

Adsorption and Adsorptive Separations: A Bibliographical Update (1992–1993)

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Abstract. This article provides a bibliographic listing of published journal papers concerned with adsorptive separations during 1992–1993. The references are taken from the 40 most important chemical engineering journals. This paper provides an update to the literature as provided in previous bibliographic papers [1, 2]. These previous papers also included membrane-type separations, however due to the number of papers and the diversity of membrane and associated processes, this material is to be published separately [3].

Other bibliographic papers covering the more traditional unit operations, e.g. distillation [4], and equilibrium-staged separations in general [5, 6] have been published. Liquid-liquid extraction [7] is the subject of a separate bibliography (for 1992–1993), due to the number of publications on this topic. A bibliography detailing supercritical extraction from 1980–1993 is also to be published separately due to the current interest in this relatively new technology [8]. A complete bibliography of the chemical engineering journal literature from 1967–1993 has been published by the author [9–12]. An earlier bibliography [13] provides access to the literature prior to 1967.

1.1 Theory

1992

- Al-Duri, B., Y. Khader, and G. McKay, "Prediction of binary component isotherms for adsorption on heterogeneous surfaces," *J. Chem. Technol. Biotechnol.*, **53**(4), 345–352 (1992).
- Al-Duri, B. and G. McKay, "Pore diffusion dependence of the effective diffusivity on the initial sorbate concentration in single and multisolute batch adsorption systems," *J. Chem. Technol. Biotechnol.*, **55**(3), 245–250 (1992).
- Binghui, W. and L. Shulin, "Investigation of polymer adsorption on to a metal surface by an optical method," *Adsorpt. Sci. Technol.*, **8**(3), 134–141 (1992).
- Bojan, M.J., R. van Slooten, and W. Steele, "Computer simulation studies of the storage of methane in microporous carbons," *Sep. Sci. Technol.*, **27**(14), 1837–1856 (1992).
- Ching, C.B., et al., "Comparative study of flow schemes for a simulated countercurrent adsorption separation process," *AIChE J.*, **38**(11), 1744–1750 (1992).
- Choudhary, V.R., V.S. Nayak, and A.S. Mamman, "Diffusion of straight- and branched-chain liquid compounds in H-ZSM-5 zeolite," *Ind. Eng. Chem. Res.*, **31**(2), 624–628 (1992).
- Costello, L.M. and W.J. Koros, "Temperature dependence of gas sorption and transport properties in polymers: Measurement and applications," *Ind. Eng. Chem. Res.*, **31**(12), 2708–2714 (1992).
- Deak, P. and A. Solyom, "Theoretical study of adsorption on a silica surface," *Period. Polytech. Chem. Eng.*, **34**(1), 121–126 (1992).
- Douss, N., "An experimental study of solid adsorption heat-pump cycles," *Int. Chem. Eng.*, **32**(4), 718–725 (1992).
- El-Halwagi, M.M. and B.K. Srinivas, "Synthesis of reactive mass-exchange networks," *Chem. Eng. Sci.*, **47**(8), 2113–2119 (1992).
- Filippov, L.K., "Adiabatic adsorption in fixed beds for quasi-linear isotherms," *Chem. Eng. Commun.*, **111**, 177–195 (1992).
- Filippov, L.K., "Coherent and incoherent frontal patterns for multi-component dynamics of adsorption: Analysis of frontal-pattern isothermal dynamics for convex mixture isotherms of adsorption," *Chem. Eng. Sci.*, **47**(5), 1199–1210 (1992).
- Filippov, L.K., "Coherent and incoherent frontal patterns for multi-component adsorption dynamics: Non-uniqueness of frontal patterns in the isothermal case for convex isotherms of two-component mixtures," *Chem. Eng. Sci.*, **47**(5), 1211–1218 (1992).
- Frey, D.D., "Mixed-gas adsorption dynamics of high-concentration components in a particulate bed," *AIChE J.*, **38**(10), 1649–1656 (1992).
- Frey, D.D., "Local equilibrium theory for the dynamics of non-isothermal mixed-gas adsorption of high-concentration components," *Chem. Eng. Commun.*, **117**, 143–162 (1992).
- Gusev, V.Y. and A.A. Fomkin, "Thermodynamics of high-pressure Tian-Calvet adsorption calorimetry and the heats of adsorption of Xe on Na-X zeolite over the temperature range 229–467 K," *Adsorpt. Sci. Technol.*, **8**(2), 75–85 (1992).
- Hassan, N.M., et al., "An isotherm model for adsorption of gases and vapours on heterogeneous adsorbents," *Gas Sep. Purif.*, **6**(4), 229–234 (1992).
- Helfferrich, F.G., "Langmuir's isotherm: Kinetics or thermodynamics?" *Chem. Eng. Educ.*, **26**(1), 23, 51 (1992).
- Hu, X. and D.D. Do, "Multicomponent adsorption kinetics of hydrocarbons onto activated carbon: Effect of adsorption equilibrium equations," *Chem. Eng. Sci.*, **47**(7), 1715–1726 (1992).
- Kaminsky, R.D. and P.A. Monson, "An analysis of the statistical model adsorption isotherm," *AIChE J.*, **38**(12), 1979–1989 (1992).
- Karavias, F. and A.L. Myers, "Molecular thermodynamics of ad-

