.60	2.26
963577	161.54	0.30	10.60	3.18	0.59	2.26
755683	126.69	0.50	11.30	5.65	0.68	2.41
764260	128.12	0.50	11.30	5.65	0.68	2.41
762794	127.88	0.50	11.30	5.65	0.68	2.41
429463	72.00	1.00	13.00	13.00	0.82	2.77
433857	72.73	1.00	13.00	13.00	0.82	2.77
433638	72.70	1.00	13.00	13.00	0.82	2.77
256594	43.02	1.50	14.20	21.30	0.89	3.02
272822	45.74	1.50	14.20	21.30	0.89	3.02
280963	47.10	1.50	14.20	21.30	0.88	3.02

Date:	4/18/96		
Subject:	C2Cl3F3 Removal from N2		
Cathode diameter:	0.8 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	60.2	cc/min
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	11.0	c	
Inlet concentration (Cin):	395.33	ppm	

GC	Cout	I	V	P	Eff	E/p
2356256	395.00	0.00	-	-	0.00	-
2356406	395.00	0.00	-	-	0.00	-
2361889	396.00	0.00	-	-	0.00	-
1216459	203.90	0.10	14.10	1.41	0.48	3.72
1216013	203.90	0.10	14.10	1.41	0.48	3.72
1223764	205.20	0.10	14.10	1.41	0.48	3.72
902084	151.20	0.20	14.60	2.92	0.62	3.85
916906	153.70	0.20	14.60	2.92	0.61	3.85
921001	154.40	0.20	14.60	2.92	0.61	3.85
779566	130.70	0.30	14.80	4.44	0.67	3.90
773248	129.60	0.30	14.80	4.44	0.67	3.90
769539	129.00	0.30	14.80	4.44	0.67	3.90
556225	93.20	0.50	15.10	7.55	0.76	3.98
560233	93.90	0.50	15.10	7.55	0.76	3.98
546704	91.70	0.50	15.10	7.55	0.77	3.98
215099	36.10	1.00	15.60	15.60	0.91	4.11
250339	42.00	1.00	15.60	15.60	0.89	4.11

Date:	4/17/96		
Subject:	C2Cl3F3 Removal from N2		
Cathode diameter:	1.26 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	60.2	cc/min
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	17.0	c	
Inlet concentration (Cin):	395.57	ppm	

GC	Cout	I	V	P	Eff	E/p
2349328	393.90	0.00	-	-	0.00	-
2358454	395.40	0.00	-	-	0.00	-
2370359	397.40	0.00	-	-	0.00	-
1025980	172.00	0.10	17.00	1.70	0.57	5.02
1042693	174.80	0.10	17.00	1.70	0.56	5.02
1009894	169.30	0.10	17.00	1.70	0.57	5.02
631381	105.80	0.20	17.10	3.42	0.73	5.05
630780	105.70	0.20	17.10	3.42	0.73	5.05
634921	106.40	0.20	17.10	3.42	0.73	5.05
414767	69.50	0.30	17.20	5.16	0.82	5.08
402956	67.60	0.30	17.20	5.16	0.83	5.08
413823	69.40	0.30	17.20	5.16	0.82	5.08
298424	50.00	0.50	17.40	8.70	0.87	5.14
308757	51.80	0.50	17.40	8.70	0.87	5.14
346465	58.10	0.50	17.40	8.70	0.85	5.14
132252	22.20	1.00	17.50	17.50	0.94	5.17
134980	22.60	1.00	17.50	17.50	0.94	5.17
131796	22.10	1.00	17.50	17.50	0.94	5.17

Date:	5/7/96		
Subject:	CH ₃ CHO Removal from air		
Cathode diameter:	0.05 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	141.3	cc/min
	O ₂	60.0	cc/min [20%]
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	20.5	c	
Inlet concentration (C_{in}):	98.43	ppm	

GC	C _{out}	I	V	P	Eff	E/p
300642	98.40	0.00	-	-	0.00	-
301763	98.80	0.00	-	-	0.00	-
299584	98.10	0.00	-	-	0.00	-
261015	85.50	0.05	4.50	0.23	0.13	0.70
262690	86.00	0.05	4.50	0.23	0.13	0.70
260882	85.40	0.05	4.50	0.23	0.13	0.70
202280	66.20	0.10	5.20	0.52	0.33	0.81
202444	66.30	0.10	5.20	0.52	0.33	0.81
199266	65.20	0.10	5.20	0.52	0.34	0.81
145977	47.80	0.15	6.00	0.90	0.51	0.94
142843	46.80	0.15	6.00	0.90	0.52	0.94
143167	46.90	0.15	6.00	0.90	0.52	0.94
85588	28.00	0.20	6.60	1.32	0.72	1.03
84062	27.50	0.20	6.60	1.32	0.72	1.03
85107	27.90	0.20	6.60	1.32	0.72	1.03
35177	11.50	0.30	7.50	2.25	0.88	1.17
36107	11.80	0.30	7.50	2.25	0.88	1.17
34828	11.40	0.30	7.50	2.25	0.88	1.17
6948	2.30	0.50	9.00	4.50	0.98	1.41
5459	1.80	0.50	9.00	4.50	0.98	1.41
4947	1.60	0.50	9.00	4.50	0.98	1.41

Date:	5/13/96		
Subject:	CH ₃ CHO Removal from air		
Cathode diameter:	0.2 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	141.3	cc/min
	O ₂	60.0	cc/min [20%]
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	16.0	c	
Inlet concentration (C_{in}):	99.57	ppm	

GC	C _{out}	I	V	P	Eff	E/p
302893	99.20	0.00	-	-	0.00	-
305200	99.90	0.00	-	-	0.00	-
304226	99.60	0.00	-	-	0.00	-
223532	73.20	0.05	7.00	0.35	0.26	1.38
222612	72.90	0.05	7.00	0.35	0.27	1.38
220898	72.30	0.05	7.00	0.35	0.27	1.38
116513	38.20	0.10	7.80	0.78	0.62	1.54
116262	38.10	0.10	7.80	0.78	0.62	1.54
114054	37.30	0.10	7.80	0.78	0.63	1.54
57710	18.90	0.15	8.20	1.23	0.81	1.61
56226	18.40	0.15	8.20	1.23	0.82	1.61
55982	18.30	0.15	8.20	1.23	0.82	1.61
27746	9.10	0.20	8.80	1.76	0.91	1.73
24068	7.90	0.20	8.80	1.76	0.92	1.73
22448	7.40	0.20	8.80	1.76	0.93	1.73
8609	2.80	0.30	9.70	2.91	0.97	1.91
7347	2.40	0.30	9.70	2.91	0.98	1.91
6259	2.00	0.30	9.70	2.91	0.98	1.91
0	0.00	0.50	11.00	5.50	1.00	2.17

Date:	5/9/96		
Subject:	CH ₃ CHO Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	141.3	cc/min
	O ₂	60.0	cc/min [20%]
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	20.5	c	
Inlet concentration (C_{in}):	98.80	ppm	

GC	C _{out}	I	V	P	Eff	E/p
301380	98.70	0.00	-	-	0.00	-
301167	98.60	0.00	-	-	0.00	-
302521	99.10	0.00	-	-	0.00	-
148882	48.70	0.05	8.10	0.41	0.51	1.72
152722	50.00	0.05	8.10	0.41	0.49	1.72
150840	49.40	0.05	8.10	0.41	0.50	1.72
85800	28.10	0.10	8.70	0.87	0.72	1.85
80849	26.50	0.10	8.70	0.87	0.73	1.85
82790	27.10	0.10	8.70	0.87	0.73	1.85
29449	9.60	0.15	9.10	1.37	0.90	1.94
30828	10.10	0.15	9.10	1.37	0.90	1.94
31238	10.20	0.15	9.10	1.37	0.90	1.94
14788	4.80	0.20	9.60	1.92	0.95	2.04
13515	4.40	0.20	9.60	1.92	0.96	2.04
12176	4.00	0.20	9.60	1.92	0.96	2.04
0	0.00	0.30	10.30	3.09	1.00	2.19
0	0.00	0.50	11.50	5.75	1.00	2.45

Date:	5/15/1996		
Subject:	CH ₃ CHO Removal from air		
Cathode diameter:	0.5 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	141.3	cc/min
	O ₂	60.0	cc/min [20%]
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	23.5	c	
Inlet concentration (C_{in}):	100.30	ppm	

GC	C _{out}	I	V	P	Eff	E/p
302205	99.00	0.00	-	-	0.00	-
307864	100.80	0.00	-	-	0.00	-
308624	101.10	0.00	-	-	0.00	-
91287	29.90	0.05	10.30	0.52	0.70	2.44
92453	30.30	0.05	10.30	0.52	0.70	2.44
90179	29.50	0.05	10.30	0.52	0.71	2.44
19629	6.40	0.10	10.80	1.08	0.94	2.56
19192	6.30	0.10	10.80	1.08	0.94	2.56
17860	5.80	0.10	10.80	1.08	0.94	2.56
6587	2.20	0.15	11.00	1.65	0.98	2.60
6227	2.00	0.15	11.00	1.65	0.98	2.60
5923	1.90	0.15	11.00	1.65	0.98	2.60
0	0.00	0.20	11.30	2.26	1.00	2.68
0	0.00	0.30	12.00	3.60	1.00	2.84
0	0.00	0.50	13.10	6.55	1.00	3.10

Date:	5/8/96		
Subject:	CH ₃ CHO Removal from N ₂		
Cathode diameter:	0.05 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	201.3	cc/min
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	19.0	c	
Inlet concentration (C_{in}):	98.43	ppm	

GC	C _{out}	I	V	P	Eff	E/p
300588	98.40	0.00	-	-	0.00	-
301012	98.60	0.00	-	-	0.00	-
300097	98.30	0.00	-	-	0.00	-
289405	94.80	0.10	3.00	0.30	0.04	0.47
289182	94.70	0.10	3.00	0.30	0.04	0.47
289842	94.90	0.10	3.00	0.30	0.04	0.47
277767	91.00	0.30	3.20	0.96	0.08	0.50
277999	91.00	0.30	3.20	0.96	0.08	0.50
279235	91.40	0.30	3.20	0.96	0.07	0.50
261057	85.50	0.50	3.40	1.70	0.13	0.53
260656	85.30	0.50	3.40	1.70	0.13	0.53
260794	85.40	0.50	3.40	1.70	0.13	0.53
236572	77.50	1.00	3.60	3.60	0.21	0.56
240549	78.80	1.00	3.60	3.60	0.20	0.56
240927	78.90	1.00	3.60	3.60	0.20	0.56
212952	69.70	1.50	3.60	5.40	0.29	0.56
211723	69.30	1.50	3.60	5.40	0.30	0.56
212469	69.60	1.50	3.60	5.40	0.29	0.56

Date:	5/13/96		
Subject:	CH ₃ CHO Removal from N ₂		
Cathode diameter:	0.2 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	201.3	cc/min
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	22.0	c	
Inlet concentration (C_{in}):	98.43	ppm	

GC	C _{out}	I	V	P	Eff	E/p
300598	98.40	0.00	-	-	0.00	-
300118	98.30	0.00	-	-	0.00	-
301172	98.60	0.00	-	-	0.00	-
287273	94.10	0.10	3.50	0.35	0.04	0.69
287813	94.20	0.10	3.50	0.35	0.04	0.69
286014	93.70	0.10	3.50	0.35	0.05	0.69
276416	90.50	0.30	3.60	1.08	0.08	0.71
275873	90.30	0.30	3.60	1.08	0.08	0.71
271728	89.00	0.30	3.60	1.08	0.10	0.71
263137	86.20	0.50	3.80	1.90	0.12	0.75
262132	85.80	0.50	3.80	1.90	0.13	0.75
259458	85.00	0.50	3.80	1.90	0.14	0.75
223511	73.20	1.00	3.90	3.90	0.26	0.77
224136	73.40	1.00	3.90	3.90	0.25	0.77
223904	73.30	1.00	3.90	3.90	0.26	0.77
199090	65.20	1.50	3.80	5.70	0.34	0.75
196842	64.50	1.50	3.80	5.70	0.34	0.75
196050	64.20	1.50	3.80	5.70	0.35	0.75

