NTEGRATION OF ALKALINE CHEMISORPTION AND PHOTOSYNTHESIS FOR CARBON DIOXIDE FIXATION

潘忠政、余世宗

E-mail: 9122504@mail.dyu.edu.tw

ABSTRACT

THE GLOBAL WARMING HAS BECOME AN INTERNATIONAL ISSUE. THE CHANGING CLIMATE DUE TO THE GLOBAL WARMING DEGRADES LIFE QUALITY OF PEOPLE, BUT ALSO CAUSE DAMAGE TO PROPERTIES. THE EMISSION OF CO2 PRODUCED BY THE COMBUSTION OF FOSSIL FUEL HAS BEEN CONSIDERED AS THE MAIN SOURCE FOR THE GLOBAL WARMING. IT IS IMPERATIVE FOR US TO TAKE STEPS TO REDUCE THE IMPACT OF THE EMISSION OF CO2. THE ADVANTAGE OF MICROBIAL FIXATION OF CARBON DIOXIDE IS THE UTILIZATION OF SOLAR ENERGY. HOWEVER, LIMITATIONS SUCH AS GAS-LIQUID TRANSFER EFFICIENCY, PHOTO SHADING OCCUR IN ALL PHOTOBIOREACTORS FOR CARBON DIOXIDE FIXATION BY MICROALGAE OR PHOTOSYNTHETIC BACTERIA. THE INTEGRATION OF CHEMICAL ABSORPTION AND ALGAL CULTURE INTO A UNIT MAY BE A GOOD SOLUTION TO THE REMOVAL OF CARBON DIOXIDE FROM INDUSTRIAL WASTE GAS STREAMS BY TAKING ADVANTAGE OF THE HIGHER MASS-TRANSFER RATE OF CHEMICAL ABSORPTION AND THE UTILIZATION OF SOLAR ENERGY BY ALGAL OR PHOTOSYNTHETIC BACTERIA. HOWEVER, THE OPERATING CONDITIONS OF CHEMICAL ABSORPTION MAY CONFLICTS THE GROWTH CONDITION OF ALGAL CULTURE. FOR EXAMPLE, ALKALINE SOLUTION FROM ABSORPTION TOWER WILL INCREASE RAPIDLY THE PH VALUE OF ALGAL CULTURE WHICH WILL INHIBIT ALGAL GROWTH. THE PURPOSE OF THIS STUDY IS： 1.TO ANALYZE THE FEASIBILITY OF INTEGRATION OF ALKALINE ABSORPTION AND ALGAL CULTURE FOR THE FIXATION OF CARBON DIOXIDE. 2.TO EVALUATE THE EFFECT OF THE CONCENTRATION OF TOTAL INORGANIC CARBON ON THE ALGAL GROWTH. IN CHAPTER THREE, A CONTINUOUS PROCESS OF ALKALINE ABSORPTION AND ALGAL CULTURE IN SERIES FOR THE FIXATION OF CARBON DIOXIDE WAS PROPOSED. ALKALINE SOLUTION CONTAINING SOME AMOUNT OF NAOH IS DESIGNED TO ABSORB CARBON DIOXIDE. SO THAT, PH OF LIQUID OUT COULD BE 8 OR SO. THE AVERAGE SPECIFIC GROWTH RATES OF BATCH CULTIVATION OF TETRASELMIS CHUI IN BUBBLE COLUMN PHOTOBIOREACTOR WERE 0.0105 H-1 UNDER AIR AND 0.0078 H-1 UNDER AIR TREATED WITH NAOH AQUEOUS SOLUTION. WITH THE SAME INITIAL CONCENTRATION OF NA2CO3, THE AVERAGE SPECIFIC GROWTH RATE OF CONTINUOUS CULTIVATION OF TETRASELMIS CHUI IN STIRRED PHOTOBIOREACTOR WERE 0.0334 H-1（LIGHT INTENSITY OF 12800 LUX）, 0.0207 H-1（LIGHT INTENSITY OF 19000 LUX）, 0.0779 H-1（LIGHT INTENSITY OF 26200 LUX）. UNDER LIGHT INTENSITY OF 12800 LUX, THE SPECIFIC GROWTH RATES OF CONTINUOUS CULTIVATION OF TETRASELMIS CHUI WERE 0.0334, 0.0250, 0.0240 AND 0.0556 H-1 CORRESPONDING WITH THE NA2CO3 FEEDING CONCENTRATIONS OF 0.02, 0.20, 1.00 AND 2.00 G/L RESPECTIVELY. UNDER LIGHT INTENSITY OF 19000 LUX, THE SPECIFIC GROWTH RATES OF CONTINUOUS CULTIVATION OF TETRASELMIS CHUI WERE 0.0207, 0.0317, 0.0200 AND 0.0407 H-1 CORRESPONDING WITH THE NA2CO3 FEEDING CONCENTRATIONS OF 0.02, 0.20, 1.00 AND 2.00 G/L RESPECTIVELY. UNDER LIGHT INTENSITY OF 26200 LUX, THE SPECIFIC GROWTH RATES OF CONTINUOUS CULTIVATION OF TETRASELMIS CHUI WERE 0.0779, 0.0419, 0.0846 AND 0.0385 H-1 CORRESPONDING WITH THE NA2CO3 FEEDING CONCENTRATIONS OF 0.02, 0.20, 1.00 AND 2.00 G/L RESPECTIVELY.