- sorption from gas mixtures: Composition of adsorbed phase from gravimetric data," *Chem. Eng. Sci.*, **47**(6), 1441–1452 (1992).
- Koopman, D.C., J.V. Cole, and H.H. Lee, "Assumption of local equilibrium in adsorption processes," *AIChE J.*, **38**(4), 623–625 (1992).
- Liu, H., L. Zhang, and N.A. Seaton, "Determination of the connectivity of porous solids from nitrogen sorption measurements: Generalisation," *Chem. Eng. Sci.*, **47**(17), 4393–4404 (1992).
- Lu, Z., et al., "Effect of intraparticle forced convection on gas desorption from fixed beds containing "large-pore" adsorbents," *Ind. Eng. Chem. Res.*, **31**(6), 1530–1540 (1992).
- Lu, Z.P., et al., "Dynamics of pressurization and blowdown of an adiabatic adsorption bed: Intraparticle diffusion/convection models," *Gas Sep. Purif.*, **6**(2), 89–100 (1992).
- Matranga, K.R., et al., "Molecular simulation of adsorbed natural gas," *Sep. Sci. Technol.*, **27**(14), 1825–1836 (1992).
- Mayagoitia, V., et al., "Simulation of heterogeneous surfaces of adsorbents by Monte Carlo methods," *Gas Sep. Purif.*, **6**(1), 35–42 (1992).
- Myers, A.L., G. Belfort, and M. Suzuki, "Prediction of multicomponent adsorption-equilibrium: Discussions on energy of adsorption in relation to adsorption equilibrium," *Int. Chem. Eng.*, **32**(3), 585–590 (1992).
- Park, I. and K.S. Knaebel, "Adsorption breakthrough behavior: Unusual effects and possible causes," *AIChE J.*, **38**(5), 660–670 (1992).
- Preiss, H. and W. Kant, "Swelling and sorption of pyrolysed halogenated mesophase pitches," *Fuel*, **71**(6), 635–640 (1992).
- Reed, B.E. and S.K. Nonavinakere, "Metal adsorption by activated carbon: Effect of complexing ligands, competing adsorbates, ionic strength, and background electrolyte," *Sep. Sci. Technol.*, **27**(14), 1985–2000 (1992).
- Rodrigues, A.E., et al., "Influence of adsorption-desorption kinetics on the performance of chromatographic processes using large-pore supports," *Chem. Eng. Sci.*, **47**(17), 4405–4414 (1992).
- Rodrigues, M.I., et al., "Dynamic modelling, simulation and control of continuous adsorption recycle extraction," *Chem. Eng. Sci.*, **47**(1), 263–270 (1992).
- Rudisill, E.N. and M.D. LeVan, "Standard states for the adsorbed-solution theory," *Chem. Eng. Sci.*, **47**(5), 1239–1246 (1992).
- Sobolik, J.L., D.K. Ludlow, and W.L. Hessevick, "Parametric sensitivity comparison of the BET and Dubinin-Radushkevich models for determining char surface area by carbon dioxide adsorption," *Fuel*, **71**(10), 1195–1202 (1992).
- Sun, W. and C.A.V. Costa, "Fast method for solving nonequilibrium fixed-bed adsorption models with variable velocity and linear isotherm," *Comput. Chem. Eng.*, **16**(6), 535–544 (1992).
- Tsibranska, I., I. Penchev, and A. Assenov, "The effect of microparticle-size distribution on the adsorption with biporous zeolite pellets," *Chem. Eng. Sci.*, **47**(2), 479–483 (1992).
- Xiao, J. and J. Wei, "Diffusion mechanism of hydrocarbons in zeolites: Theory and analysis of experimental observations," *Chem. Eng. Sci.*, **47**(5), 1123–1160 (1992).
- Yao, C. and C. Tien, "Approximation of intraparticle mass transfer in adsorption processes: Linear and non-linear systems," *Chem. Eng. Sci.*, **47**(2), 457–474 (1992).
- reduction potential of porous and non-porous carbons," *Adsorpt. Sci. Technol.*, **9**(2), 84–91 (1993).
- Carta, G., "Exact solution and linear driving force approximation for cyclic mass transfer in a bidisperse sorbent," *Chem. Eng. Sci.*, **48**(9), 1613–1618 (1993).
- Chen, Y.D. and R.T. Yang, "Surface diffusion of multilayer adsorbed species," *AIChE J.*, **39**(4), 599–606 (1993).
- Chen, Y.D., R.T. Yang, and L.M. Sun, "Further work on predicting multicomponent diffusivities from pure-component diffusivities for surface diffusion and diffusion in zeolites," *Chem. Eng. Sci.*, **48**(15), 2815–2816 (1993).
- Ching, C.B., et al., "Experimental study of a simulated counter-current adsorption system: Effects of non-linear and interacting isotherms," *Chem. Eng. Sci.*, **48**(7), 1343–1351 (1993).
- Cooney, D.O., "Comparison of simple adsorber breakthrough curve method with exact solution," *AIChE J.*, **39**(2), 355–358 (1993).
- Davis, A.M.J. and C.R. Ethier, "Transport through materials bounded by porous surfaces," *Chem. Eng. Sci.*, **48**(9), 1655–1664 (1993).
- Do, D.D. and X. Hu, "An energy-distributed model for adsorption kinetics in large heterogeneous microporous particles," *Chem. Eng. Sci.*, **48**(11), 2119–2128 (1993).
- Filippov, L.K., "Study of adsorption on polymer by ellipsometry," *Chem. Eng. Sci.*, **48**(19), 3391–3398 (1993).
- Gilbert, S.W., "Linear algebraic solution for multicomponent adsorption on porous media," *AIChE J.*, **39**(3), 518–520 (1993).
- Golden, T.C. and R. Kumar, "Adsorption equilibrium and kinetics for multiple trace impurities in various gas streams on activated carbon," *Ind. Eng. Chem. Res.*, **32**(1), 159–165 (1993).
- Goto, M. and T. Hirose, "Approximate rate equation for intraparticle diffusion with or without reaction," *Chem. Eng. Sci.*, **48**(10), 1912–1915 (1993).
- Gouvalias, G.S. and N.C. Markatos, "Mathematical modeling of heat and mass transfer in packed-bed adsorbers/regenerators," *AIChE J.*, **39**(11), 1799–1809 (1993).
- Gutsche, R., "Concentration-dependent micropore diffusion analysed by measuring laboratory adsorber dynamics: Study of the adsorber flow behaviour and micropore diffusion mechanism," *Chem. Eng. Sci.*, **48**(21), 3723–3742 (1993).
- Harriott, G.M., "Memory-integral mass-transfer models for adsorption process simulation," *AIChE J.*, **39**(3), 422–433 (1993).
- Henning, K.D. and S. Schafer, "Impregnated activated carbon for environmental protection," *Gas Sep. Purif.*, **7**(4), 235–240 (1993).
- Hu, X. and D.D. Do, "Role of energy distribution in multicomponent sorption kinetics in bidispersed solids," *AIChE J.*, **39**(10), 1628–1640 (1993).
- Hu, X., G.N. Rao, and D.D. Do, "Effect of energy distribution on sorption kinetics in bidispersed particles," *AIChE J.*, **39**(2), 249–261 (1993).
- Jordi, R.G. and D.D. Do, "Analysis of the frequency response method for sorption kinetics in bidispersed structured sorbents," *Chem. Eng. Sci.*, **48**(6), 1103–1130 (1993).
- Kaguei, S. and N. Wakao, "Diffusion of adsorbate through slab adsorbents: Investigation of diffusion modes," *Chem. Eng. Sci.*, **48**(7), 1353–1356 (1993).
- Kikkinides, E.S. and R.T. Yang, "Effects of bed pressure drop on isothermal and adiabatic adsorber dynamics," *Chem. Eng. Sci.*, **48**(9), 1545–1556 (1993).
- Kikkinides, E.S. and R.T. Yang, "Further work on approximations for intraparticle diffusion rates in cyclic adsorption and desorption," *Chem. Eng. Sci.*, **48**(6), 1169–1173 (1993).
- Krishna, R., "A unified approach to the modelling of intraparticle

- diffusion in adsorption processes," *Gas Sep. Purif.*, **7**(2), 91–104 (1993).
- Lu, Z. and A.E. Rodrigues, "Intensification of sorption processes using "large-pore" materials," *Ind. Eng. Chem. Res.*, **32**(1), 230–235 (1993).
- Masthan, S.K., et al., "Derivation of the expanded form of the BJH equation and its application to the pore structure analysis of mesoporous adsorbents," *Adsorpt. Sci. Technol.*, **9**(4), 212–230 (1993).
- McKay, G., B. Al-Duri, and S. McKee, "Development of solutions to two-resistance mass transport models based on external and pore diffusion: Theoretical development and experimental results," *Dev. Chem. Eng. Mineral Process.*, **1**(2), 129–157 (1993).
- Ming, F. and J.A. Howell, "Parameter estimation for a column adsorption model incorporating axial dispersion: Application to a novel monolithic ion-exchange column," *Food Bioprod. Process.*, **71**(C4), 267–272 (1993).
- Moon, H. and C. Tien, "Further work on the prediction of gas-mixture adsorption equilibrium using the potential theory," *Sep. Technol.*, **3**(3), 161–167 (1993).
- Muralidhar, R. and J. Talbot, "Polydisperse mixture adsorption kinetics," *AIChE J.*, **39**(8), 1322–1329 (1993).
- Northrup, M.A., et al., "Direct measurement of interstitial velocity field variations in a porous medium using fluorescent-particle image velocimetry," *Chem. Eng. Sci.*, **48**(1), 13–22 (1993).
- Ochoa-Tapia, J.A., J.A. del Rio, and S. Whitaker, "Bulk and surface diffusion in porous media: An application of the surface-averaging theorem," *Chem. Eng. Sci.*, **48**(11), 2061–2082 (1993).
- Otowa, T., R. Tanibata, and M. Itoh, "Production and adsorption characteristics of MAXSORB: High-surface-area active carbon," *Gas Sep. Purif.*, **7**(4), 241–246 (1993).
- Rossi, P.F., "Adsorption heat-flow microcalorimetry applied to coal surface properties," *Adsorpt. Sci. Technol.*, **9**(3), 148–189 (1993).
- Rota, R., G. Gamba, and M. Morbidelli, "On the use of the adsorbed solution theory for designing adsorption separation units," *Sep. Technol.*, **3**(4), 230–237 (1993).
- Ruthven, D.M. and P. Stapleton, "Measurement of liquid phase counter-diffusion in zeolite crystals by the ZLC method," *Chem. Eng. Sci.*, **48**(1), 89–98 (1993).
- Scholl, S., H. Kajsika, and A. Mersmann, "Adsorption and desorption kinetics in activated carbon," *Gas Sep. Purif.*, **7**(4), 207–212 (1993).
- Schroter, H.J., "Carbon molecular sieves for gas separation processes," *Gas Sep. Purif.*, **7**(4), 247–252 (1993).
- Sereno, C. and A. Rodrigues, "Can steady-state momentum equations be used in modelling pressurization of adsorption beds?" *Gas Sep. Purif.*, **7**(3), 167–174 (1993).
- Sotirchos, S.V. and S. Zarkanitis, "A distributed pore size and length model for porous media reacting with diminishing porosity," *Chem. Eng. Sci.*, **48**(8), 1487–1502 (1993).
- Storti, G., et al., "Robust design of binary countercurrent adsorption separation processes," *AIChE J.*, **39**(3), 471–492 (1993).
- Sun, L.M., F. Meunier, and J. Karger, "On the heat effect in measurements of sorption kinetics by the frequency response method," *Chem. Eng. Sci.*, **48**(4), 715–722 (1993).
- Tien, C., "Multicomponent adsorption calculations," *Sep. Technol.*, **3**(1), 32–45 (1993).
- von Gemmingen, U., "A new approach to adsorption isotherms," *Gas Sep. Purif.*, **7**(3), 175–182 (1993).
- Watson, J.S., "The effects of flow through highly porous adsorbents on adsorption rates with favorable (nonlinear) isotherms," *Sep. Sci. Technol.*, **28**(1), 519–532 (1993).
- Webb, S.W., "Multicomponent inverse gas chromatography for analyses of sorption in polymers," *AIChE J.*, **39**(4), 701–706 (1993).
- Whitley, R.G., K.E. Van Cott, and N.H.L. Wang, "Analysis of nonequilibrium adsorption/desorption kinetics and implications for analytical and preparative chromatography," *Ind. Eng. Chem. Res.*, **32**(1), 149–159 (1993).
- Xiu, G.H. and N. Wakao, "Batch adsorption: Intraparticle adsorbate concentration profile models," *AIChE J.*, **39**(12), 2042–2044 (1993).
- Yao, C. and C. Tien, "Approximations of uptake rate of spherical adsorbent pellets and their application to batch adsorption calculations," *Chem. Eng. Sci.*, **48**(1), 187–198 (1993).
- Yu, M.C. and S. Middleman, "Air entrapment during liquid infiltration of porous media," *Chem. Eng. Commun.*, **123**, 61–70 (1993).
- Zhong, G.M., L.M. Sun, and F. Meunier, "Interference theory: Moment solution for linear isothermal multicomponent adsorption in a pellet," *Chem. Eng. Sci.*, **48**(24), 4115–4118 (1993).

