ENHANCEMENTS OF VOC REMOVAL BY A SURFACTANT CONTAINING ATOMIZED MIST SYSTEM

陳世彬、林啟文

E-mail: 9018995@mail.dyu.edu.tw

ABSTRACT

THE OBJECTIVE OF THE STUDY IS TO PERFORM LABORATORY SCALE RESEARCH ON THE FACTORS CONTROLLING VOC REMOVAL BY A GEOMETRICALLY IDEALIZED ATOMIZED MIST SCRUBBER TO DETERMINE THE EFFECTIVENESS OF CONVENTIONAL SCRUBBING VIA AQUEOUS SOLUTION IN REMOVING VOCS, AND TO CONDUCT INVESTIGATION OF USE OF SURFACTANTS TO ENHANCE VOC CONTROL. THE TARGET COMPOUNDS OF THE VOCS INCLUDE N-OCTANE, N-HEXANE, TOLUENE, METHANOL, AND MTBE. SURFACTANTS OF SDS AND TRITON X-100 ARE ADDED IN THE SCRUBBING SOLUTION. RESULTS FROM EXPERIMENTS INDICATE THAT: (1) REMOVALS OF TARGET COMPOUNDS OF N-OCTANE INCREASE IN THE RANGE OF 2.5-5.3 TIMES, WITH THE ADDITION OF SDS. IN CONTRAST, REMOVALS OF TOLUENE AND METHANOL ARE NOT ENHANCED BY THE ADDITION OF SURFACTANTS. (2) REMOVALS FOR N-OCTANE HAS ALSO BEEN ENHANCED BY THE FACTORS RANGING FROM 1.5 TO 3.7 WITH THE ADDITION OF TRITON X-100. (3) REMOVING EFFICIENCIES OF N-OCTANE INCREASE 2 TIMES AND 1.8 TIMES WITH THE INCREASING OF LIQUID-TO-GAS FLOW RATIOS FROM 1/4,500 TO 1/465, AT BEST CONCENTRATION OF SDS AND TRITON X-100, RESPECTIVELY; IN A SIMILAR TEST CONDITION, REMOVALS OF METHANOL AND MTBE INCREASE 1.4-1.5 TIMES; HOWEVER, REMOVALS OF TOLUENE AND N-HEXANE ARE INSIGNIFICANT. (4) REMOVAL RATES OF VOCS ARE PROPORTIONAL INVERSELY TO THEIR INLET CONCENTRATIONS. (5) REMOVALS FOR N-OCTANE ARE REDUCED FROM 62% TO 55% IN A MIXED COMPOUND FEEDING CONDITION, COMPARED TO SINGLE COMPOUND FEEDING CONDITION. (6) REMOVAL RATES ARE INCREASED WITH THE INCREASES OF SCRUBBER LENGTH IN THE AXIAL DIRECTION. BASED UPON THE EXPERIMENTAL DATA FOR N-OCTANE REMOVALS, A PREDICTED MODEL IS DEVELOPED USING THE NON-REGRESSION ANALYSIS BY A STATISTIC SOFTWARE. THE PROPOSED MODEL EQUATION IS OBTAINED BY ASSUMING THAT REMOVAL EFFICIENCY(RE) IS RELATED TO CONCENTRATION OF SURFACTANT(S), LIQUID FLOW RATE(L), GAS FLOW RATE(G), AND INLET VOC CONCENTRATION(V). FROM THE MODEL EQUATION OF , IT IS FOUND THAT REMOVING EFFICIENCY OF THE SCRUBBER IS PROPORTIONAL TO CONCENTRATION OF SURFACTANT AND LIQUID FLOW RATE BUT PROPORTIONAL INVERSELY TO GAS FLOW RATE AND INLET VOC CONCENTRATION. THE REGRESSION MODEL EQUATION IS FURTHER EXAMINED BY THE FISHER'S F-TEST TO ASSESS ITS SIGNIFICANT LEVEL. STATISTIC RESULTS INDICATE THAT THE MODEL EQUATION IS MEANINGFUL, WITH P-VALUE OF 0.01. THEREFORE, THE PROPOSED MODEL MAY BE USED TO INVESTIGATE THE FACTORS CONTROLLING THE VOC REMOVAL, AND PROVIDED A USEFUL TOOL FOR DESIGNING THE FULL-SCALE ATOMIZED MIST SCRUBBER.