Keywords : GAS ABSORPTION TOWER；PHOTOBIOREACTOR；CARBON DIOXIDE；MICROALGAL ；PHOTOSYNTHETIC BACTERIA.

Table of Contents

REFERENCES

1.「我國因應聯合國氣候變化綱要公約之溫室氣體排放量規劃」，行政院環境保護署空品質保證及噪音管制處，1998。 2.陳衍昌，「藻類與酸雨」，海洋大學水產養殖系，HTTP://IND.NTOU.EDU.TW/~B0232/ACIDRAIN.HTML。 3.「全球暖化將使泥炭土中二氧化碳大舉釋出加劇溫室效應」HTTP://MEMBERS.TRIPODASIA.COM.TW/A590116/HOT/01_10.HTM。 4.「ENVIRONMENTAL SCIENCE/SIXTH EDITION」/G.TYLER MILLER, JR. , PAGES 510. 5.徐谷，「電源開發與二氧化碳排放」，溫室效應與能源開發，第33-45頁，1998。 6.馬小康等，「國內CO2溫室效應現況之研究」，第六章1-14頁，1998。 7.陳茂松，「二氧化碳回收及其處理技術」，臺電工程月刊，第527期，第54-59頁，1992。 8.葉安晉，「混合醇胺溶液（MEA/AMP）去除二氧化碳氣體之填充式吸收塔設計」，第十六屆空氣污染控制技術研討會論文集，1999。 9.朱信、邱崇銘、許家豪、施育林，「以氨水溶液去除煙道中二氧化碳之反應動力研究」，，第十七屆空氣污染控制技術研討會論文集，2000。 10.CHEN, MAO-SUNG，「A NEW PCF POWER PLANT WITH O2/CO2 COMBUSTION PROCESS FOR CO2 RECOVERY」，臺電工程月刊，第548期，1994.4。 11.林俊成、李國忠，「森林資源碳吸收效果與京都議定書」，台大森林學研究所，1999。 12.CHEN, MAO-SUNG，「OVERVIEW ON THE COUNTERMEASURING TECHNIQUES FOR CARBON DIOXIDE IN JAPAN'S POWER COMPANY」，臺電工程月刊，第562期，1995.6。 13.顧洋、何淑珠，「以紫外線/二氧化鈦光還原程序回收二氧化碳反應行為之研究」，第十四屆空氣污染控制技術研討會論文集，1997。 14.陳重修，「二氧化碳及二氧化硫整合性控制技術之研究」，碩士論文，國立臺灣大學環境工程研究所，2000。 15.王進琦，「基礎微生物學」，第217-241頁，1986。 16.MERCHUK J. C., RONEN M., GIRIS S., ARAD SHOSHANA (MALIS), 1998, " LIGHT/DARK CYCLES IN THE GROWTH OF THE RED MICROALGA PORPHYRIDIUM SP.", BIOTECHNOLOGY AND BIOENGINEERING VOLUME: 59, PAGES: 705-713 BIOTECHNOLOGY AND BIOENGINEERING VOLUME: 62, PAGES: 71-86. 17.TSYGANKOV A. A., LAURINAVICHENE T. V., 1996, " INFLUENCE OF THE DEGREE AND MODE OF LIGHT LIMITATION ON GROWTH CHARACTERISTICS OF THE RHODOBACTER CAPSULATUS CONTINUOUS CULTURES ", BIOTECHNOLOGY AND BIOENGINEERING VOLUME : 51, PAGES: 605-612. 18.HANS, C. P. MATTHIJS, HANS BALKE, UDO M. VAN HES, BERND M. A. KROON KROON, LUUC R. MUR, ROGER A. BINOT, 1996, " APPLICATION OF LIGHT-EMITTING DIODES IN BIOREACTORS: FLASHING LIGHT EFFECTS AND ENERGY ECONOMY IN ALGAL CULTURE (CHLORELLA PYRENOIDOSA) " , BIOTECHNOLOGY AND BIOENGINEERING VOLUME: 50, PAGES: 98-107. 19.林安秋，「作物之光合作用」，第141-145頁，1991。 20.CLAIR N. SAWYER，PERRY L. MCCARTY，GENE F. PARKIN，「CHEMISTRY FOR ENVIRONMENTAL ENGINEERING，4/E」，PAGES: 485-506. 21.MAZZUCA SOBCZUK T. GARC, CAMACHO F., CAMACHO RUBIO F., ACI FERNDEZ F. G., MOLINA GRIMA E., 2000, " CARBON DIOXIDE UPTAKE EFFICIENCY BY OUTDOOR MICROALGAL CULTURES IN TUBULAR AIRLIFT PHOTOBIOREACTORS ", BIOTECHNOLOGY AND BIOENGINEERING VOLUME: 67, PAGES: 465-475. 22.葉育材，「光合作用 ― 植物生產力的生理基礎 」，第189-206頁，1979。 23.梅鎮安、孫琦、容壽榆編著，「光合作用」，淑馨出版社、北京大學出版社合作出版，第99-102頁，1991。 24.邱承美譯，「基礎生物化學」，第362頁，1987。 25.BOROWITZKA MA. , 1996, " CLOSED ALGAL PHOTOBIOREACTORS : DESIGN CONSIDERATIOND FOR LARGE-SCALE SYSTEMS. ", J.MAR BIOTECHNOL VOLUME : 4,PAGES 185-191. 26.王敏盈，「培養藻類於新型光化學生物反應器以進行二氧化碳之固定」，中興大學農業生物科技研究所，國科會/環保署環保科技合作研究計劃，NSC88-EPA-Z-005-004（空污費精簡報告），1999。 27.張志強，「光合菌在光生物反應器