1.2 Design Data

1992

- Ahmad, S., A. Mannan, and I.H. Qureshi, "Adsorption studies of radioactive cobalt on a minerals mixture," *Sep. Sci. Technol.*, **27**(4), 523–534 (1992).
- Allen, S., et al., "An evaluation of single resistance transfer models in the sorption of metal ions by peat," *J. Chem. Technol. Biotechnol.*, **54**(3), 271–276 (1992).
- Baksh, M.S.A., E.S. Kikkinides, and R.T. Yang, "Lithium type X zeolite as a superior sorbent for air separation," *Sep. Sci. Technol.*, **27**(3), 277–294 (1992).
- Bardacki, T. and F.G. King, "Measurements of argon, nitrogen and carbon dioxide diffusion through random assemblies of small spheres," *Gas Sep. Purif.*, **6**(1), 43–48 (1992).
- Bhaskar, G.V. and R.S.M. Bhamidimarri, "Adsorption of 2,4-D onto activated carbon: Application of Nth order approximation," *J. Chem. Technol. Biotechnol.*, **53**(3), 297–300 (1992).
- Bhutani, M.M., A. Santosh, and A.K. Mitra, "Abnormal mode of chromate adsorption on ignited sulphates as carrier surfaces," *Adsorpt. Sci. Technol.*, **8**(1), 1–12 (1992).
- Boyer, P.M. and J.T. Hsu, "Effects of ligand concentration on protein adsorption in dye-ligand adsorbents," *Chem. Eng. Sci.*, **47**(1), 241–252 (1992).
- Bruckner, P., et al., "Adsorption and immersion of benzene in active carbons," *Adsorpt. Sci. Technol.*, **8**(1), 57–68 (1992).
- Buroni, M., et al., "Behaviour of calcium-based sorbents towards sulphur-dioxide capture in a high-pressure thermobalance," *Fuel*, **71**(8), 919–924 (1992).
- Carrasco-Marin, F., et al., "Adsorption of sulphur dioxide in flowing air onto activated carbons from olive stones," *Fuel*, **71**(5), 575–578 (1992).
- Crawshaw, J.P. and J.H. Hills, "Experimental determination of binary sorption and desorption kinetics for the system ethanol, water, and maize at 90 degC," *Ind. Eng. Chem. Res.*, **31**(3), 887–892 (1992).
- Desai, R., M. Hussain, and D.M. Ruthven, "Adsorption of water vapour on activated alumina: Equilibrium and kinetic behaviour," *Can. J. Chem. Eng.*, **70**(4), 699–715 (1992).
- Economy, J., et al., "Tailoring carbon fibres for adsorbing volatilities," *Chemtech*, **22**(10), 597–603 (1992).

- Eiden, U. and E.U. Schlunder, "Inert gas desorption of single organic vapours from activated carbon," *Chem. Eng. Process.*, **31**(2), 63–76 (1992).
- Gonzalez-Pradas, E., M. Villafranca-Sanchez, and A.C. Gallego, "Effects of experimental variables on phosphate adsorption on bentonite," *J. Chem. Technol. Biotechnol.*, **54**(3), 291–296 (1992).
- Gow, A.S. and J. Phillips, "Calorimetric-study of oxygen adsorption on a high surface area polymer-derived carbon," *Energy Fuels*, **6**(2), 184–188 (1992).
- Gray, P.G. and D.D. Do, "Modelling of the interaction of nitrogen dioxide with activated carbon: Adsorption dynamics at the single particle scale," *Chem. Eng. Commun.*, **117**, 219–240 (1992).
- Hall, C.R., R.J. Holmes, and I.W. Lawston, "Further observations on the displacement of pre-adsorbed water from BPL activated carbon by chloropicrin vapour," *Adsorpt. Sci. Technol.*, **8**(2), 69–74 (1992).
- Hassan, N.M., et al., "Adsorption of radon from a humid atmosphere on activated carbon," *Sep. Sci. Technol.*, **27**(14), 1955–1968 (1992).
- Hedges, S.W. and J.T. Yeh, "Kinetics of sulfur dioxide uptake on supported cerium oxide sorbents," *Environ. Prog.*, **11**(2), 98–103 (1992).
- Hylton, T.D., "Evaluation of the TCE catalytic oxidation unit at Wurtsmith Air Force base," *Environ. Prog.*, **11**(1), 54–57 (1992).
- Irabien, A., F. Cortabitarte, and M.I. Ortiz, "Kinetics of flue gas desulfurization at low temperatures: Nonideal surface adsorption model," *Chem. Eng. Sci.*, **47**(7), 1533–1543 (1992).
- Ismail, H.M., N.E. Fouad, and M.I. Zaki, "Nitrogen and pyridine adsorption on chromia-coated silica and alumina catalysts: Probing the chromia dispersity," *Adsorpt. Sci. Technol.*, **8**(1), 34–43 (1992).
- Jasra, R.V. and S.G.T. Bhat, "Thermal desorption of linear alkenes from zeolite molecular sieve 5A," *Adsorpt. Sci. Technol.*, **8**(4), 174–183 (1992).
- Kaguei, S. and N. Wakao, "Relationships between surface diffusivity and pore diffusivity in batch adsorption: Measurements of the diffusivities for *n*-hexane and *n*-decane in 5A molecular sieves," *Chem. Eng. Sci.*, **47**(8), 2109–2113 (1992).
- Kaur, P., et al., "Studies on the sorption behaviour of some amino acids on silica gel pretreated with alkalis in relation to chromatography," *Adsorpt. Sci. Technol.*, **8**(3), 157–173 (1992).
- Klobucar, J.M. and M.J. Pilat, "Continuous flow thermal desorption of VOCs from activated carbon," *Environ. Prog.*, **11**(1), 11–17 (1992).
- Kocjan, R., "Additional purification of some salts by using silica gel modified with Calmagit as a sorbent," *Sep. Sci. Technol.*, **27**(3), 409–418 (1992).
- Kodama, K., S. Kaguei, and N. Wakao, "Batch adsorption of trichlorotrifluoroethane (Freon-113) onto activated carbon: Surface diffusivity and pore diffusivity," *Can. J. Chem. Eng.*, **70**(2), 244–249 (1992).
- Kumar, R., et al., "Novel adsorption-distillation hybrid scheme for propane/propylene separation," *Sep. Sci. Technol.*, **27**(15), 2157–2170 (1992).
- Lee, C.K., A.S.T. Chiang, and F.Y. Wu, "Lattice model for the adsorption of benzene in silicalite 1," *AIChE J.*, **38**(1), 128–135 (1992).
- Ludmany, A. and L.G. Nagy, "Investigation on the factors influencing the mechanism of the alkaline sorption on the surface of titanium phosphate sorbent," *Period. Polytech. Chem. Eng.*, **34**(1), 31–36 (1992).
- Maeda, S., et al., "Iron(III) hydroxide-loaded coral limestone as an adsorbent for arsenic(III) and arsenic(V)," *Sep. Sci. Technol.*, **27**(5), 681–690 (1992).
- Matranga, K.R., A.L. Myers, and E.D. Glandt, "Storage of natural gas by adsorption on activated carbon," *Chem. Eng. Sci.*, **47**(7), 1569–1579 (1992).
- Mentasty, L., R.J. Faccio, and G. Zgrablich, "High-pressure methane adsorption in 5A zeolite and the nature of gas-solid interactions," *Adsorpt. Sci. Technol.*, **8**(2), 105–113 (1992).
- Nassar, M.M., "Equilibrium studies on the adsorption of glycine on resin," *Adsorpt. Sci. Technol.*, **8**(2), 86–94 (1992).
- Pizzio, L.R., C.V. Caceres, and M.N. Blanco, "Parameters for the adsorption of tungsten from metatungstate solution on to alumina," *Adsorpt. Sci. Technol.*, **8**(3), 142–152 (1992).
- Raghuram, S. and S.A. Wilcher, "The separation of *n*-paraffins from paraffin mixtures," *Sep. Sci. Technol.*, **27**(14), 1917–1954 (1992).
- Rajakovic, L.V., "The sorption of arsenic onto activated carbon impregnated with metallic silver and copper," *Sep. Sci. Technol.*, **27**(11), 1423–1434 (1992).
- Ramesh, R., et al., "Isotheric and calorimetric heats of adsorption of methanol on coal," *Energy Fuels*, **6**(3), 239–241 (1992).
- Ray, M.S., "Adsorptive and membrane-type separations: A bibliographical guide 1991," *Adsorpt. Sci. Technol.*, **8**(3), 114–133 (1992).
- Rives, V., "A computer program for analyzing nitrogen adsorption isotherms on porous solids," *Adsorpt. Sci. Technol.*, **8**(2), 95–104 (1992).
- Ruthven, D.M., "Diffusion of oxygen and nitrogen in carbon molecular sieve," *Chem. Eng. Sci.*, **47**(17), 4305–4308 (1992).
- Sato, T., et al., "Uptake of benzenecarboxylate ions by magnesium aluminium oxides," *J. Chem. Technol. Biotechnol.*, **55**(4), 385–390 (1992).
- Shah, G.C., "Improve activated carbon bed adsorber operations," *Hydrocarbon Process.*, **71**(11), 61–63 (1992).
- Sifton, J.B., M. Eic, and D.M. Ruthven, "Development of an alternative technique for sampling stack gas by using zeolite 3A," *Gas Sep. Purif.*, **6**(4), 179–184 (1992).
- Sircar, S., "Estimation of isosteric heats of adsorption of single gas and multicomponent gas mixtures," *Ind. Eng. Chem. Res.*, **31**(7), 1813–1819 (1992).
- Suckow, M., et al., "Calculation of the hydrothermal long-term stability of zeolites in gas-desulfurization and gas-drying processes," *Gas Sep. Purif.*, **6**(2), 101–108 (1992).
- Susarla, S., G.V. Bhaskar, and S.M. Rao Bhamidimarri, "Competitive adsorption and desorption of 2,4-D and PCOC in a volcanic soil," *Adsorpt. Sci. Technol.*, **8**(4), 184–195 (1992).
- Tan, C.S., C.L. Liao, and S.T. Chiang, "Separation of diethylbenzene isomers on silicalite in the presence of high pressure carbon dioxide and propane," *Adsorpt. Sci. Technol.*, **8**(4), 226–234 (1992).
- Todorovic, M., et al., "Adsorption of radioactive ions $^{137}\text{Cs}^-$, $^{85}\text{Sr}^{2+}$, and $^{60}\text{Co}^{2+}$ on natural magnetite and hematite," *Sep. Sci. Technol.*, **27**(5), 671–680 (1992).