Date:	5/10/96		
Subject:	CH ₃ CHO Removal from N ₂		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	201.3	cc/min
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	22.5	c	
Inlet concentration (C_{in}):	98.43	ppm	

GC	C _{out}	I	V	P	Eff	E/p
300588	98.40	0.00	-	-	0.00	-
301012	98.60	0.00	-	-	0.00	-
300097	98.30	0.00	-	-	0.00	-
285406	93.50	0.10	3.70	0.37	0.05	0.79
286667	93.90	0.10	3.70	0.37	0.05	0.79
286980	94.00	0.10	3.70	0.37	0.05	0.79
257219	84.20	0.30	3.80	1.14	0.14	0.81
262369	85.90	0.30	3.80	1.14	0.13	0.81
263071	86.10	0.30	3.80	1.14	0.13	0.81
240733	78.80	0.50	3.90	1.95	0.20	0.83
241493	79.10	0.50	3.90	1.95	0.20	0.83
241382	79.00	0.50	3.90	1.95	0.20	0.83
211709	69.30	1.00	4.00	4.00	0.30	0.85
210327	68.90	1.00	4.00	4.00	0.30	0.85
213195	69.80	1.00	4.00	4.00	0.29	0.85
184625	60.50	1.50	4.00	6.00	0.39	0.85
183603	60.10	1.50	4.00	6.00	0.39	0.85
181570	59.50	1.50	4.00	6.00	0.40	0.85

APPENDIX C**EXPERIMENTAL DATA OF EFFECT OF ANODE DIMENSIONS****Notation for the following data sheets**

- GC = peak area of chromatogram [-]
C_{out} = outlet concentration [ppm]
I = discharge current [mA]
V = applied voltage [kV]
P = electric power [W]
Eff = removal efficiency [-]
E/p = ratio of electric field strength to pressure [$\text{Vm}^{-1}\text{Pa}^{-1}$]

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Date:	6/3/96		
Subject:	CH3I Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	76 mm x 70 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	131.9	cc/min
	O2	49.1	cc/min [20%]
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	28.0	c	
Inlet concentration (Cin):	75.83	ppm	

GC	Cout	I	V	P	Eff	E/p
253597	76.40	0.00	-	-	0.00	-
249725	75.30	0.00	-	-	0.00	-
251664	75.80	0.00	-	-	0.00	-
201743	60.80	0.05	15.30	0.77	0.20	1.43
194641	58.70	0.05	15.30	0.77	0.23	1.43
195654	59.00	0.05	15.30	0.77	0.22	1.43
140279	42.30	0.10	18.90	1.89	0.44	1.77
135964	41.00	0.10	18.90	1.89	0.46	1.77
139740	42.10	0.10	18.90	1.89	0.44	1.77
70585	21.30	0.20	23.00	4.60	0.72	2.15
69957	21.10	0.20	23.00	4.60	0.72	2.15
69903	21.10	0.20	23.00	4.60	0.72	2.15
26103	7.90	0.30	26.00	7.80	0.90	2.43
27644	8.30	0.30	26.00	7.80	0.89	2.43
30152	9.10	0.30	26.00	7.80	0.88	2.43
0	0.00	0.50	30.50	15.25	1.00	2.85

Date:	3/30/96		
Subject:	CH3I Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	131.9	cc/min
	O2	49.1	cc/min [20%]
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	19.0	c	
Inlet concentration (Cin):	77.87	ppm	

GC	Cout	I	V	P	Eff	E/p
255311	76.95	0.00	-	-	0.00	-
257528	77.62	0.00	-	-	0.00	-
262227	79.03	0.00	-	-	0.00	-
132487	39.93	0.05	8.80	0.44	0.49	1.87
136455	41.13	0.05	8.80	0.44	0.47	1.87
135926	40.97	0.05	8.80	0.44	0.47	1.87
74832	22.55	0.10	9.30	0.93	0.71	1.98
68679	20.70	0.10	9.30	0.93	0.73	1.98
75020	22.61	0.10	9.30	0.93	0.71	1.98
20539	6.19	0.20	10.00	2.00	0.92	2.13
17400	5.24	0.20	10.00	2.00	0.93	2.13
15981	4.82	0.20	10.00	2.00	0.94	2.13
0	0.00	0.30	10.60	3.18	1.00	2.26
0	0.00	0.30	10.60	3.18	1.00	2.26
0	0.00	0.30	10.60	3.18	1.00	2.26
0	0.00	0.50	11.70	5.85	1.00	2.49

Date:	5/30/96		
Subject:	CH3I Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	19 mm x 1120 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	131.9	cc/min
	O2	49.1	cc/min [20%]
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	27.5	c	
Inlet concentration (Cin):	75.83	ppm	

GC	Cout	I	V	P	Eff	E/p
253597	76.40	0.00	-	-	0.00	-
249725	75.30	0.00	-	-	0.00	-
251664	75.80	0.00	-	-	0.00	-
76398	23.00	0.05	6.20	0.31	0.70	3.06
75907	22.90	0.05	6.20	0.31	0.70	3.06
72216	21.80	0.05	6.20	0.31	0.71	3.06
18064	5.40	0.10	6.60	0.66	0.93	3.25
19209	5.80	0.10	6.60	0.66	0.92	3.25
21222	6.40	0.10	6.60	0.66	0.92	3.25
0	0.00	0.20	6.70	1.34	1.00	3.30
0	0.00	0.30	6.80	2.04	1.00	3.35
0	0.00	0.50	7.00	3.50	1.00	3.45

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Date:	12/1/95		
Subject:	C2Cl3F3 Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	76 mm x 70 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	40.1	cc/min
	O2	20.1	cc/min [20.1%]
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	12.0	c	
Inlet concentration (Cin):	394.28	ppm	

GC	Cout	I	V	P	Eff	E/p
2299133	398.80	0.00	-	-	0.00	-
2251258	390.50	0.00	-	-	0.00	-
2243590	389.20	0.00	-	-	0.00	-
2298195	398.60	0.00	-	-	0.00	-
2167534	376.00	0.10	18.60	1.86	0.05	1.74
2160855	374.80	0.10	18.60	1.86	0.05	1.74
2164836	375.50	0.10	18.60	1.86	0.05	1.74
2089397	362.40	0.20	24.00	4.80	0.08	2.24
2035604	353.10	0.20	24.00	4.80	0.10	2.24
2072117	359.40	0.20	24.00	4.80	0.09	2.24
2004220	347.70	0.30	28.00	8.40	0.12	2.62
1951123	338.40	0.30	28.00	8.40	0.14	2.62
1956694	339.40	0.30	28.00	8.40	0.14	2.62
1764508	306.10	0.50	31.10	15.55	0.22	2.91
1758558	305.00	0.50	31.10	15.55	0.23	2.91
1766130	306.40	0.50	31.10	15.55	0.22	2.91
1333675	231.30	1.00	34.00	34.00	0.41	3.18
1421145	246.50	1.00	34.00	34.00	0.37	3.18
1450694	251.60	1.00	34.00	34.00	0.36	3.18

Date:	4/8/96		
Subject:	C2Cl3F3 Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	40.2	cc/min
	O2	20.0	cc/min [20%]
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	16.0	c	
Inlet concentration (Cin):	394.30	ppm	

GC	Cout	I	V	P	Eff	E/p
2372688	397.80	0.00	-	-	0.00	-
2323368	392.90	0.00	-	-	0.00	-
2339291	392.20	0.00	-	-	0.00	-
2172907	364.30	0.10	9.20	0.92	0.08	1.96
2185728	366.40	0.10	9.20	0.92	0.07	1.96
2181289	365.70	0.10	9.20	0.92	0.07	1.96
2044749	342.80	0.20	10.10	2.02	0.13	2.15
2038428	341.70	0.20	10.10	2.02	0.13	2.15
1912422	320.60	0.30	10.90	3.27	0.19	2.32
1912542	320.60	0.30	10.90	3.27	0.19	2.32
1911332	320.40	0.30	10.90	3.27	0.19	2.32
1721591	288.60	0.50	12.00	6.00	0.27	2.55
1714520	287.40	0.50	12.00	6.00	0.27	2.55
1726905	289.50	0.50	12.00	6.00	0.27	2.55
1374242	230.40	1.00	14.00	14.00	0.42	2.98
1367191	229.20	1.00	14.00	14.00	0.42	2.98
1372952	230.20	1.00	14.00	14.00	0.42	2.98
1188971	199.30	1.50	15.20	22.80	0.49	3.24
1214732	203.60	1.50	15.20	22.80	0.48	3.24
1235021	207.00	1.50	15.20	22.80	0.48	3.24

Date:	12/2/95
Subject:	C2Cl3F3 Removal from air
Cathode diameter:	0.3 mm
Anode diameter and length:	19 mm x 1120 mm
Number of cathodes:	1 cathode
Gas flow rate:	N2 40.1 cc/min
	O2 20.1 cc/min [20.1%]
	C2Cl3F3 39.8 cc/min [400 ppm]
	Total 100.0 cc/min
Temperature:	14.0 c
Inlet concentration (Cin):	408.55 ppm

GC	Cout	I	V	P	Eff	E/p
2360248	409.40	0.00	-	-	0.00	-
2364141	410.10	0.00	-	-	0.00	-
2363540	410.00	0.00	-	-	0.00	-
2333329	404.70	0.00	-	-	0.00	-
1997824	346.50	0.20	7.00	1.40	0.15	3.45
1995555	346.20	0.20	7.00	1.40	0.15	3.45
1942418	336.90	0.20	7.00	1.40	0.18	3.45
1680926	291.60	0.40	7.10	2.84	0.29	3.50
1624702	281.80	0.40	7.10	2.84	0.31	3.50
1731720	300.40	0.40	7.10	2.84	0.26	3.50
1495992	259.50	0.60	7.20	4.32	0.36	3.55
1457969	252.90	0.60	7.20	4.32	0.38	3.55
1483701	257.40	0.60	7.20	4.32	0.37	3.55
1306536	226.60	0.80	7.30	5.84	0.45	3.60
1319541	228.90	0.80	7.30	5.84	0.44	3.60
1241949	215.40	0.80	7.30	5.84	0.47	3.60

Date:	5/16/96					
Subject:	CH ₃ CHO Removal from air					
Cathode diameter:	0.2 mm					
Anode diameter and length:	76 mm x 70 mm					
Number of cathodes:	1 cathode					
Gas flow rate:	N ₂	141.3	cc/min			
	O ₂	60.0	cc/min	[20.%]		
	CH ₃ CHO	98.7	cc/min	[100 ppm]		
	Total	300.0	cc/min			
Temperature:	23.0	c				
Inlet concentration (C_{in}):	100.30	ppm				