產氫之研究」，碩士論文，國立中央大學化學工程研究所，2000。 28.ACIEN FERNDEZ F. G., SCHEZ PEZ J. A., FERNDEZ SEVILLA J. M., GARC CAMACHO F., MOLINA GRIMA E, 2000, " MODELING OF EICOSAPENTAENOIC ACID (EPA) PRODUCTION FROM PHAEODACTYLUM TRICORNUTUM CULTURES IN TUBULAR PHOTOBIOREACTORS. EFFECTS OF DILUTION RATE, TUBE DIAMETER, AND SOLAR IRRADIANCE " BIOTECHNOLOGY AND BIOENGINEERING VOLUME: 68, PAGES: 173-183. 29.MORITA MASAHIKO, WATANABE YOSHITOMO, SAIKI HIROSHI ,2000," INVESTIGATION OF PHOTOBIOREACTOR DESIGN FOR ENHANCING THE PHOTOSYNTHETIC PRODUCTIVITY OF MICROALGAE " BIOTECHNOLOGY AND BIOENGINEERING VOLUME: 69, PAGES: 693-698. 30.BORODIN V. B., TSYGANKOV A. A., RAO K. K., HALL D. O., 2000, " HYDROGEN PRODUCTION BY ANABAENA VARIABILIS PK84 UNDER SIMULATED OUTDOOR CONDITIONS " BIOTECHNOLOGY AND BIOENGINEERING VOLUME: 69, PAGES: 478-485. 31.YOHITOMO WATANABE ET AL., 「DEVELOPMENT OF A PHOTOBIOREACTOR INCORPORATING CHLORELLA SP. FOR REMOVAL OF CO2 IN STACK GAS」，ENERGY CONVERS. MGMT VOL.38: 4,PAGES S499-S503，1997。 32.陳龍英，「物理學（下）」，三民書局，，第29-31頁，1990。 33.CLAUS FLEISCHER., STEFAN BECKER., GERHART EIGENBERGER.,1996, " DETAILED MODELING OF THE CHEMISORPTION OF CO2 INTO NAOH IN A BUBBLE COLUMN ", CHEMICAL ENGINEERING SCIENCE VOLUME : 51, NO. 10 , PAGES: 1715-1724 34.工業污染防治技術手冊，「廢氣濕式處理」，經濟部工業局，1995.6。 35.黃榮茂等，「化學化工百科辭典」，第182-183頁，曉園出版社，1992。 36.呂誌翼、白淑玲、張富龍、陳啟祥，「利用二氧化碳藻類的研究與其應用」，溫室效應與能源開發，第94-108頁，中華生質能源學會，（1997）. 37.陳俊興，「利用海洋微藻生產Ω-3族系之多元不飽和酯肪酸」，碩士論文，私立大葉大學食品工程研究所，1996。 38.TSYGANKOV A. A., BORODIN V. B., RAO K. K., HALL D. O, 1999," H2 PHOTOPRODUCTION BY BATCH CULTURE OF ANABAENA VARIABILIS ATCC 29413 AND ITS MUTANT PK84 IN A PHOTOBIOREACTOR " BIOTECHNOLOGY AND BIOENGINEERING VOLUME: 64, PAGES: 709-715 39.CAMACHO RUBIO F., ACIEN FERNDEZ F. G., SCHEZ PEZ J. A., GARC CAMACHO F., E. MOLINA GRIMA, 1999, " PREDICTION OF DISSOLVED OXYGEN AND CARBON DIOXIDE CONCENTRATION PROFILES IN TUBULAR PHOTOBIOREACTORS FOR MICROALGAL CULTURE 40.KURANO, N., IKEMOTO, H., MIYASHITA, H, HASEGAWA, T. HATA, H., AND MIYACHI, S. , 1995, "FIXATION AND UTILIZATION OF CARBON DIOXIDE BY MICROALGAL PHOTOSYNTHESIS"；ENERGY CONVERS. MGMT VOL. 36, NO.6-9, PP.689-692,1995. 