Ahlbeck, J., et al., "A method for measuring the reactivity of adsorbents for wet flue gas desulfurization," *Chem. Eng. Sci.*, **48**(20), 3479–3484 (1993).

- Aitani, A.M., "Sour natural gas drying," *Hydrocarbon Process.*, **72**(4), 67-73 (1993).
- Aksenenko, E.V. and Y.I. Tarasevich, "Non-specific adsorption of hydrocarbons on microporous surfaces: A comprehensive molecular-statistical/chromatographic approach," *Adsorpt. Sci. Technol.*, **9**(2), 54-71 (1993).
- Akubuiro, E.C., "Potential mechanistic routes for the oxidative disin-
tegration of ketones on carbon adsorbents," *Ind. Eng. Chem. Res.*, **32**(12), 2960-2968 (1993).
- Ching, C.B., K. Hidajat, and X. Liu, "Sorption and diffusion of cresols on bonded beta-cyclodextrin-silica stationary phase," *Ind. Eng. Chem. Res.*, **32**(11), 2789-2793 (1993).
- Choudary, V.N., R.V. Jasra, and T.S.G. Bhat, "Adsorption of a nitrogen-oxygen mixture in NaCaA zeolites by elution chromatography," *Ind. Eng. Chem. Res.*, **32**(3), 548-552 (1993).
- Choudhary, V.R. and S. Mayadevi, "Adsorption of methane, ethane, ethylene, and carbon dioxide on X, Y, L, and M zeolites using a gas chromatography pulse technique," *Sep. Sci. Technol.*, **28**(8), 1595-1608 (1993).
- Ciembroniewicz, A. and A. Marecka, "Kinetics of carbon dioxide sorption for two Polish hard coals," *Fuel*, **72**(3), 405-408 (1993).
- Eissmann, R.N. and M.D. Le Van, "Coadsorption of organic compounds and water vapor on BPL activated carbon: 1,1,2-trichloro-1,2,2-trifluoroethane and dichloromethane," *Ind. Eng. Chem. Res.*, **32**(11), 2752-2757 (1993).
- El-Guendi, M.S. and I.H. Aly, "Equilibrium studies during the adsorption of acid dyestuffs into maize cob," *Adsorpt. Sci. Technol.*, **9**(3), 121-129 (1993).
- El-Naggar, I.M., et al., "Sorption behavior of uranium and thorium on cryptomelane-type hydrous manganese dioxide from aqueous solution," *Solvent Extr. Ion Exch.*, **11**(3), 521-540 (1993).
- Eldridge, R.B., "Olefin/paraffin separation technology: A review," *Ind. Eng. Chem. Res.*, **32**(10), 2208-2212 (1993).
- Georgiev, J.K., "On the possibility of effective helium extraction from air," *Sep. Sci. Technol.*, **28**(15), 2401-2418 (1993).
- Gergova, K., N. Petrov, and V. Minkova, "A comparison of adsorption characteristics of various activated carbons," *J. Chem. Technol. Biotechnol.*, **56**(1), 77-82 (1993).
- Germerdonk, R. and A. Wang, "Pollutant adsorption during activated carbon and steam regeneration in technical columns (experiments, modelling): Influence of radial maldistribution during adsorption and desorption," *Chem. Eng. Process.*, **32**(6), 359-368 (1993).
- Germerdonk, R. and A. Wang, "Pollutant adsorption during activated carbon and steam regeneration in technical columns (experiments, modelling): Influence of process parameters on exit concentration during steam regeneration," *Chem. Eng. Process.*, **32**(6), 369-378 (1993).
- Ghosh, T.K., H.D. Lin, and A.L. Hines, "Hybrid adsorption-distillation process for separating propane and propylene," *Ind. Eng. Chem. Res.*, **32**(10), 2390-2399 (1993).
- Goto, A., et al., "Desorption of uranium from amidoxime fiber adsorbent," *Sep. Sci. Technol.*, **28**(13), 2229-2236 (1993).
- Gray, P.G. and D.D. Do, "Modelling of the interaction of nitrogen dioxide with activated carbon: Kinetics of reaction with pore evolution," *Chem. Eng. Commun.*, **125**, 109-120 (1993).
- Hawash, S., et al., "Useful adsorption equilibria by means of natural clay," *Adsorpt. Sci. Technol.*, **9**(4), 231-243 (1993).
- Hawash, S., J.Y. Farah, and M.S. El-Geundi, "Investigation of nickel ion removal by means of activated clay," *Adsorpt. Sci. Technol.*, **9**(4), 244-257 (1993).
- Helmy, A.K., E.A. Ferreiro, and S.G. de Bussetti, "Apparent and partial specific sorption of phosphate by binary mixtures of hydrated Al oxides," *Adsorpt. Sci. Technol.*, **9**(2), 72-83 (1993).
- Hershkowitz, F. and P.D. Madiara, "Simultaneous measurement of adsorption, reaction, and coke using a pulsed microbalance reactor," *Ind. Eng. Chem. Res.*, **32**(12), 2969-2974 (1993).
- Hu, X. and D.D. Do, "Multicomponent adsorption kinetics of hydrocarbons onto activated carbon: Contribution of micropore resistance," *Chem. Eng. Sci.*, **48**(7), 1317-1324 (1993).
- Hu, X., G.N. Rao, and D.D. Do, "Multicomponent sorption kinetics of ethane and propane in activated carbon: Simultaneous adsorption," *Gas Sep. Purif.*, **7**(1), 39-46 (1993).
- Hu, X., G.N. Rao, and D.D. Do, "A mathematical model for multicomponent adsorption, desorption and displacement kinetics of ethane, propane and n-butane on activated carbon," *Gas Sep. Purif.*, **7**(4), 197-206 (1993).
- Hufton, J.R. and R.P. Danner, "Chromatographic study of alkanes in silicalite: Equilibrium properties," *AIChE J.*, **39**(6), 954-961 (1993).
- Hufton, J.R. and R.P. Danner, "Chromatographic study of alkanes in silicalite: Transport properties," *AIChE J.*, **39**(6), 962-974 (1993).
- Illan-Gomez, M.J., et al., "NO reduction by activated carbons: The role of carbon porosity and surface area," *Energy Fuels*, **7**(1), 146-154 (1993).
- Jarvelin, H. and J.R. Fair, "Adsorptive separation of propylene-propane mixtures," *Ind. Eng. Chem. Res.*, **32**(10), 2201-2207 (1993).
- Jha, S., et al., "Chromatographic utilization of the sorption behaviour of some nitrophenols on acid-treated alumina," *Adsorpt. Sci. Technol.*, **9**(2), 92-108 (1993).
- Kabay, N. and H. Egawa, "Kinetic behavior of lightly crosslinked chelating resins containing amidoxime groups for batchwise adsorption of UO_2^{2+} ," *Sep. Sci. Technol.*, **28**(11), 1985-1994 (1993).
- Kapoor, A., K.R. Krishnamurthy, and A. Shirley, "Kinetic separation of carbon dioxide from hydrocarbons using carbon molecular sieve," *Gas Sep. Purif.*, **7**(4), 259-263 (1993).
- Kats, B.M. and V.V. Kutarov, "Adsorption of the vapour of low-molecular substances by swelling polymers," *Adsorpt. Sci. Technol.*, **9**(1), 30-35 (1993).
- Kats, B.M., V.V. Kutarov, and A.A. Chagodar, "Applications of non-linear diffusion equations to the kinetics of water vapour adsorption by polymeric fibres," *Adsorpt. Sci. Technol.*, **9**(4), 269-275 (1993).
- Kawamura, Y., et al., "Adsorption of metal ions on polyaminated highly porous chitosan chelating resin," *Ind. Eng. Chem. Res.*, **32**(2), 386-391 (1993).
- Kikkinides, E.S. and R.T. Yang, "Gas separation and purification by polymeric adsorbents: Flue gas desulfurization and sulfur dioxide recovery with styrenic polymers," *Ind. Eng. Chem. Res.*, **32**(10), 2365-2372 (1993).
- Krings, U., M. Kelch, and R.G. Berger, "Adsorbents for the recovery of aroma compounds in fermentation processes," *J. Chem. Technol. Biotechnol.*, **58**(3), 293-299 (1993).
- Loughlin, K.F., et al., "Rate and equilibrium sorption parameter for nitrogen and methane on carbon molecular sieve," *Gas Sep. Purif.*, **7**(4), 264-273 (1993).
- Lu, G.Q. and D.D. Do, "Retention of sulfur dioxide as sulfuric acid by activated coal reject char," *Sep. Technol.*, **3**(2), 106-110 (1993).
- Madras, G., C. Erkey, and A. Akgerman, "Supercritical fluid regeneration of activated carbon loaded with heavy molecular weight organics," *Ind. Eng. Chem. Res.*, **32**(6), 1163-1168 (1993).
- Mattuschka, B. and G. Straube, "Biosorption of metals by a waste