GC	C _{out}	I	V	P	Eff	E/p
302205	99.00	0.00	-	-	0.00	-
307864	100.80	0.00	-	-	0.00	-
308624	101.10	0.00	-	-	0.00	-
248328	81.30	0.05	13.40	0.67	0.19	1.17
247271	81.00	0.05	13.40	0.67	0.19	1.17
242029	79.20	0.05	13.40	0.67	0.21	1.17
165550	54.20	0.10	16.90	1.69	0.46	1.47
166290	54.40	0.10	16.90	1.69	0.46	1.47
104096	34.10	0.15	19.90	2.99	0.66	1.74
105061	34.40	0.15	19.90	2.99	0.66	1.74
102543	33.60	0.15	19.90	2.99	0.67	1.74
55210	18.10	0.20	22.00	4.40	0.82	1.92
57264	18.80	0.20	22.00	4.40	0.81	1.92
58484	19.10	0.20	22.00	4.40	0.81	1.92
25905	8.50	0.30	25.00	7.50	0.92	2.18
28840	9.40	0.30	25.00	7.50	0.91	2.18
28803	9.40	0.30	25.00	7.50	0.91	2.18
8134	2.70	0.50	29.00	14.50	0.97	2.53
7973	2.60	0.50	29.00	14.50	0.97	2.53
10616	3.50	0.50	29.00	14.50	0.97	2.53

Date:	5/13/96		
Subject:	CH ₃ CHO Removal from air		
Cathode diameter:	0.2 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N ₂	141.3	cc/min
	O ₂	60.0	cc/min [20%]
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	16.0	c	
Inlet concentration (C_{in}):	99.57	ppm	

GC	C _{out}	I	V	P	Eff	E/p
302893	99.20	0.00	-	-	0.00	-
305200	99.90	0.00	-	-	0.00	-
304226	99.60	0.00	-	-	0.00	-
223532	73.20	0.05	7.00	0.35	0.26	1.38
222612	72.90	0.05	7.00	0.35	0.27	1.38
220898	72.30	0.05	7.00	0.35	0.27	1.38
116513	38.20	0.10	7.80	0.78	0.62	1.54
116262	38.10	0.10	7.80	0.78	0.62	1.54
114054	37.30	0.10	7.80	0.78	0.63	1.54
57710	18.90	0.15	8.20	1.23	0.81	1.61
56226	18.40	0.15	8.20	1.23	0.82	1.61
55982	18.30	0.15	8.20	1.23	0.82	1.61
27746	9.10	0.20	8.80	1.76	0.91	1.73
24068	7.90	0.20	8.80	1.76	0.92	1.73
22448	7.40	0.20	8.80	1.76	0.93	1.73
8609	2.80	0.30	9.70	2.91	0.97	1.91
7347	2.40	0.30	9.70	2.91	0.98	1.91
6259	2.00	0.30	9.70	2.91	0.98	1.91
0	0.00	0.50	11.00	5.50	1.00	2.17

Date:	5/28/1996					
Subject:	CH ₃ CHO Removal from air					
Cathode diameter:	0.2 mm					
Anode diameter and length:	19 mm x 1120 mm					
Number of cathodes:	1 cathode					
Gas flow rate:	N ₂	141.3	cc/min			
	O ₂	60.0	cc/min	[20%]		
	CH ₃ CHO	98.7	cc/min	[100 ppm]		
	Total	300.0	cc/min			
Temperature:	26.0	c				
Inlet concentration (C_{in}):	100.60	ppm				
GC	C _{out}	I	V	P	Eff	E/p
307353	100.60	0.00	-	-	0.00	-
305780	100.10	0.00	-	-	0.00	-
308764	101.10	0.00	-	-	0.00	-
179172	58.70	0.05	4.80	0.24	0.42	2.17
180920	59.20	0.05	4.80	0.24	0.41	2.17
182994	59.90	0.05	4.80	0.24	0.40	2.17
62425	20.40	0.10	5.00	0.50	0.80	2.26
62636	20.50	0.10	5.00	0.50	0.80	2.26
59498	19.50	0.10	5.00	0.50	0.81	2.26
0	0.00	0.15	5.10	0.77	1.00	2.30
0	0.00	0.20	5.20	1.04	1.00	2.35
0	0.00	0.30	5.30	1.59	1.00	2.39
0	0.00	0.50	5.50	2.75	1.00	2.48

APPENDIX D**EXPERIMENTAL DATA OF EFFECT OF NUMBER OF CATHODES****Notation for the following data sheets**

- GC = peak area of chromatogram [-]
Cout = outlet concentration [ppm]
I = discharge current [mA]
V = applied voltage [kV]
P = electric power [W]
Eff = removal efficiency [-]
E/p = ratio of electric field strength to pressure [$\text{Vm}^{-1}\text{Pa}^{-1}$]

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Date:	3/30/96		
Subject:	CH3I Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	131.9	cc/min
	O2	49.1	cc/min [20%]
	CH3I	64.0	cc/min [80 ppm]
	Total	245.0	cc/min
Temperature:	19.0	c	
Inlet concentration (Cin):	77.87	ppm	

GC	Cout	I	V	P	Eff
255311	76.95	0.00	-	-	0.00
257528	77.62	0.00	-	-	0.00
262227	79.03	0.00	-	-	0.00
132487	39.93	0.05	8.80	0.44	0.49
136455	41.13	0.05	8.80	0.44	0.47
135926	40.97	0.05	8.80	0.44	0.47
74832	22.55	0.10	9.30	0.93	0.71
68679	20.70	0.10	9.30	0.93	0.73
75020	22.61	0.10	9.30	0.93	0.71
20539	6.19	0.20	10.00	2.00	0.92
17400	5.24	0.20	10.00	2.00	0.93
15981	4.82	0.20	10.00	2.00	0.94
0	0.00	0.30	10.60	3.18	1.00
0	0.00	0.30	10.60	3.18	1.00
0	0.00	0.30	10.60	3.18	1.00
0	0.00	0.50	11.70	5.85	1.00

Date:	11/7/95		
Subject:	CH3I Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	5 cathodes		
Gas flow rate:	N2	132.0	cc/min
	O2	49.0	cc/min [20%]
	CH3I	63.4	cc/min [80.2 ppm]
	Total	244.4	cc/min
Temperature:	17.5	c	
Inlet concentration (Cin):	74.65	ppm	

	Cout	I	V	P	Eff	
	76.20	0.00	-	-	0.00	
	76.20	0.00	-	-	0.00	
	76.30	0.00	-	-	0.00	
	72.70	0.00	-	-	0.00	
	73.20	0.00	-	-	0.00	
	73.30	0.00	-	-	0.00	
	55.50	0.05	8.40	0.42	0.26	
	58.90	0.05	8.40	0.42	0.21	
	54.30	0.05	8.40	0.42	0.27	
	32.70	0.10	8.70	0.87	0.56	
	34.40	0.10	8.70	0.87	0.54	
	33.20	0.10	8.70	0.87	0.56	
	9.30	0.20	9.00	1.80	0.88	
	10.90	0.20	9.00	1.80	0.85	
	10.00	0.20	9.00	1.80	0.87	
	5.30	0.30	9.20	2.76	0.93	
	4.80	0.30	9.20	2.76	0.94	
	5.00	0.30	9.20	2.76	0.93	
	0.90	0.50	9.80	4.90	0.99	
	0.00	0.50	9.80	4.90	1.00	
	0.00	0.50	9.80	4.90	1.00	

Date:	4/8/96		
Subject:	C2Cl3F3 Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	1 cathode		
Gas flow rate:	N2	40.2	cc/min
	O2	20.0	cc/min [20%]
	C2Cl3F3	39.8	cc/min [400 ppm]
	Total	100.0	cc/min
Temperature:	16.0	c	
Inlet concentration (Cin):	394.30	ppm	

GC	Cout	I	V	P	Eff	
2372688	397.80	0.00	-	-	0.00	
2323368	392.90	0.00	-	-	0.00	
2339291	392.20	0.00	-	-	0.00	
2172907	364.30	0.10	9.20	0.92	0.08	
2185728	366.40	0.10	9.20	0.92	0.07	
2181289	365.70	0.10	9.20	0.92	0.07	
2044749	342.80	0.20	10.10	2.02	0.13	
2038428	341.70	0.20	10.10	2.02	0.13	
1912422	320.60	0.30	10.90	3.27	0.19	
1912542	320.60	0.30	10.90	3.27	0.19	
1911332	320.40	0.30	10.90	3.27	0.19	
1721591	288.60	0.50	12.00	6.00	0.27	
1714520	287.40	0.50	12.00	6.00	0.27	
1726905	289.50	0.50	12.00	6.00	0.27	
1374242	230.40	1.00	14.00	14.00	0.42	
1367191	229.20	1.00	14.00	14.00	0.42	
1372952	230.20	1.00	14.00	14.00	0.42	
1188971	199.30	1.50	15.20	22.80	0.49	
1214732	203.60	1.50	15.20	22.80	0.48	
1235021	207.00	1.50	15.20	22.80	0.48	

Date:	11/30/95
Subject:	C2Cl3F3 Removal from air
Cathode diameter:	0.3 mm
Anode diameter and length:	38 mm x 280 mm
Number of cathodes:	5 cathodes
Gas flow rate:	N2 40.1 cc/min
	O2 20.1 cc/min [20.1%]
	C2Cl3F3 39.8 cc/min [400 ppm]
	Total 100.0 cc/min
Temperature:	14.0 c
Inlet concentration (Cin):	394.28 ppm

GC	Cout	I	V	P	Eff
2299133	398.80	0.00	-	-	0.00
2251258	390.50	0.00	-	-	0.00
2243590	389.20	0.00	-	-	0.00
2298195	398.60	0.00	-	-	0.00
2195250	380.80	0.10	9.20	0.92	0.03
2210147	383.40	0.10	9.20	0.92	0.03
2214751	384.20	0.10	9.20	0.92	0.03
2127014	369.00	0.20	9.30	1.86	0.06
2129641	369.40	0.20	9.30	1.86	0.06
2118883	367.50	0.20	9.30	1.86	0.07
2018536	350.10	0.30	9.60	2.88	0.11
1968788	341.50	0.30	9.60	2.88	0.13
2027136	351.60	0.30	9.60	2.88	0.11
1870474	324.50	0.50	9.90	4.95	0.18
1896533	329.00	0.50	9.90	4.95	0.17
1510126	261.90	1.00	10.80	10.80	0.34
1594941	276.70	1.00	10.80	10.80	0.30
1601894	277.90	1.00	10.80	10.80	0.30

Date:	5/9/96				
Subject:	CH ₃ CHO Removal from air				
Cathode diameter:	0.3 mm				
Anode diameter and length:	38 mm x 280 mm				
Number of cathodes:	1 cathode				
Gas flow rate:	N ₂	141.3	cc/min		
	O ₂	60.0	cc/min	[20%]	
	CH ₃ CHO	98.7	cc/min	[100 ppm]	
	Total	300.0	cc/min		
Temperature:	20.5	c			
Inlet concentration (C_{in}):	98.80	ppm			

GC	C _{out}	I	V	P	Eff
301380	98.70	0.00	-	-	0.00
301167	98.60	0.00	-	-	0.00
302521	99.10	0.00	-	-	0.00
148882	48.70	0.05	8.10	0.41	0.51
152722	50.00	0.05	8.10	0.41	0.49
150840	49.40	0.05	8.10	0.41	0.50
85800	28.10	0.10	8.70	0.87	0.72
80849	26.50	0.10	8.70	0.87	0.73
82790	27.10	0.10	8.70	0.87	0.73
29449	9.60	0.15	9.10	1.37	0.90
30828	10.10	0.15	9.10	1.37	0.90
31238	10.20	0.15	9.10	1.37	0.90
14788	4.80	0.20	9.60	1.92	0.95
13515	4.40	0.20	9.60	1.92	0.96
12176	4.00	0.20	9.60	1.92	0.96
0	0.00	0.30	10.30	3.09	1.00
0	0.00	0.50	11.50	5.75	1.00