Keywords : N-OCTANE, SDS, TRITON X-100, ATOMIZED MIST SCRUBBER, REGRESSION MODEL

Table of Contents

REFERENCES

1.王鳳英(1998)，界面活性劑的原理與應用，高立圖書有限公司，五版三刷。 2.林振寰(2000)，「含汽油添加劑甲基第三丁基醚分解菌之研究」，大葉大學食品工程研究所碩士論 文。 3.黃小林、李慧梅(1999)，「界面活性劑對氣相多環芳香烴化合物增溶效應之研究」，第十六屆空氣 污染控制技術研討會論文專輯，PP.474-479。 4.黃惠淳(2000)，「B環糊精對十二烷基硫酸鈉臨界微胞濃度之影響:毛細管電泳法之研究」，國立 台灣大學化學工程研究所碩士論文。 5.陳重修(2000)，「二氧化碳與二氧化硫整合性控制技術之研究」，國立台灣大學環境工程研究所碩 士論文。 6.羅金翔(1996)，「霧粒中疏水性有機化合物溶解機制之研究」，國立台灣大學環境工程研究所博士 論文。 7.ALTSHULLER, A.P. AND COHEN, I.R., (1960), "APPLICATION OF DIFFUSION CELL TO THE PRODUC -TION OF KNOWN CONCENTRATIONS OF GASEOUS HYDROCARBONS," ANALYSIS CHEMISTRY, 32, PP.802 -810. 8.ANG, C.C. AND A.S. ABSUL, (1991), "AQUEOUS SURFACTANT WASHING OF RESIDUAL OIL CONTAMIN -ATION FROM SANDY SOIL," GROUND WATER MONITORING REVIEW, 11, PP.121-127. 9.CALVERT, S., (1970), "VENTURI AND OTHER ATOMIZING SCRUBBERS' EFFICIENCY AND PRESSURE DROP," AMERICAN INSTITUTE CHEMICAL ENGINEERING JOURNAL, 16, PP.392-402. 10.CAPEL, P.D., R. GUNDE, F. ZURCHER AND W. GIGER, (1990), "CARBON SPECIATION AND SURFACE TENSION OF FOG," ENVIRONMENTAL SCIENCE AND TECHNOLOGY, 24, PP.722-727. 11.CAPEL, P.D., C. LEUENBERGER AND W. GIGER, (1991), "HYDROPHOBIC ORGANIC CHEMICALS IN URB -AN FOG," ATMOSPHERIC ENVIRONMENT, 25A(7), PP.1335-1346. 12.CARD, T.R., (1989), "VOLATILE ORGANIC COMPOUNDS REMOVAL IN PACKED TOWERS AND ATOMIZED MIST ODOR SCRUBBING SYSTEMS," SAN FRANCISCO, CA, USA. 13.CORSI, R.L., D.P-Y CHANG, AND B.E. LAROCK, (1988), "A NUMERICAL SOLUTION FOR MASS TRAN -SPORT IN MEMBRANE-BASED DIFFUSION SCRUBBERS," ENVIRONMENTAL SCIENCE AND TECHNOLOGY, 22 (4), PP.561-565. 14.CRAWFORD, M., (1976), AIR POLLUTION CONTROL THEORY, SAN FRANCISCO, MCGRAW-HILL. 15.EILLIS, W.D. AND PAYNE J.R.(1984), "DEVELOPMENT OF CHEMICAL COUNTERMEASURES FOR HAZARD -OUS WASTE CONTAMINATE SOIL," HAZARDOUS MATERIALS SPILLS CONFERENCE, CINCINNATI, PP.116 -124. 16.GILL, P.S., T.E. GRAEDEL AND C.J. WESCHLER, (1983), "ORGANIC FILMS ON ATOMSPHERIC AERO -SOL PARTICLES, FOG DROPLETS, CLOUD DROPLETS, RAIN DROPS AND SNOW FLAKES," J. REV. GEO -PHYS. SPACE PHYS., 21, PP.903-920. 17.GLOTFELTY, D.E., J.N. SEIBER AND L.A. LILIJEDAHL, (1987), "PESTICIDES IN FOG," NATURE, 325(12), PP.602-605. 18.GLOTFLTY, D.E., M.S. MAJEWSKI, AND J.N. SEUBER, (1990), "DISTRIBUTION OF SEVERAL ORGAN -OPHOSPHORUS INSECTICIDES AND THEIR OXYGEN ANALOGUES IN A FOGGY ATMOSPHERE," NATURE, 325(12), PP.602-605. 