- biomass," *J. Chem. Technol. Biotechnol.*, **58**(1), 57–64 (1993).
- Mehandjiev, D.R. and R.N. Nickolov, "Dependence of the *C* constant in the Brunauer-Emmett-Teller equation on water pre-adsorbed on activated carbon," *Adsorpt. Sci. Technol.*, **9**(1), 48–53 (1993).
- Miyake, Y. and M. Suzuki, "Removal of trichloroethylene from air stripping off-gas by adsorption on activated carbon fibre," *Gas Sep. Purif.*, **7**(4), 229–234 (1993).
- Mushtaq, A., "Sorption behavior of carrier-free technetium-99m on zinc dust," *Sep. Sci. Technol.*, **28**(9), 1743–1752 (1993).
- Niswander, R.H., et al., "A more energy efficient product for carbon dioxide separation," *Sep. Sci. Technol.*, **28**(1), 565–578 (1993).
- Park, S.W., W.K. Lee, and H. Moon, "Adsorption and desorption of gaseous methyl iodide in a triethylenediamine-impregnated activated carbon bed," *Sep. Technol.*, **3**(3), 133–142 (1993).
- Perona, J.J., C.H. Byers, and J.K. Prazniak, "Vacuum sorption pumping studies of argon and oxygen on 4A molecular sieves," *Sep. Sci. Technol.*, **28**(1), 595–614 (1993).
- Petersen, F.W. and S. Kruger, "The adsorption of gold cyanide onto porous adsorbents: Relation between liquid-phase concentration, suspended solids, and mass-transfer mechanisms," *Sep. Sci. Technol.*, **28**(10), 1849–1858 (1993).
- Rajniak, P. and R.T. Yang, "A simple model and experiments for adsorption-desorption hysteresis: Water vapor on silica gel," *AIChE J.*, **39**(5), 774–786 (1993).
- Reed, B.E. and M.R. Matsumoto, "Modeling cadmium adsorption by activated carbon using the Langmuir and Freundlich isotherm expressions," *Sep. Sci. Technol.*, **28**(13), 2179–2196 (1993).
- Ruhl, M.J., "Recover VOCs via adsorption and activated carbon," *Chem. Eng. Prog.*, **89**(7), 37–41 (1993).
- Ruthven, D.M. and B.K. Kaul, "Adsorption of aromatic hydrocarbons in NaX zeolite: Equilibrium," *Ind. Eng. Chem. Res.*, **32**(9), 2047–2052 (1993).
- Ruthven, D.M. and B.K. Kaul, "Adsorption of aromatic hydrocarbons in NaX zeolite: Kinetics," *Ind. Eng. Chem. Res.*, **32**(9), 2053–2057 (1993).
- Ruthven, D.M. and Z. Xu, "Diffusion of oxygen and nitrogen in 5A zeolite crystals and commercial 5A pellets," *Chem. Eng. Sci.*, **48**(18), 3307–3312 (1993).
- Sadowski, Z., "The influence of the sodium oleate adsorption on the behavior of calcite suspensions," *Chem. Eng. Sci.*, **48**(2), 305–312 (1993).
- Schweiger, T.A.J. and M.D. LeVan, "Steam regeneration of solvent adsorbers," *Ind. Eng. Chem. Res.*, **32**(10), 2418–2429 (1993).
- Sharma, P.K. and G.S. Hickey, "A comparison of the oxygen uptake characteristics of copper-exchanged zeolite with copper dispersed on a silica support," *Gas Sep. Purif.*, **7**(3), 141–146 (1993).
- Stankiewicz, Z. and H. Schreiner, "Temperature-vacuum process for the desorption of activated charcoal," *Process Safety Environ. Prot.*, **71**(B2), 134–140 (1993).
- Stenger, H.G., K. Hu, and D.R. Simpson, "Competitive adsorption of NO, sulphur dioxide and water onto mordenite synthesized from perlite," *Gas Sep. Purif.*, **7**(1), 19–26 (1993).
- Stenzel, M.H., "Remove organics by activated carbon adsorption," *Chem. Eng. Prog.*, **89**(4), 36–43 (1993).
- Stradella, L., "Heats of adsorption of different gases on polycrystalline transition metals," *Adsorpt. Sci. Technol.*, **9**(3), 190–198 (1993).
- Strauss, H., H. Heegn, and I. Strienitz, "Effect of PAA adsorption on stability and rheology of titanium dioxide dispersions," *Chem. Eng. Sci.*, **48**(2), 323–332 (1993).
- Takeuchi, Y. and T. Itoh, "Removal of ozone from air by activated carbon treatment," *Sep. Technol.*, **3**(3), 168–175 (1993).
- Takeuchi, Y., A. Shigeta, and H. Iwamoto, "Adsorption of solvent vapor mixture in air by activated carbon fiber bed," *Sep. Technol.*, **3**(1), 46–52 (1993).
- Teng, H. and E.M. Suuberg, "Chemisorption of nitric oxide on char: Irreversible carbon oxide formation," *Ind. Eng. Chem. Res.*, **32**(3), 416–423 (1993).
- Tezel, F.H. and G. Apolonatos, "Chromatographic study of adsorption for nitrogen, CO and methane in molecular sieve zeolites," *Gas Sep. Purif.*, **7**(1), 11–18 (1993).
- Various, "Activated carbon and carbon molecular sieves (topic issue)," *Gas Sep. Purif.*, **7**(4), 195–284 (1993).
- Wakker, J.P., A.W. Gerritsen, and J.A. Moulijn, "High temperature hydrogen sulfide and COS removal with MnO and FeO on gamma-alumina acceptors," *Ind. Eng. Chem. Res.*, **32**(1), 139–149 (1993).
- Webb, O.F., T.J. Phelps, and P.R. Bienkowski, "Multicomponent adsorption of polycyclic aromatic hydrocarbons in manufactured gas plant soils," *Sep. Sci. Technol.*, **28**(1), 873–894 (1993).
- Weber, G., et al., "*t*-Curves for *n*-hexane," *Adsorpt. Sci. Technol.*, **9**(4), 258–268 (1993).
- Westgate, P.J. and M.R. Ladisch, "Sorption of organics and water on starch," *Ind. Eng. Chem. Res.*, **32**(8), 1676–1680 (1993).
- Yoshida, H., A. Okamoto, and T. Kataoka, "Adsorption of acid dye on cross-linked chitosan fibers: Equilibria," *Chem. Eng. Sci.*, **48**(12), 2267–2272 (1993).