Date:	6/5/96		
Subject:	CH ₃ CHO Removal from air		
Cathode diameter:	0.3 mm		
Anode diameter and length:	38 mm x 280 mm		
Number of cathodes:	5 cathodes		
Gas flow rate:	N ₂	141.3	cc/min
	O ₂	60.0	cc/min [20%]
	CH ₃ CHO	98.7	cc/min [100 ppm]
	Total	300.0	cc/min
Temperature:	23.0	c	
Inlet concentration (C_{in}):	98.80	ppm	

GC	C _{out}	I	V	P	Eff
301380	98.70	0.00	-	-	0.00
301167	98.60	0.00	-	-	0.00
302521	99.10	0.00	-	-	0.00
262451	85.90	0.05	6.70	0.34	0.13
259273	84.90	0.05	6.70	0.34	0.14
260338	85.20	0.05	6.70	0.34	0.14
174664	57.20	0.10	7.40	0.74	0.42
171278	56.10	0.10	7.40	0.74	0.43
165553	54.20	0.10	7.40	0.74	0.45
79508	26.00	0.15	8.00	1.20	0.74
73890	24.20	0.15	8.00	1.20	0.76
73403	24.00	0.15	8.00	1.20	0.76
35969	11.80	0.20	8.30	1.66	0.88
31598	10.30	0.20	8.30	1.66	0.90
33837	11.10	0.20	8.30	1.66	0.89
10304	3.40	0.30	8.70	2.61	0.97
8609	2.80	0.30	8.70	2.61	0.97
7970	2.60	0.30	8.70	2.61	0.97
0	0.00	0.50	9.30	4.65	1.00

APPENDIX E

ADDITIONAL FIGURES OF EFFECT OF CATHODE DIAMETER

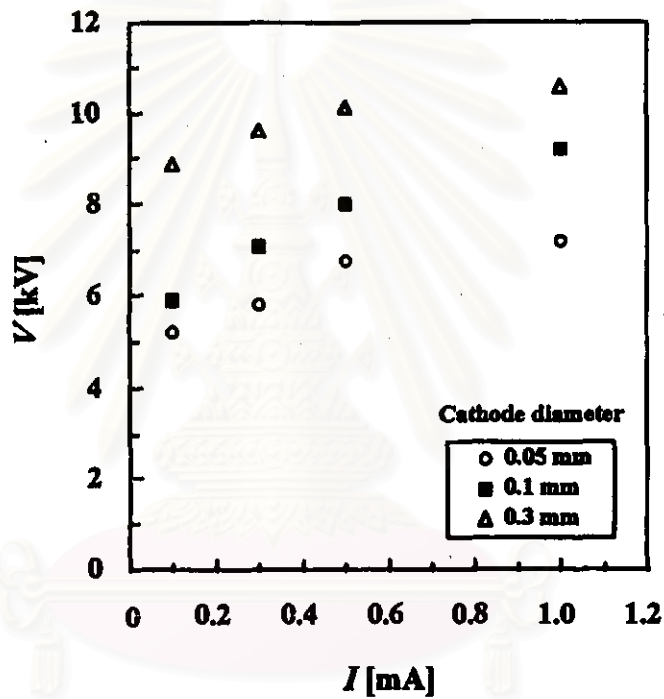


Figure E.1 Discharge current-voltage relationship for CH₃I removal from N₂; (anode diameter x length = 38 mm x 280 mm, C_{in} = 80 ppm, SV = 46.3 h⁻¹)

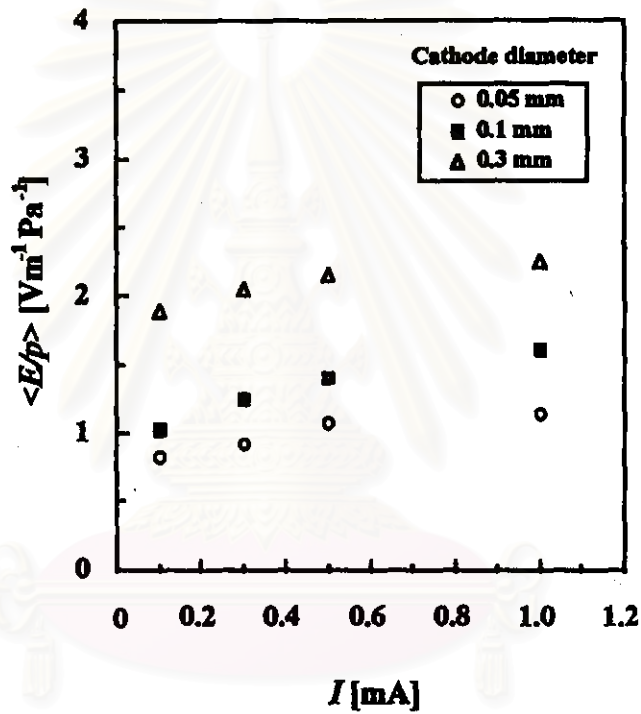


Figure E.2 Average electric field strength/pressure as a function of discharge current for CH_3I removal from N_2 ; (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

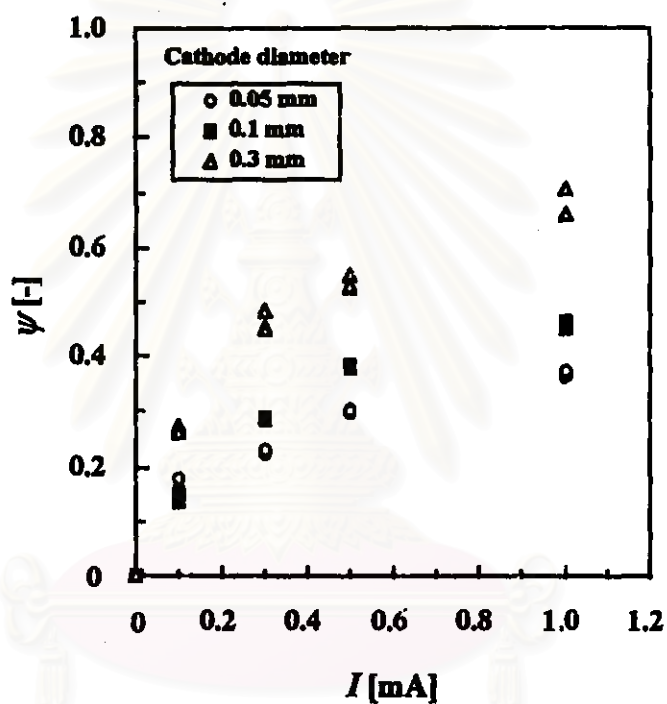


Figure E.3 Removal efficiency of CH_3I from N_2 as a function of discharge current; (anode diameter \times length = 38 mm \times 280 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

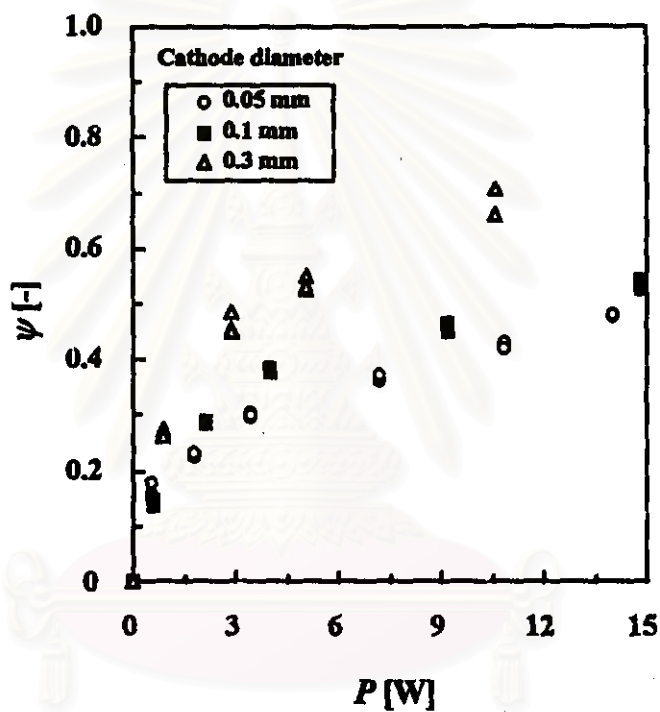


Figure E.4 Removal efficiency of CH_3I from N_2 as a function of electric power; (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

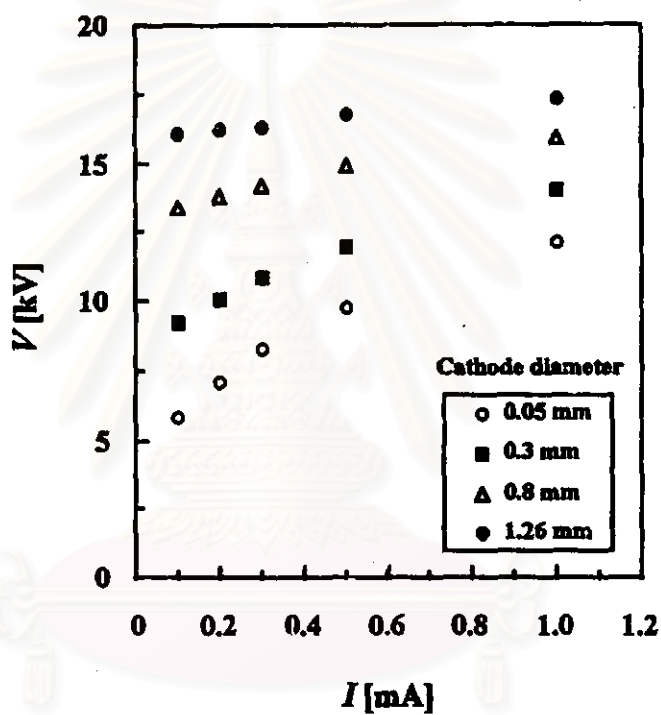


Figure E.5 Discharge current-voltage relationship for $C_2Cl_3F_3$ removal from air (20% O_2); (anode diameter x length = 38 mm x 280 mm, C_{in} = 400 ppm, $SV = 18.9 h^{-1}$)

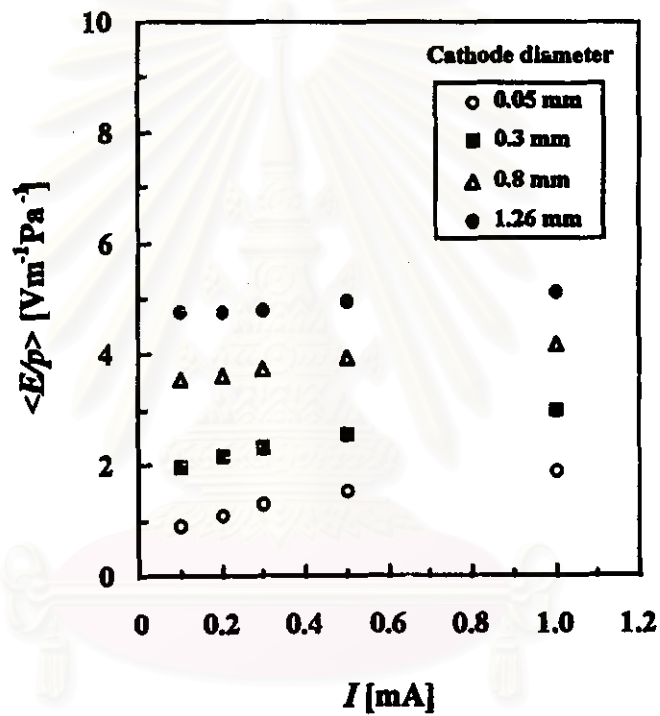


Figure E.6 Average electric field strength/pressure as a function of discharge current for $\text{C}_2\text{Cl}_3\text{F}_3$ removal from air (20% O_2); (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 400$ ppm, $SV = 18.9 \text{ h}^{-1}$)