19.HENTZ, L.H., MURRAY C.M., THOMPSON, J.L., GASNER L.L., AND DUNSON, J.B., (1992) "ODOR CONTROL RESEARCH AT THE MONTGOMERY COUNTY REGIONAL COMPOSTING FACILITY," WATER ENVIRON -MENT RESEARCH, 64(13), PP.13-18. 20.HOLLAND, P.M. AND D.N. RUBINGH, (EDS.), (1992), MIXED SURFACTANT SYSTEMS, AMERICAN CHE -MICAL SOCIETY, WASHINGTON, DC, USA. 21.HOWELING S., F. DENTENER, J. LELIEVLD, (1998), "THE IMPACT OF NONMETHANE HYDROCARBON COMPOUNDS ON TROPOSPHERIC PHOTOCHEMISTRY," J. GEOPHY. RES., 103, PP.10673-10696. 22.INGHAM, D.B., (1975), "DIFFUSION OF AEROSOLS FROM A STREAM FLOWING THROUGH A CYLINDRIC -AL TUBE," JOURNAL OF AEROSOL SCIENCE, 6, PP.125-135. 23.JAYCOCK, M.J., PARFITT, G.D., (1986), CHEMISTRY OF INTERFACES, JOHN WILEY & SONS, NEW YORK, USA. 24.KAWAMURA, K. AND I.R. KAPLAN, (1984), "CAPILLARY GAS CHROMATOGRAPHY DETERMINATION OF VOLATILE ORGANIC ACIDS IN RAIN AND FOG SAMPLES," ANALYSIS CHEMISTRY, 56, PP.1616-1620. 25.KILE, D.E. AND CHIOU, C.T., (1990), "EFFECT OF SOME PETROLEUM SULFONATE SURFACTANTS ON THE APPARENT WATER SOLUBILITY OF ORGANIC COMPOUNDS," ENVIRONMENTAL SCIENCE AND TECHNOL -OGY, 24, PP.205-211. 26.LIN, C.W. AND P.Y. CHANG, (1995), "VOC REMOVAL EFFICIENCY BY ATOMIZED MIST SCRUBBING," PRESENTED AT THE 88TH ANNUAL MEETING OF THE AIR AND WASTE MANAGEMENT ASSOCIATION, SAN ANTONIO, USA. 27.LIN, C.W., (2000),"A COMPUTATIONAL MODEL OF THE PERFORMANCE ON AN IDEAL ATOMIZED MIST SCRUBBER," ADVANCES IN ENVIRONMENTAL RESEARCH, 3(4). 28.O'KEEFFE, A.E. AND ORTMAN, G.C., (1966), "PRIMARY STANDARD FOR TRACE GAS ANALYSIS," ANA -LYSIS CHEMISTRY, 38, PP.760-763. 29.OGINO, K. AND M. ABE, (1993), MIXED SURFACTANT SYSTEMS, MARCEL DEKKER, INC., NEW YORK, USA. 30.PATTERSON, R.G., R.C. JAIN, AND S. ROBINSON, (1984), "ODOR CONTROLS FOR SEWAGE TREATM -ENT FACILITIES," PRESENTED AT THE 77TH ANNUAL MEETING OF THE AIR POLLUTION CONTROL ASSOCIATION, SAN FRANCISCO, CALIFORNIA, USA. 31.PERONA, M.A., (1992), "THE SOLUBILITY OF HYDROPHOBIC COMPOUNDS IN AQUEOUS DROPLETS," ATMOSPHERIC ENVIRONMENT, 26A(14), PP.2549. 32.RADIAN CORP, (1978), "CONTROL TECHNIQUES FOR VOLATILE ORGANIC EMISSIONS FROM STATION -ARY SOURCE," USEPA, EPA-450.2-78-022, USA. 33.RAFSON, H.J., (1993), "RECENT DEVELOPMENTS IN REMOVAL OF HAZARDOUS AND TOXIC CHEMICALS USING MIST SCRUBBING TECHNOLOGY,"