1.3 Adsorbents

1992

- Akubuiro, E.C. and N.J. Wagner, "Assessment of activated carbon stability toward adsorbed organics," *Ind. Eng. Chem. Res.*, **31**(1), 339–346 (1992).
- Baksh, M.S., E.S. Kikkinides, and R.T. Yang, "Characterization by physisorption of a new class of microporous adsorbents: Pillared clays," *Ind. Eng. Chem. Res.*, **31**(9), 2181–2189 (1992).
- Baksh, M.S.A. and R.T. Yang, "Unique adsorption properties and potential energy profiles of microporous pillared clays," *AIChE J.*, **38**(9), 1357–1368 (1992).
- Baksh, M.S.A., E.S. Kikkinides, and R.T. Yang, "Lithium type X zeolite as a superior sorbent for air separation," *Sep. Sci. Technol.*, **27**(3), 277–294 (1992).
- Bhattacharya, A., et al., "Studies on the synthesis of SAPO-5 molecular sieves," *J. Chem. Technol. Biotechnol.*, **54**(4), 399–407 (1992).
- Brown, S., "New interest in activated carbon," *Process Eng. (London)*, May, 139–140 (1992).
- Davies, M.E., "Large and extra-large pore molecular sieves," *Chem. Ind. (London)*, 17 February, 137–139 (1992).
- de Lucas, A., et al., "Synthesis of 13X zeolite from calcined kaolins and sodium silicate for use in detergents," *Ind. Eng. Chem. Res.*, **31**(9), 2134–2140 (1992).
- Ernstson M.L. and A. Rasmuson, "Field and laboratory measurements of the air permeability of chipped forest-fuel materials," *Fuel*, **71**(8), 963–970 (1992).
- Fan, L.T., A.A. Boateng, and W.P. Walawender, "Surface fractal dimension of rice hull-derived charcoal from a fluidized-bed reactor," *Can. J. Chem. Eng.*, **70**(2), 387–390 (1992).