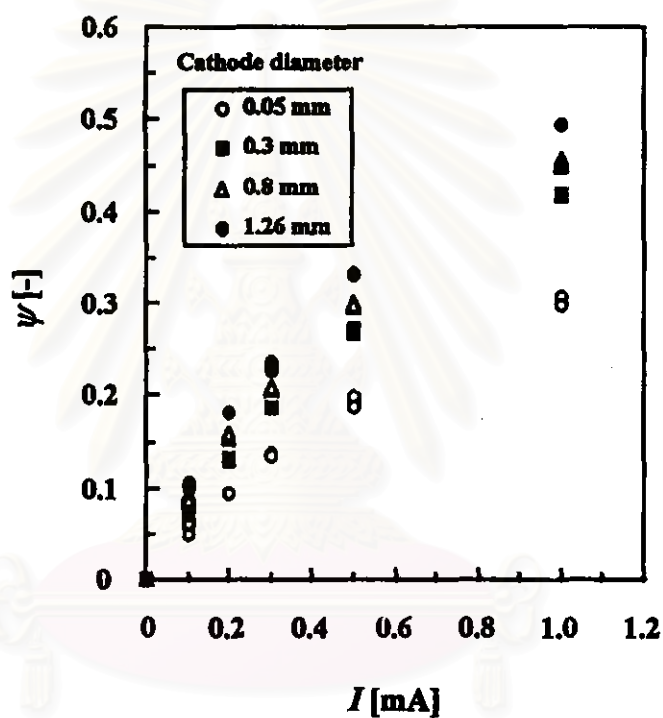


Figure E.7 Removal efficiency of $C_2Cl_3F_3$ from air (20% O_2) as a function of discharge current; (anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9$ h $^{-1}$)

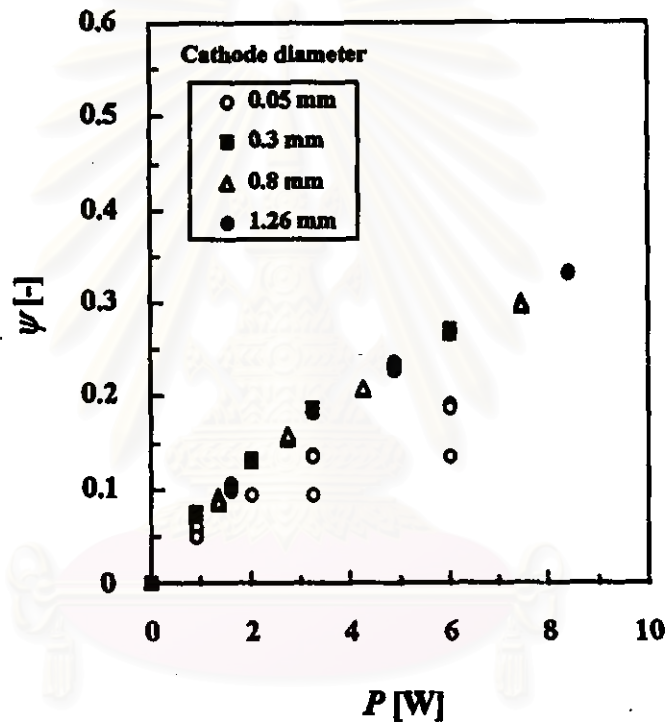


Figure E.8 Removal efficiency of $C_2Cl_3F_3$ from air (20% O_2) as a function of electric power; (anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9$ h $^{-1}$)

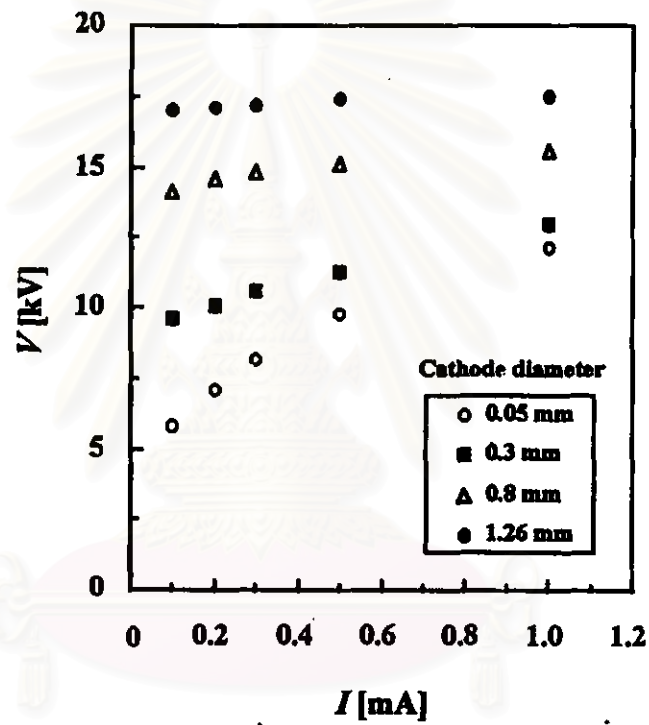


Figure E.9 Discharge current-voltage relationship for $C_2Cl_3F_3$ removal from N_2 ; (anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9$ h⁻¹)

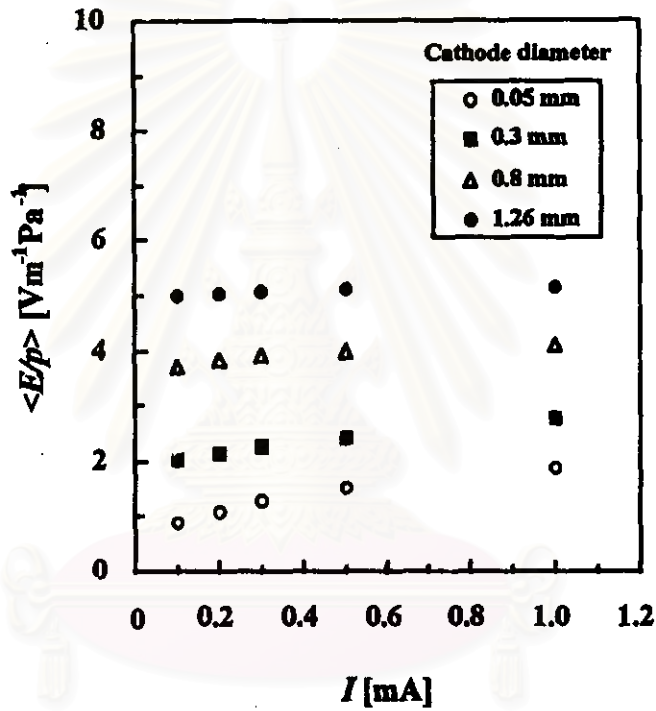


Figure E.10 Average electric field strength/pressure as a function of discharge current for $C_2Cl_3F_3$ removal from N_2 ; (anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9$ h⁻¹)

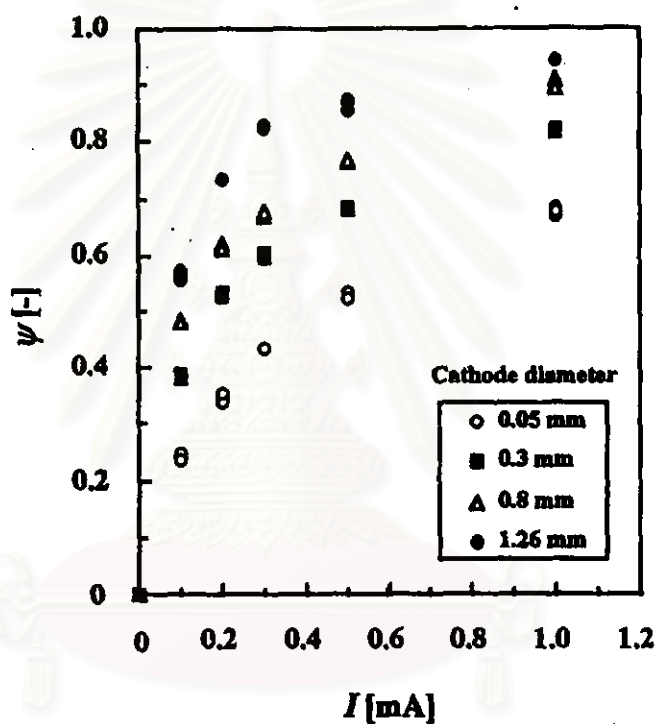


Figure E.11 Removal efficiency of $C_2Cl_3F_3$ from N_2 as a function of discharge current; (anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9$ h⁻¹)

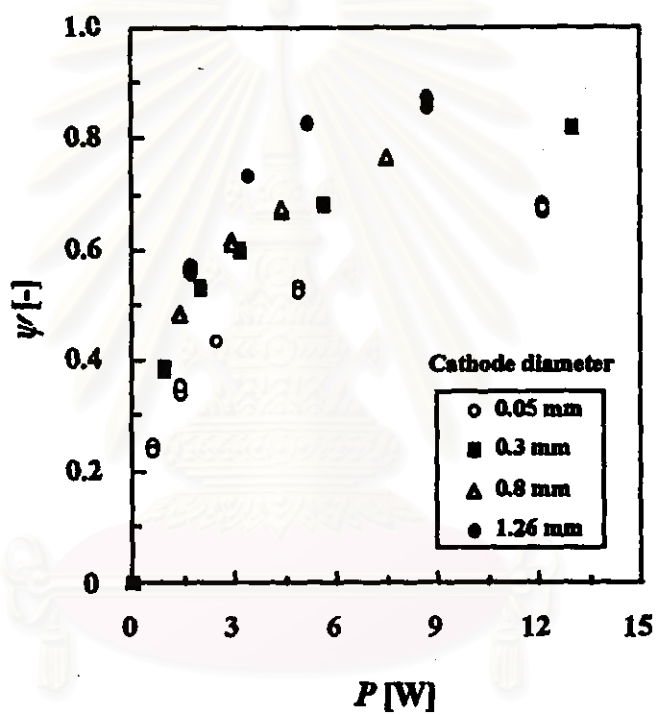


Figure E.12 Removal efficiency of $C_2Cl_3F_3$ from N_2 as a function of electric power; (anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9$ h⁻¹)

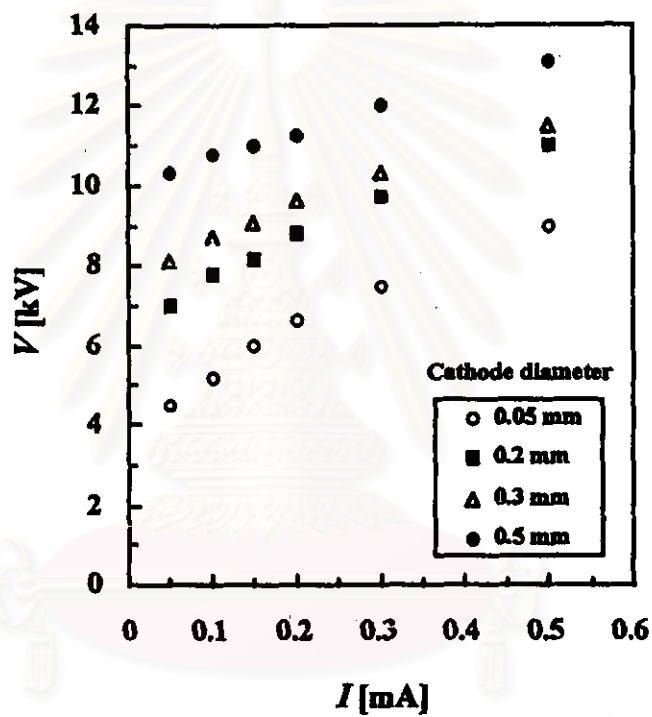


Figure E.13 Discharge current-voltage relationship for CH_3CHO removal from air (20% O_2); (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