PRESENTED AT THE 86TH ANNUAL MEETING OF THE AIR AND WASTE MANAGEMENT ASSOCIATION, DENVER, COLORADO, USA. 34.RAFSON, H.J., (1994),"VOC REMOVAL WITH UNIQUE MIST SCRUBBER," PRESENTED AT THE 87TH AN -NUAL MEETING OF THE AIR AND WASTE MANAGEMENT ASSOCIATION, CINCINNATI, OHIO, USA. 35.RESEARCH AND DEVELOPMENT STAFFS OF KAO CORPORATION, (1983), SURFACTANTS - A COMPREHEN -SIVE GUIDE, TOKYO, JAPAN. 36.SCAMEHORN, J.F. (EDS), (1986), PHENOMENA IN MIXED SURFACTANT SYSTEMS, AMERICAN CHEMIC -AL SOCIETY, WASHINGTON, DC, USA. 37.SCHWARZENBACH RENE P., PHILIP M. GSCHWEND, AND DIETER M.IMBODEN, (1993), ENVIRONMENTAL ORGANIC CHEMISTRY, WILEY. INTERSCIENCE, NEW YORK, USA. 38.SEINFELD, J.H., (1986), ATMOSPHERIC CHEMISTRY AND PHYSICS OF AIR POLLUTION, WILEY-INTE -RSCIENCE, NEW YORK, USA. 39.TAN, C.W., (1969), "DIFFUSION OF DISINTEGRATION PRODUCTS OF INERT GASES IN CYLINDRICAL TUBES," INTERNATIONAL JOURNAL OF HEAT AND MASS TRANSFER, 12, PP.471-478. 40.THOMPSON, J.L., C.M. MURRAY, AND D.K. GRIMES, (1995), "IMPROVING COMPOST ODOR SCRUBBING PERFORMANCE," BIOCYCLE, 36(2), PP.80. 41.VALSARAJ K.T., G.J. THOMA, D.D. REIBLE AND L.J. THIBODEAUX, (1993), "ON THE ENRICHMENT OF HYDROPHOBIC ORGANIC COMPOUNDS IN FOG DROPLETS," ATMOSPHERIC ENVIRONMENT, 27(A), PP. 203. 42.VALSARAJ K.T., (1994), "HYDROPHOBIC COMPOUNDS IN THE ENVIRONMENT ADSORPTION EQUILIBRIU -M AT THE AIR-WATER INTERFACE," WATER RESEARCH, 28(4), PP.819-830. 43.VAN DURME, G.P., B. MCNAMARA, AND C. MCGINLEY, (1992), "BENCH-SCALE REMOVAL OF ODOR AND VOLATILE ORGANIC COMPOUNDS AT A COMPOSTING FACILITY," WATER ENVIRONMENT RESEARCH, 64(1) , PP.19. 44.WITHERSPOON, J., M. WALLIS, S. SUZUKI, T. CARD, D. CHANG, AND B. SLENTER, (1998), "DOU -BLE DUTY FOR ODOR CONTROL," WATER ENVIRONMENT & TECHNOLOGY, 70(2), PP.47-52. 45.YOU, J.H., P.C. CHIANG, S.C. CHANG AND S.W. WU, (1996), "POLYCYCLIC AROMATIC HYDROCARB -ONS (PAHS) AND MUTAGENICITY IN AIR EMISSION FROM THE TWO-STAGE INCINERATION OF POLYST -YRENE WITH VARIOUS METALLIC SALT ADDITIVES," JOURNAL OF HAZARDOUS MATERIALS, 48, PP.69 -82.