- Gray, P.G. and D.D. Do, "A graphical method for determining pore and surface diffusivities in adsorption systems," *Ind. Eng. Chem. Res.*, **31**(4), 1176–1182 (1992).
- Guy, P.J. and G.J. Perry, "Victorian brown coal as a source of industrial carbons (review paper)," *Fuel*, **71**(10), 1083–1086 (1992).
- Haggin, J., "Molecular sieves have controlled pore volume," *Chem. Eng. News*, 2 November, 28 (1992).
- Ho, C.S. and S.M. Shih, "Calcium hydroxide/fly ash sorbents for sulfur dioxide removal," *Ind. Eng. Chem. Res.*, **31**(4), 1130–1135 (1992).
- Kago, T., et al., "Preparation and performance of amidoxime fiber adsorbents for recovery of uranium from seawater," *Ind. Eng. Chem. Res.*, **31**(1), 204–209 (1992).
- Kocjan, R., "Additional purification of some salts by using silica gel modified with Calmagit as a sorbent," *Sep. Sci. Technol.*, **27**(3), 409–418 (1992).
- Liu, P.K.T., "Surface and porous characterization of two commercial activated carbons with polymer and petroleum coke as precursors," *Ind. Eng. Chem. Res.*, **31**(9), 2216–2222 (1992).
- Lu, G.Q. and D.D. Do, "Physical structure and adsorption properties of coal washery reject," *Fuel*, **71**(7), 809–814 (1992).
- Maeda, S., et al., "Iron(III) hydroxide-loaded coral limestone as an adsorbent for arsenic(III) and arsenic(V)," *Sep. Sci. Technol.*, **27**(5), 681–690 (1992).
- Mann, R. and H.N.S. Yousef, "Quantification of random pore structures of porous adsorbents," *Adsorpt. Sci. Technol.*, **8**(4), 196–216 (1992).
- Merchant, A.A. and M.A. Petrich, "Preparation and characterization of activated carbons from scrap tires, almond shells, and Illinois coal," *Chem. Eng. Commun.*, **118**, 251–264 (1992).
- Munoz-Guillena, M.J., et al., "Activated carbons from Spanish coals: Two-stage carbon dioxide activation," *Energy Fuels*, **6**(1), 9–15 (1992).
- Oger, L., et al., "Heterogeneities and characteristic lengths in porous media," *Int. Chem. Eng.*, **32**(4), 674–688 (1992).
- Portsmouth, R.L. and L.F. Gladden, "Mercury porosimetry as a probe of pore connectivity," *Chem. Eng. Res. Des.*, **70**(1), 63–70 (1992).
- Todorovic, M., et al., "Adsorption of radioactive ions $^{137}\text{Cs}^-$, $^{85}\text{Sr}^{2+}$, and $^{60}\text{Co}^{2+}$ on natural magnetite and hematite," *Sep. Sci. Technol.*, **27**(5), 671–680 (1992).
- Gray, P.G. and D.D. Do, "A graphical method for determining pore and surface diffusivities in adsorption systems," *Ind. Eng. Chem. Res.*, **31**(4), 1176–1182 (1992).
- Guy, P.J. and G.J. Perry, "Victorian brown coal as a source of industrial carbons (review paper)," *Fuel*, **71**(10), 1083–1086 (1992).
- Haggin, J., "Molecular sieves have controlled pore volume," *Chem. Eng. News*, 2 November, 28 (1992).
- Ho, C.S. and S.M. Shih, "Calcium hydroxide/fly ash sorbents for sulfur dioxide removal," *Ind. Eng. Chem. Res.*, **31**(4), 1130–1135 (1992).
- Kago, T., et al., "Preparation and performance of amidoxime fiber adsorbents for recovery of uranium from seawater," *Ind. Eng. Chem. Res.*, **31**(1), 204–209 (1992).
- Kocjan, R., "Additional purification of some salts by using silica gel modified with Calmagit as a sorbent," *Sep. Sci. Technol.*, **27**(3), 409–418 (1992).
- Liu, P.K.T., "Surface and porous characterization of two commercial activated carbons with polymer and petroleum coke as precursors," *Ind. Eng. Chem. Res.*, **31**(9), 2216–2222 (1992).
- Lu, G.Q. and D.D. Do, "Physical structure and adsorption properties of coal washery reject," *Fuel*, **71**(7), 809–814 (1992).
- Maeda, S., et al., "Iron(III) hydroxide-loaded coral limestone as an adsorbent for arsenic(III) and arsenic(V)," *Sep. Sci. Technol.*, **27**(5), 681–690 (1992).
- Mann, R. and H.N.S. Yousef, "Quantification of random pore structures of porous adsorbents," *Adsorpt. Sci. Technol.*, **8**(4), 196–216 (1992).
- Merchant, A.A. and M.A. Petrich, "Preparation and characterization of activated carbons from scrap tires, almond shells, and Illinois coal," *Chem. Eng. Commun.*, **118**, 251–264 (1992).
- Munoz-Guillena, M.J., et al., "Activated carbons from Spanish coals: Two-stage carbon dioxide activation," *Energy Fuels*, **6**(1), 9–15 (1992).
- Oger, L., et al., "Heterogeneities and characteristic lengths in porous media," *Int. Chem. Eng.*, **32**(4), 674–688 (1992).
- Portsmouth, R.L. and L.F. Gladden, "Mercury porosimetry as a probe of pore connectivity," *Chem. Eng. Res. Des.*, **70**(1), 63–70 (1992).
- Todorovic, M., et al., "Adsorption of radioactive ions $^{137}\text{Cs}^-$, $^{85}\text{Sr}^{2+}$, and $^{60}\text{Co}^{2+}$ on natural magnetite and hematite," *Sep. Sci. Technol.*, **27**(5), 671–680 (1992).
- Browne, T.E. and Y. Cohen, "Polymer-grafted silica: A screening system for polymeric adsorption resin development," *Ind. Eng. Chem. Res.*, **32**(4), 716–725 (1993).
- Chanda, M. and G.L. Rempel, "Poly(4-vinylpyridine) gel-coated on silica: High capacity and fast kinetics in uranyl sulfate recovery," *Ind. Eng. Chem. Res.*, **32**(4), 726–732 (1993).
- de Lucas, A., et al., "Use of Spanish natural clays as additional silica sources to synthesize 13X zeolite from kaolin," *Ind. Eng. Chem. Res.*, **32**(8), 1645–1650 (1993).
- Gergova, K., et al., "Evolution of the active surface of carbons produced from various raw materials by steam pyrolysis/activation," *J. Chem. Technol. Biotechnol.*, **58**(4), 321–330 (1993).
- Gergova, K., S. Eser, and H.H. Schobert, "Preparation and characterization of activated carbons from anthracite," *Energy Fuels*, **7**(5), 661–668 (1993).
- Gergova, K., N. Petrov, and V. Minkova, "A comparison of adsorption characteristics of various activated carbons," *J. Chem. Technol. Biotechnol.*, **56**(1), 77–82 (1993).
- Gladden, L.F., "Nuclear magnetic resonance studies of porous media," *Chem. Eng. Res. Des.*, **71**(6), 657–674 (1993).
- Guzel, F. and Z. Tez, "The characterization of the micropore structures of some activated carbons of plant origin by nitrogen and carbon dioxide adsorptions," *Sep. Sci. Technol.*, **28**(8), 1609–1628 (1993).
- Haggin, J., "Progress in design of zeolite synthesis," *Chem. Eng. News*, 13 September, 41–43 (1993).
- Ho, C.S. and S.M. Shih, "Characteristics and sulphur dioxide capture capacities of sorbents prepared from products of spray-drying flue gas desulphurization," *Can. J. Chem. Eng.*, **71**(6), 934–939 (1993).
- Knoblauch, K., "Activated carbon and carbon molecular sieves in gas separation and purification," *Gas Sep. Purif.*, **7**(4), 195–196 (1993).
- Li, R.J., et al., "Transport of gases in miscible polymer blends above and below the glass transition region," *AIChE J.*, **39**(9), 1509–1518 (1993).
- Merchant, A.A. and M.A. Petrich, "Pyrolysis of scrap tires and conversion of chars to activated carbon," *AIChE J.*, **39**(8), 1370–1376 (1993).
- Miyabe, K. and M. Suzuki, "Adsorption characteristics of octadecylsilyl-silica gel in gaseous systems," *AIChE J.*, **39**(11), 1791–1798 (1993).
- Patrick, V., G.R. Gavalas, and P.K. Sharma, "Reduction, sulfidation, and regeneration of mixed iron-aluminum oxide sorbents," *Ind. Eng. Chem. Res.*, **32**(3), 519–532 (1993).
- Rees, L.V.C. and D. Shen, "Characterization of microporous sorbents by frequency-response methods," *Gas Sep. Purif.*, **7**(2), 83–90 (1993).
- Spaull, A.J.B., "Cahn's perfect wetting theory in determining monolayer capacity," *J. Chem. Technol. Biotechnol.*, **57**(1), 87–92 (1993).
- Tomasko, D.L., et al., "Pilot scale study and design of a granular activated carbon regeneration process using supercritical fluids," *Environ. Prog.*, **12**(3), 208–217 (1993).
- Tsuji, M. and S. Komarneni, "Selectivity study of alkaline earth and divalent transition metal ions on $[\text{Al}^{3+}/\text{Na}^+]$ -substituted tobermorites," *Sep. Sci. Technol.*, **28**(11), 2061–2072 (1993).
- Various, "Activated carbon and carbon molecular sieves (topic issue)," *Gas Sep. Purif.*, **7**(4), 195–284 (1993).
- Vyas, S.N., et al., "Synthesis of carbon molecular sieves by activation and coke deposition," *Fuel*, **72**(4), 551–556 (1993).
- Yenkie, M.K.N. and G.S. Natarajan, "Determination of specific sur-

1993

face area of granular activated carbon by aqueous phase adsorption of phenol and from pore size distribution measurements," *Sep. Sci. Technol.*, **28**(5), 1177–1190 (1993).

Zhong, S. and M.T. Hepworth, "Thermodynamic studies of iron oxy-sulfide as a sulfur sorbent," *Energy Fuels*, **7**(6), 1073–1078 (1993).

1.4 PSA and Cyclic Systems, and Applications

1992

Alpay, E. and D.M. Scott, "The linear driving force model for fast-cycle adsorption and desorption in spherical particle," *Chem. Eng. Sci.*, **47**(2), 499–502 (1992).

Anon., "TSA process for propane/propylene split," *Chem. Eng. Prog.*, **88**(3), 12 (1992).

Banerjee, R., K.G. Narayankhedkar, and S.P. Sukhatme, "Exergy analysis of kinetic pressure swing adsorption processes: Comparison of different cycle configurations," *Chem. Eng. Sci.*, **47**(5), 1307–1311 (1992).

Bossy, A., D. Tondue, and A. Jedrzejak, "A non-linear equilibrium analysis of blowdown policy in pressure-swing-adsorption separation," *Chem. Eng. J.*, **48**(3), 173–182 (1992).

Farooq, S. and D.M. Ruthven, "Effect of equilibrium selectivity in a kinetically controlled PSA separation," *Chem. Eng. Sci.*, **47**(8), 2093–2094 (1992).

Inui, T., et al., "Performance of iron-incorporated A-type zeolites for oxygen/nitrogen separation from air by pressure swing adsorption," *Gas Sep. Purif.*, **6**(4), 185–190 (1992).

Kumar, R., et al., "Gas mixture fractionation to produce two high purity products by pressure swing adsorption," *Sep. Sci. Technol.*, **27**(4), 509–522 (1992).

Kumar, R., et al., "Novel adsorption-distillation hybrid scheme for propane/propylene separation," *Sep. Sci. Technol.*, **27**(15), 2157–2170 (1992).

Lemcoff, N.O. and A.I. LaCava, "Effect of regeneration pressure level in kinetically controlled pressure swing adsorption," *Gas Sep. Purif.*, **6**(1), 9–14 (1992).

Lu, Z.P., et al., "Intraparticle convection effect on pressurization and blowdown of adsorbents," *AIChE J.*, **38**(6), 857–867 (1992).

Lu, Z.P., et al., "Dynamics of pressurization and blowdown of an adiabatic bed," *Gas Sep. Purif.*, **6**(1), 15–24 (1992).

Lu, Z.P., et al., "Intraparticle diffusion/convection models for pressurization and blowdown of adsorption beds with Langmuir isotherm," *Sep. Sci. Technol.*, **27**(14), 1857–1874 (1992).

Mutasim, Z.Z. and J.H. Bowen, "Multicomponent pressure swing adsorption for non-isothermal non-equilibrium conditions," *Chem. Eng. Res. Des.*, **70**(4), 346–353 (1992).

Portsmouth, R.L. and L.F. Gladden, "Transport in zeolites: Application to pressure and temperature swing process," *Chem. Eng. Res. Des.*, **70**(2), 186–188 (1992).

Rao, M.B. and S. Sircar, "Production of motor fuel grade alcohol by concentration swing adsorption," *Sep. Sci. Technol.*, **27**(14), 1875–1888 (1992).

Rodrigues, M.I., et al., "Dynamic modelling, simulation and control of continuous adsorption recycle extraction," *Chem. Eng. Sci.*, **47**(1), 263–270 (1992).