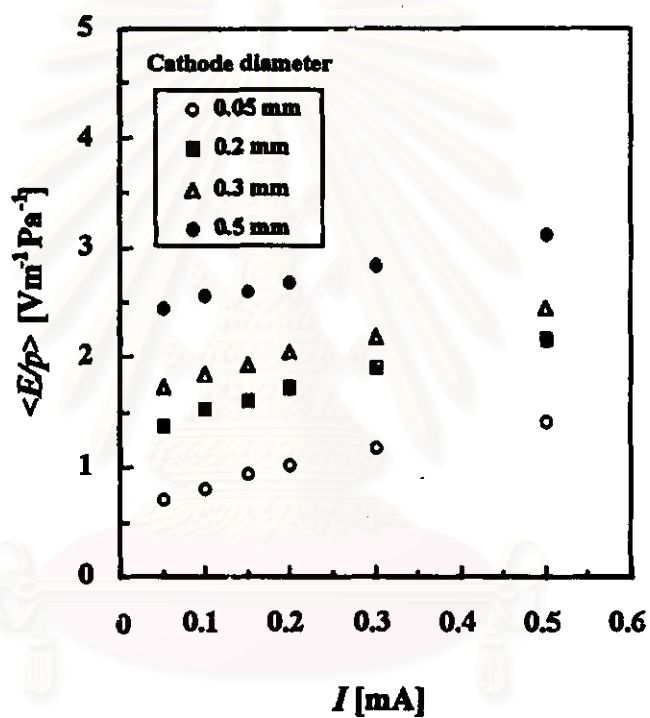


Figure E.14 Average electric field strength/pressure as a function of discharge current for CH_3CHO removal from air (20% O_2); (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

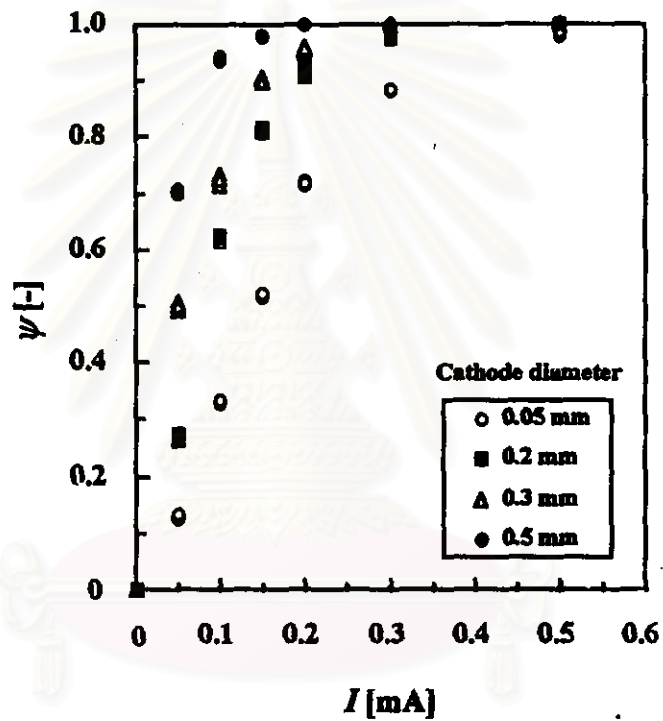


Figure E.15 Removal efficiency of CH_3CHO from air (20% O_2) as a function of discharge current; (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

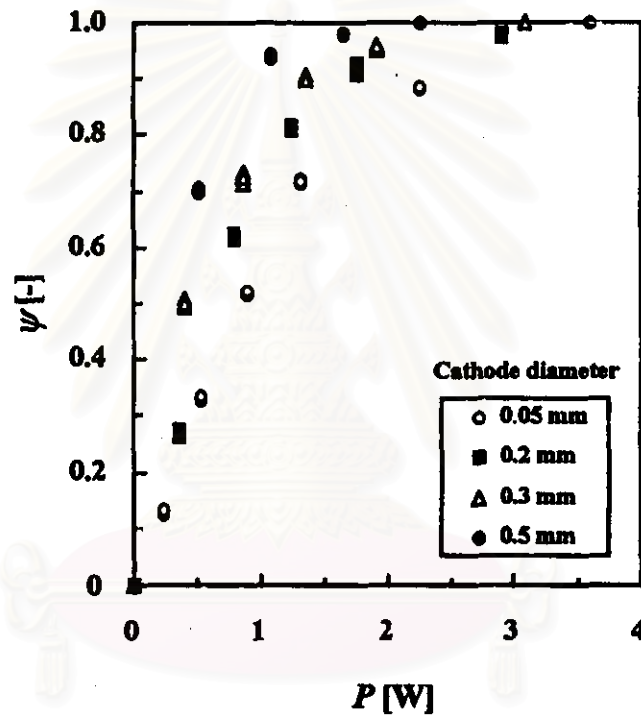


Figure E.16 Removal efficiency of CH_3CHO from air (20% O_2) as a function of electric power; (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

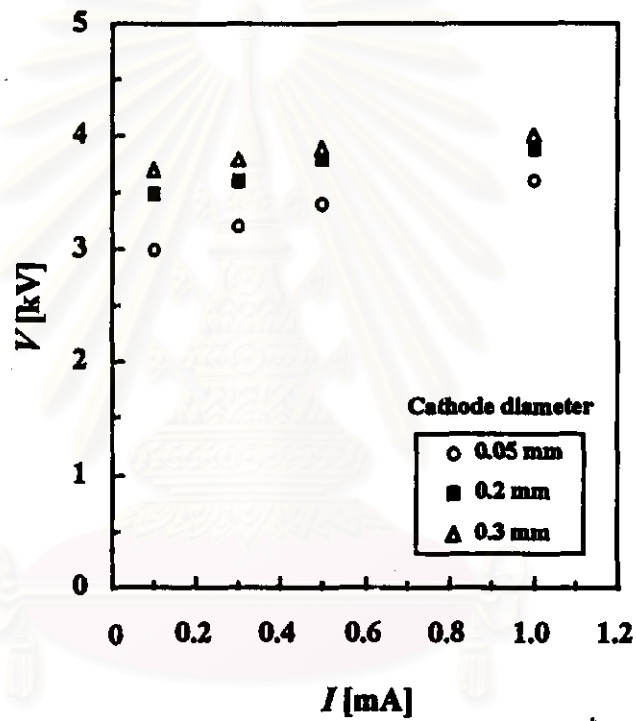


Figure E.17 Discharge current-voltage relationship for CH_3CHO removal from N_2 ; (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

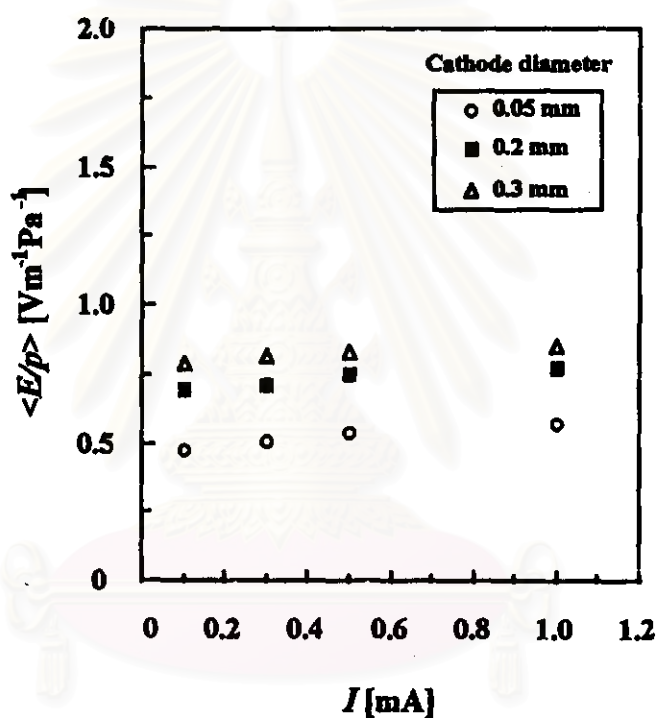


Figure E.18 Average electric field strength/pressure as a function of discharge current for CH_3CHO removal from N_2 ; (anode diameter x length = 38 mm x 280 mm, $C_{in} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

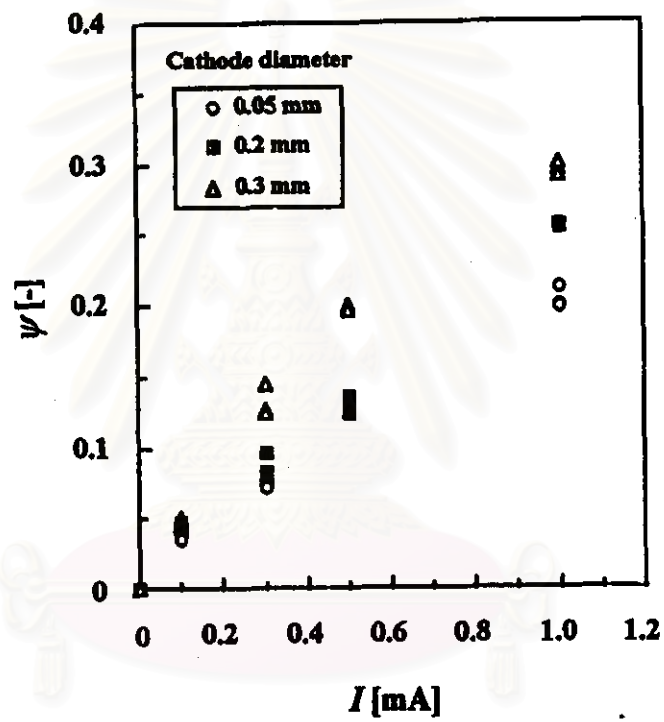


Figure E.19 Removal efficiency of CH_3CHO from N_2 as a function of discharge current; (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

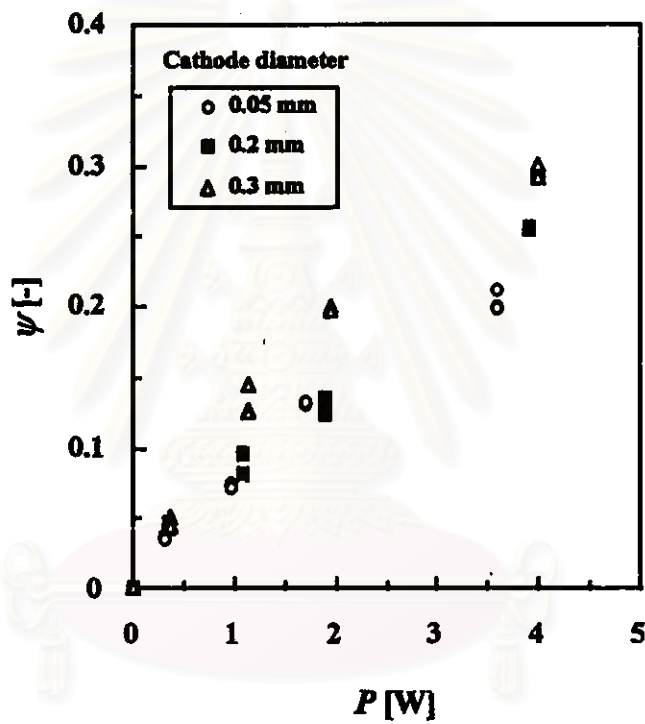


Figure E.20 Removal efficiency of CH_3CHO from N_2 as a function of electric power; (anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 100 \text{ ppm}$, $SV = 56.7 \text{ h}^{-1}$)