41.YOSHITOMO WATANABE AND DAVID O. HALL, 1996,"PHOTOSYNTHETIC CO2 FIXATION TECHNOLOGIES USING A HELICAL TUBULAR BIOREACTOR INCORPORATING THE FILAMENTOUS CYANOBACTERIUM SPIRULINA PLATENSIS" ENERGY CONVERS. MGMT VOL. 36, NO. 6-9, PP. 721-724, 1995. 42.E. MOLINA GRIMA, F.G. ACIEN FERNANDEZ, F. GARCIA CAMACHO, YUSUF CHISTI, " PHOTOBIOREACTORS: LIGHT REGIME ,MASS TRANSFER, AND SCALEUP" JOURNAL OF BIOTECHNOLOGY 70 PP. 231-247,1999. 43.F. GARCIA CAMACHO, E. MOLINA GRIMA, F.G. ACIEN FERNANDEZ, " USE OF CONCENTRIC-TUBE AIRLIFT PHOTOBIOREACTORS FOR MICROALGAL OUTDOOR MASS CULTURES" ENZYME AND MICROBIAL TECHNOLOGY 24: PP. 164-172,1999. 44.SATOSHI HIRATA, MASAO HAYASHITANI, MASAHITO TAYA, AND SETSUJI TONE, "CARBON DIOXIDE FIXATION IN BATCH CULTURE OF CHLORELLA SP. USING A PHOTOBIOREACTOR WITH A SUNLIGHT-COLLECTION DEVICE",JOURNAL OF FERMENTATION AND BIOENGINEERING VOL. 81, NO.5 ,470-472, 1996. 45.JAMES C. OGBONNA, HIROKAZU YADA, AND HIDEO TANAKA, " KINETIC STUDY ON LIGHT-LIMITED BATCH CULTIVATION OF PHOTOSYNTHETIC CELLS", JOURNAL OF FERMENTATION AND BIOENGINEERING VOL. 80 ,NO.3,256-264,1995. 46.KATHRYN G. ZEILER,DANA A. HEACOX, SUSAN Y. TOON, "THE USE OF MICROALGAE FOR ASSIMILATION AND UTILIZATION OF CARBON DIOXIDE FROM FOSSIL FUEL-FIRED POWER PLANT FLUE GAS" ,ENERGY CONVERS. MGMT VOL.36 , NO.6-9 , PP. 707-712, 1995. 47.PAITOON TONTIWA CHWUTHIKUL, ADISORN AROONWILAS" MECHANISTIC MODEL FOR PREDICTION OF STRUCTURED PACKING MASS TRANSFER PERFORMANCE IN CO2 ABSORPTION WITH CHEMICAL REACTIONS.",CHEMICAL ENGINEERING SCIENCE 55, PP.3651-3663,2000. 48.CHRISTIE J. GEANKOPLIS, 「TRANSPORT PROCESSES AND UNIT OPERATIONS, 2/E」, PAGES:572-621.