APPENDIX F

ADDITIONAL FIGURES OF EFFECT OF ANODE DIMENSIONS

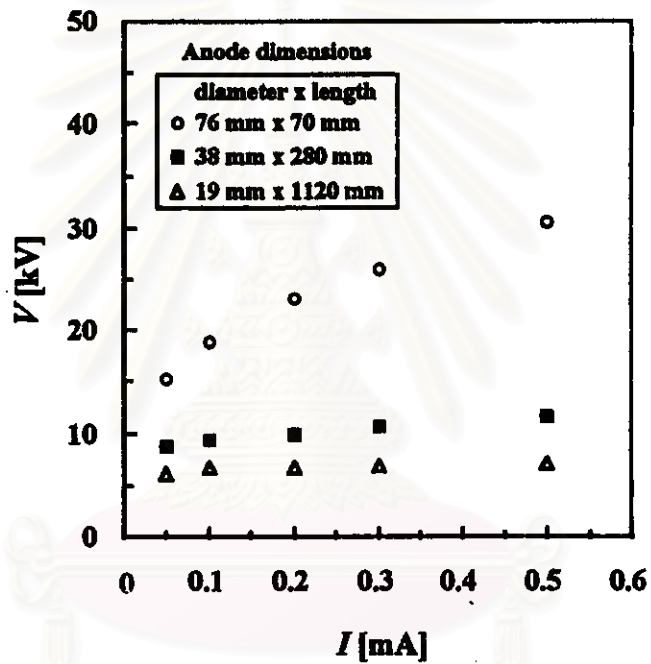


Figure F.1 Discharge current-voltage relationship for CH_3I removal from air (20% O_2); (cathode diameter = 0.3 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

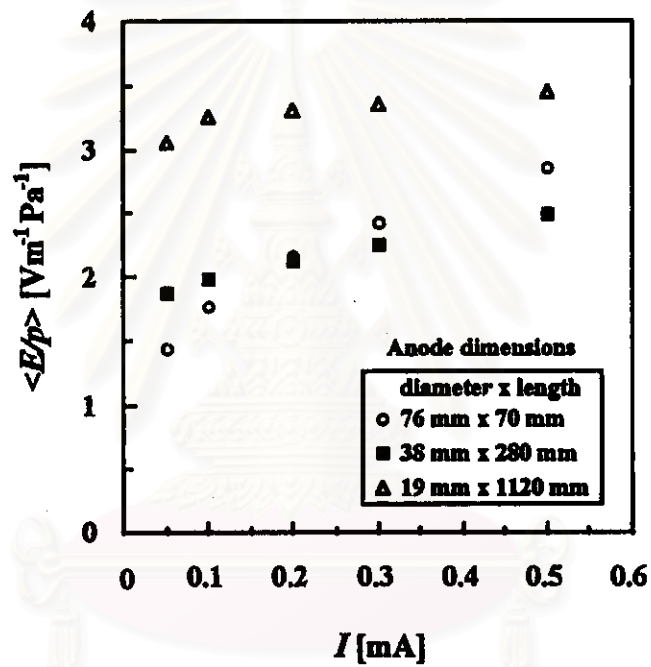


Figure F.2 Average electric field strength/pressure as a function of discharge current for CH_3I removal from air (20% O_2); (cathode diameter = 0.3 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3$ h⁻¹)

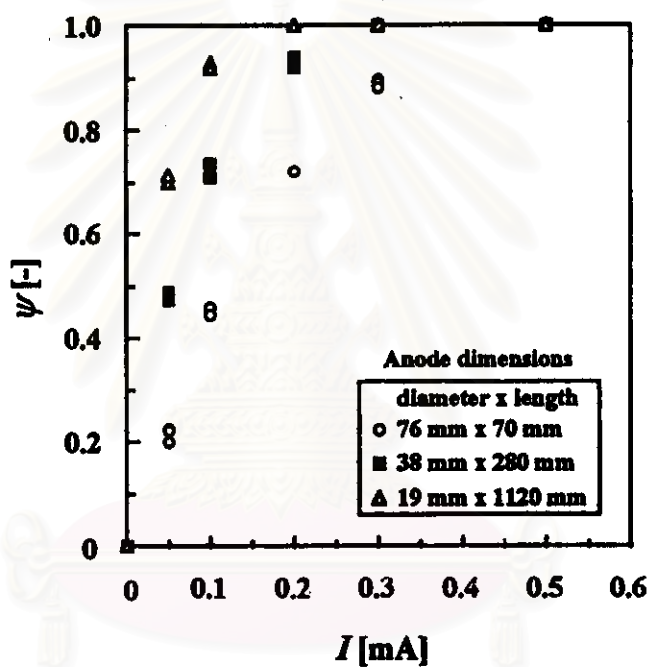


Figure F.3 Removal efficiency of CH_3I from air (20% O_2) as a function of discharge current; (cathode diameter = 0.3 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

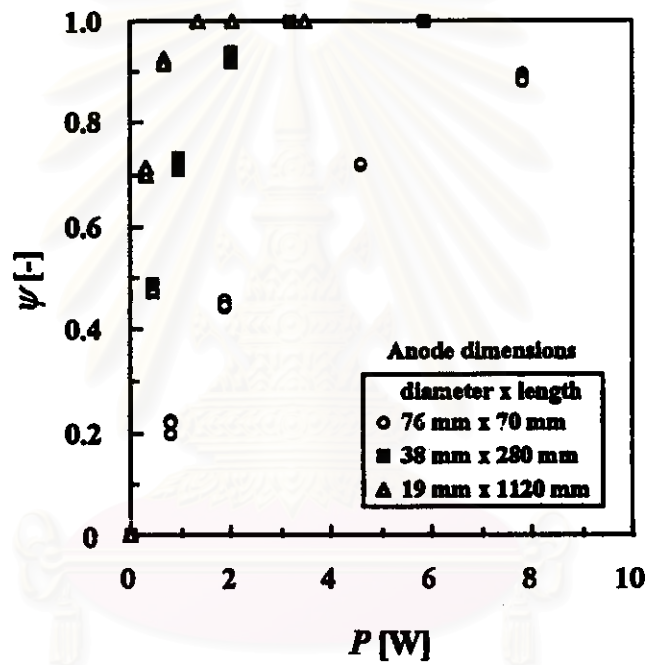


Figure F.4 Removal efficiency of CH_3I from air (20% O_2) as a function of electric power; (cathode diameter = 0.3 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

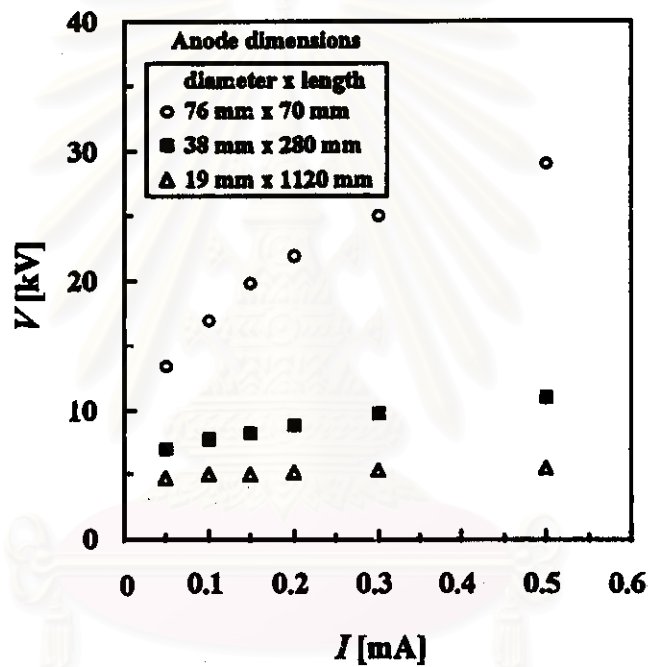


Figure F.5 Discharge current-voltage relationship for CH_3CHO removal from air (20% O_2); (cathode diameter = 0.2 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

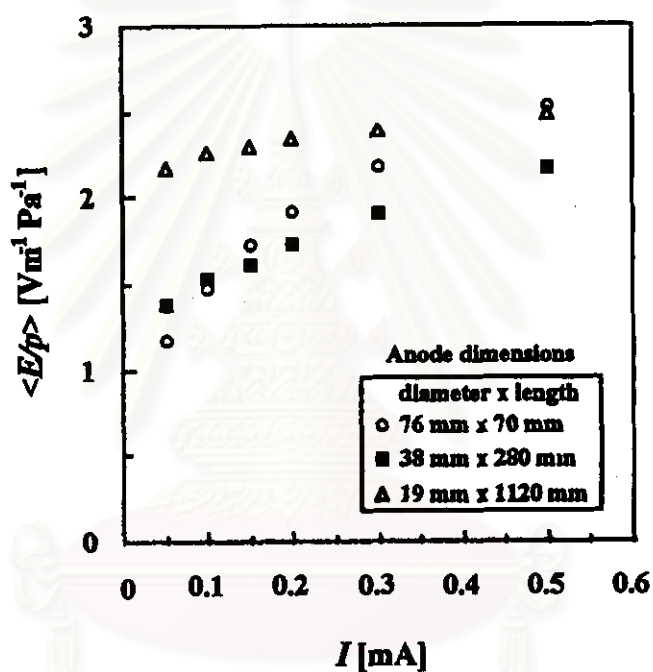


Figure F.6 Average electric field strength/pressure as a function of discharge current for CH₃CHO removal from air (20% O₂); (cathode diameter = 0.2 mm, C_{in} = 100 ppm, SV = 56.7 h⁻¹)

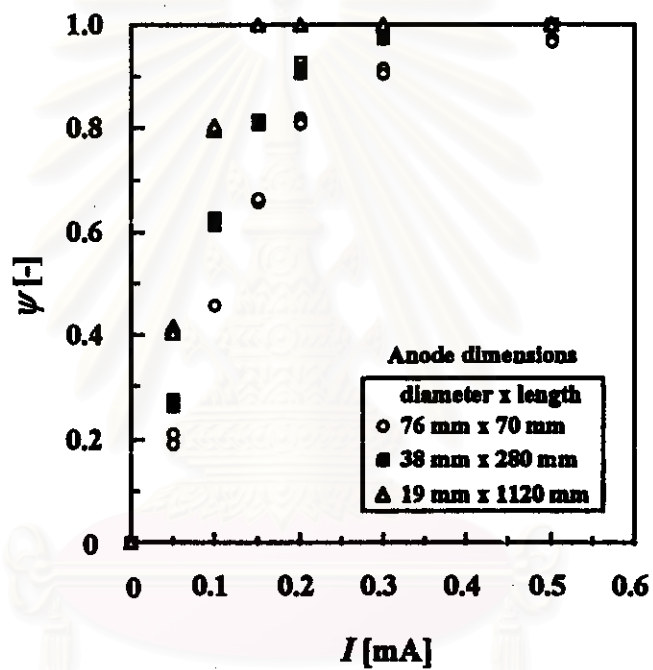


Figure F.7 Removal efficiency of CH_3CHO from air (20% O_2) as a function of discharge current; (cathode diameter = 0.2 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

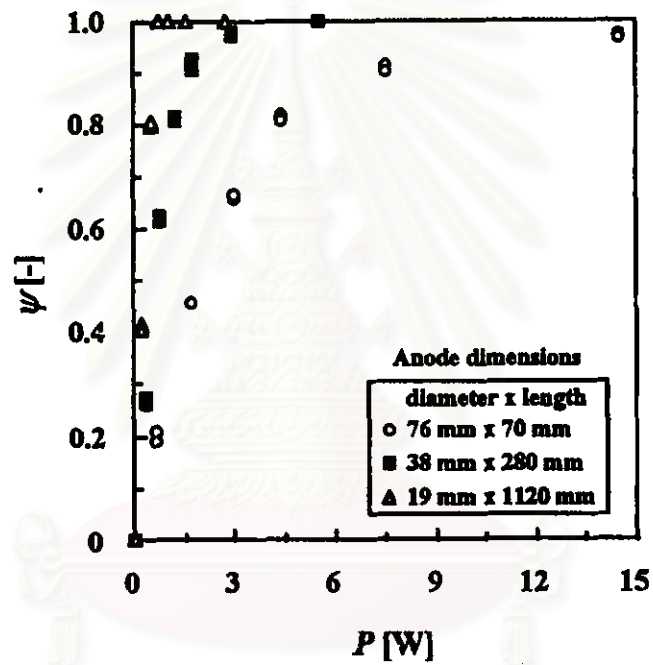


Figure F.8 Removal efficiency of CH_3CHO from air (20% O_2) as a function of electric power; (cathode diameter = 0.2 mm, $C_{\text{in}} = 100$ ppm, $SV = 56.7 \text{ h}^{-1}$)

APPENDIX G

ADDITIONAL FIGURES OF EFFECT OF NUMBER OF CATHODES

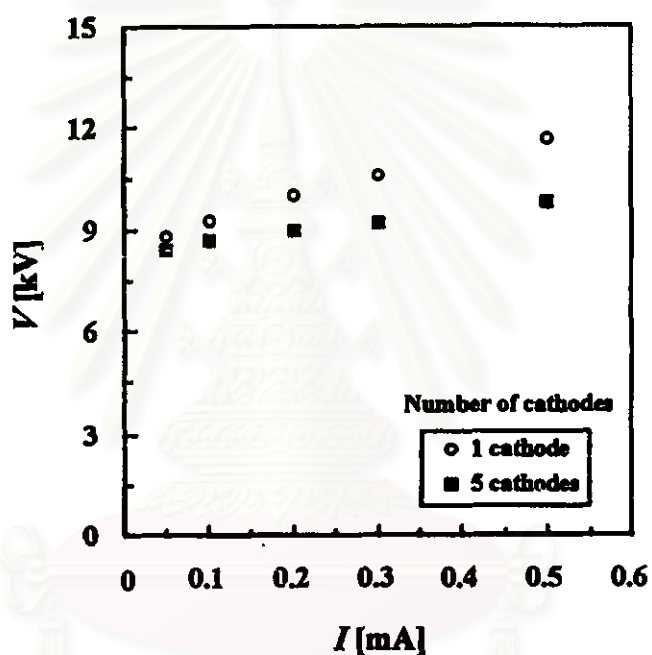


Figure G.1 Discharge current-voltage relationship for CH_3I removal from air (20% O_2); (cathode diameter = 0.3 mm, anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

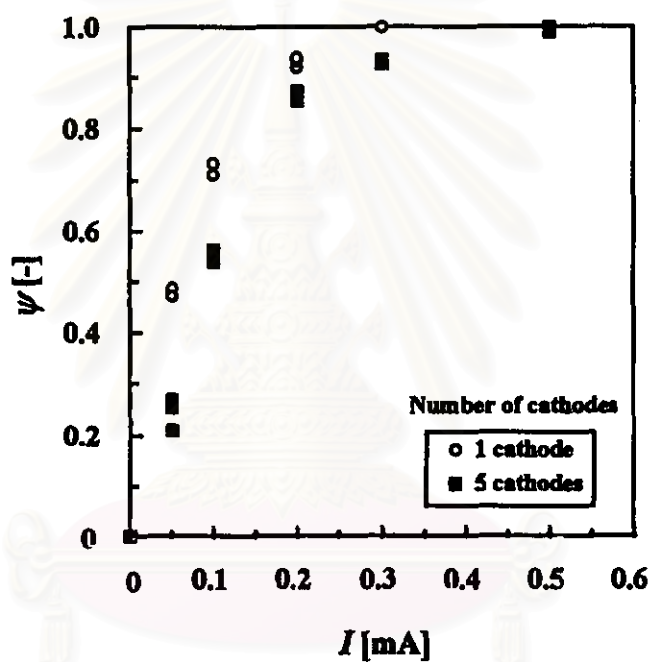


Figure G.2 Removal efficiency of CH_3I from air (20% O_2) as a function of discharge current; (cathode diameter = 0.3 mm, anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

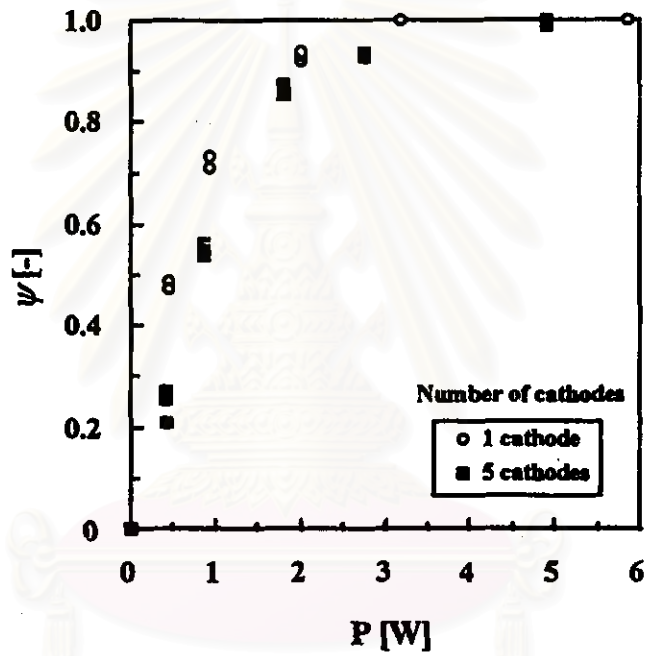


Figure G.3 Removal efficiency of CH_3I from air (20% O_2) as a function of electric power; (cathode diameter = 0.3 mm, anode diameter x length = 38 mm x 280 mm, $C_{\text{in}} = 80$ ppm, $SV = 46.3 \text{ h}^{-1}$)

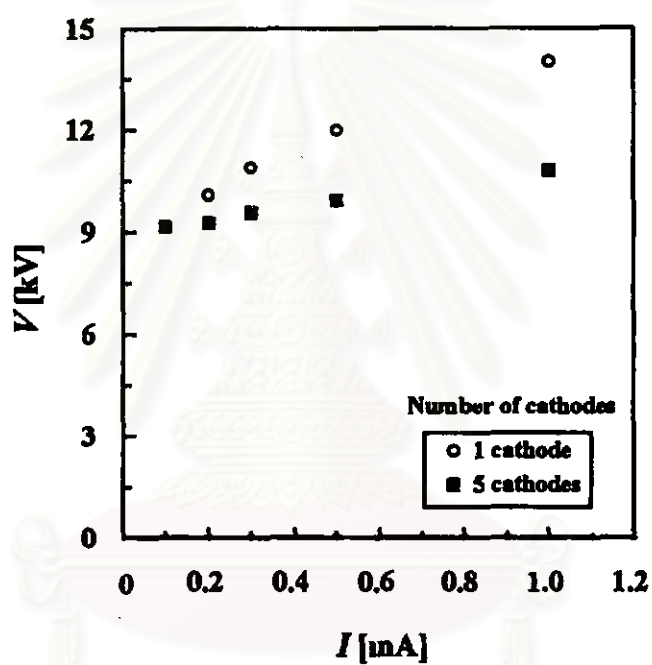


Figure G.4 Discharge current-voltage relationship for $C_2Cl_3E_3$ removal from air (20% O_2); (cathode diameter = 0.3 mm, anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9$ h⁻¹)

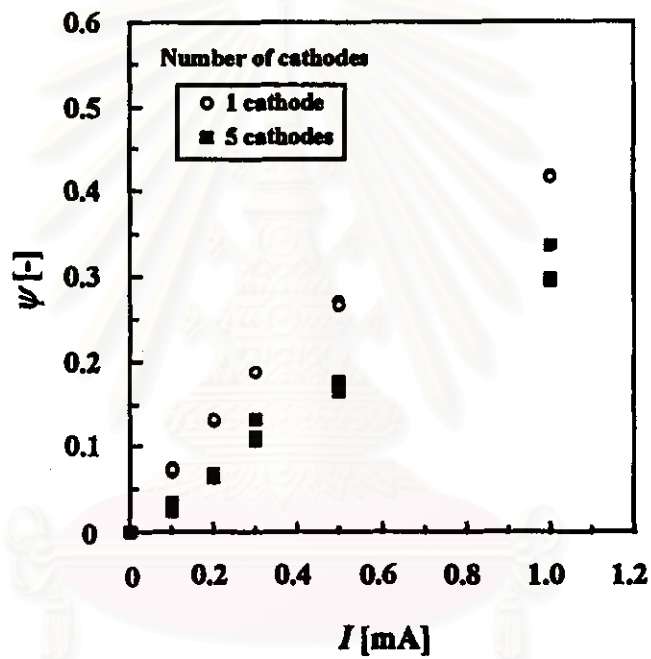


Figure G.5 Removal efficiency of $\text{C}_2\text{Cl}_3\text{F}_3$ from air (20% O_2) as a function of discharge current; (cathode diameter = 0.3 mm, anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9 \text{ h}^{-1}$)

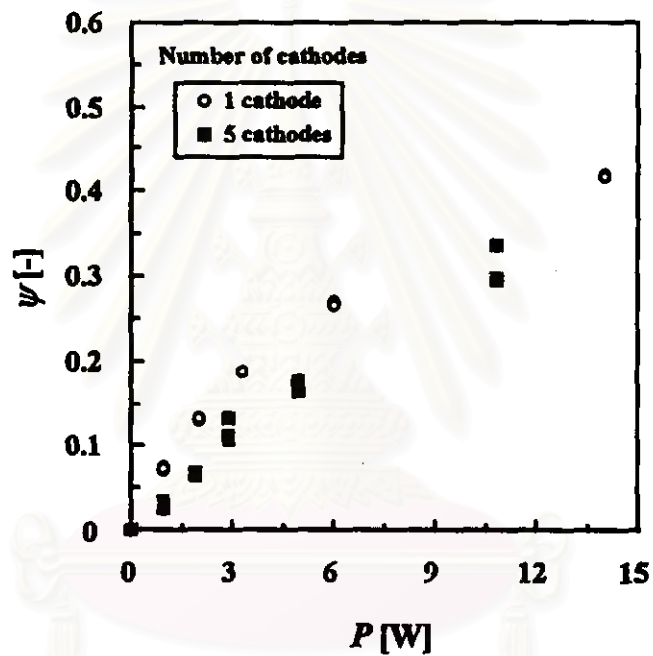


Figure G.6 Removal efficiency of $C_2Cl_3F_3$ from air (20% O_2) as a function of electric power; (cathode diameter = 0.3 mm, anode diameter x length = 38 mm x 280 mm, $C_{in} = 400$ ppm, $SV = 18.9$ h⁻¹)

VITA

Mr. Kittisak Larpsuriyakul was born in Bangkok, Thailand, on February 9, 1970, the first son of Sa-nga and Benjaporn Larpsuriyakul. He entered Wat Suthiwararam School in 1982. After completing his high-school study in March, 1988, he entered Chulalongkorn University, Bangkok, in June, 1988. After earning the degree of Bachelor of Engineering in Petroleum Engineering in 1991, he gained admission to the Graduate School of Chulalongkorn University in June, 1994. He was supported one-year scholarship from October, 1995 to September, 1996, under an Exchange Program sponsored by The Association of International Education Japan to carry out research work in Prof. Morio Okazaki's Lab, Department of Chemical Engineering, Kyoto University, Japan. In October, 1997, he was awarded the degree of Master of Engineering in Chemical Engineering.

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