Smith, O.J. and A.W. Westerberg, "The optimal design of pressure swing adsorption systems," *Chem. Eng. Sci.*, **47**(15), 4213–4217 (1992).

Smith, O.J. and A.W. Westerberg, "Acceleration of cyclic steady state convergence for pressure swing adsorption models," *Ind. Eng. Chem. Res.*, **31**(6), 1569–1573 (1992).

Storti, G., et al., "Performance of a six-port simulated moving-bed pilot plant for vapor-phase adsorption separations," *Sep. Sci. Technol.*, **27**(14), 1889–1916 (1992).

Zhong, G.M., et al., "Pressurization of a single-component gas in an adsorption column," *Chem. Eng. Sci.*, **47**(3), 543–550 (1992).

1993

Alpay, E., C.N. Kenney, and D.M. Scott, "Simulation of rapid pressure swing adsorption and reaction processes," *Chem. Eng. Sci.*, **48**(18), 3173–3186 (1993).

Baron, G., "Modelling PSA processes," *Gas Sep. Purif.*, **7**(2), 111–118 (1993).

Ellis, D.I., P.J. Heggs, and M.G. Lawrie, "The removal of Freon 12 from air using pressure swing adsorption," *Chem. Eng. Res. Des.*, **71**(2), 169–180 (1993).

Farooq, S., M.N. Rathor, and K. Hidajat, "A predictive model for a kinetically controlled pressure swing adsorption separation process," *Chem. Eng. Sci.*, **48**(24), 4129–4142 (1993).

Fish, B.B., R.W. Carr, and R. Aris, "Design and performance of a simulated countercurrent moving-bed separator," *AIChE J.*, **39**(11), 1783–1790 (1993).

Golden, T.C., et al., "Carbon-based oxygen selective dessicants for use in nitrogen PSA," *Gas Sep. Purif.*, **7**(4), 274–278 (1993).

Gong, S.Y. and W.K. Lee, "The effect of the time length of pressure changing steps on concentration in the gas phase in the pressure swing adsorption process," *Sep. Sci. Technol.*, **28**(11), 1995–2006 (1993).

Guan, J. and Z. Ye, "Analog circuit for simulation of pressure swing adsorption: Kinetic model," *Chem. Eng. Sci.*, **48**(15), 2821–2823 (1993).

Huang, C.C., T.L. Hwu, and Y.S. Hsai, "Regeneration of a fixed bed of activated carbon adsorbed organic vapour by using hot nitrogen purge," *Sep. Sci. Technol.*, **28**(15), 2431–2448 (1993).

Ivo, R. and D. Pavel, "Pressure swing adsorption: Analytical solution for optimum purge," *Chem. Eng. Sci.*, **48**(4), 723–734 (1993).

Kikkinides, E.S., R.T. Yang, and S.H. Cho, "Concentration and recovery of carbon dioxide from flue gas by pressure swing adsorption," *Ind. Eng. Chem. Res.*, **32**(11), 2714–2720 (1993).

Lu, Z., et al., "Pressure swing adsorption processes: Intraparticle diffusion/convection models," *Ind. Eng. Chem. Res.*, **32**(11), 2740–2751 (1993).

Lu, Z.P., et al., "Simulation of a three-step one-column pressure swing adsorption process," *AIChE J.*, **39**(9), 1483–1496 (1993).

Lu, Z.P., et al., "Pressurization and blowdown of adsorption beds: Effect of the momentum and equilibrium relations on isothermal operation," *Chem. Eng. Sci.*, **48**(9), 1699–1708 (1993).

Meunier, F., "Thermal swing adsorption refrigeration (heat pump)," *Sep. Sci. Technol.*, **3**(3), 143–150 (1993).

Ng, M., J.M. Schork, and K.R. Fabergas, "The mass transfer zone in nitrogen PSA columns," *Gas Sep. Purif.*, **7**(3), 159–166 (1993).

Rao, M.B. and S. Sircar, "Concentration-thermal swing adsorption process for separation of bulk liquid mixtures," *Sep. Sci. Technol.*, **28**(10), 1837–1848 (1993).

Ruthven, D.M., Z. Xu, and S. Farooq, "Sorption kinetics in PSA systems," *Gas Sep. Purif.*, **7**(2), 75–82 (1993).

- Schoofs, G.R., "Operation of adsorbers for purifying ammonia synthesis make-up gas," *Ind. Eng. Chem. Res.*, **32**(4), 613–619 (1993).
- Schoofs, G.R. and P. Petit, "Repressurization of adsorption purifiers for cryogenic air separation," *Chem. Eng. Sci.*, **48**(4), 753–760 (1993).
- Schork, J.M., R. Srinivasan, and S.R. Auvel, "A shortcut computational method for designing nitrogen PSA adsorbents," *Ind. Eng. Chem. Res.*, **32**(10), 2226–2235 (1993).
- Schulte-Schulze-Berndt, A. and K. Krabiell, "Nitrogen generation by pressure swing adsorption on carbon molecular sieves," *Gas Sep. Purif.*, **7**(4), 253–258 (1993).
- Scott, D.M., "Effects of bed pressure drop on adsorption and desorption with Langmuir isotherms," *Chem. Eng. Sci.*, **48**(17), 3001–3006 (1993).
- Shirley, A.I. and A.I. LaCava, "Novel pressurization methods in pressure swing adsorption systems for the generation of high-purity gas," *Ind. Eng. Chem. Res.*, **32**(5), 906–910 (1993).
- Sircar, S., "Recent trends in pressure swing adsorption: Production of multiple products from a multicomponent feed gas," *Gas Sep. Purif.*, **7**(2), 69–74 (1993).
- Sircar, S. and B.F. Hanley, "Fractionated vacuum swing adsorption process for air separation," *Sep. Sci. Technol.*, **28**(17), 2553–2566 (1993).
- Sundaram, N., "A noniterative solution for periodic steady states in gas purification pressure swing adsorption," *Ind. Eng. Chem. Res.*, **32**(8), 1686–1691 (1993).
- Takeguchi, T., W. Tanakulrungsank, and T. Inui, "Separation and/or concentration of carbon dioxide from carbon dioxide/nitrogen gaseous mixture by PSA using metal-incorporated microporous crystals with high surface area," *Gas Sep. Purif.*, **7**(1), 3–10 (1993).
- Tondeur, D. and M. Chlendi, "Front analysis and cycle policy in PSA operations," *Gas Sep. Purif.*, **7**(2), 105–110 (1993).
- Various, "Application of gas and liquid phase adsorption (topic issue)," *Sep. Sci. Technol.*, **27**(14), 1822–2040 (1992).
- Various, "Papers from 'Gas Separation by PSA' (14 February 1992, The Netherlands)," *Gas Sep. Purif.*, **7**(2), 67–118 (1993).
- Wankat, P.C., "Feed purge cycles in pressure swing adsorption," *Sep. Sci. Technol.*, **28**(17), 2567–2586 (1993).
- Westgate, P.J. and M.R. Ladisch, "Air drying using corn grits as the sorbent in a pressure swing adsorber," *AIChE J.*, **39**(4), 720–723 (1993).
- Duprat, F., "Model of adsorption equilibrium of pyridine ternary mixture at saturation conditions," *Ind. Eng. Chem. Res.*, **31**(8), 1907–1913 (1992).
- El-Geundi, M.S., "Homogeneous surface diffusion model for the adsorption of basic dyestuffs onto natural clay in batch adsorbers," *Adsorpt. Sci. Technol.*, **8**(4), 217–225 (1992).
- Furlan, L.T., B.C. Chaves, and C.C. Santana, "Separation of liquid mixtures of p-xylene and o-xylene in X zeolites: The role of water content on the adsorbent selectivity," *Ind. Eng. Chem. Res.*, **31**(7), 1780–1784 (1992).
- Garcia-Delgado, R.A., L.M. Cotoruelo, and J.J. Rodriguez, "Adsorption of anionic surfactant mixtures by polymeric resins," *Sep. Sci. Technol.*, **27**(8), 1065–1076 (1992).
- Garcia-Delgado, R.A., L.M. Cotoruelo-Minguez, and J. Rodriguez, "Equilibrium study of single-solute adsorption of anionic surfactants with polymeric XAD resins," *Sep. Sci. Technol.*, **27**(7), 975–988 (1992).
- Hasany, S.M. and M.M. Saeed, "A kinetic and thermodynamic study of silver sorption onto manganese dioxide from acid solutions," *Sep. Sci. Technol.*, **27**(13), 1789–1800 (1992).
- Ito, Y., et al., "Uranium adsorption characteristics of a circulating fluidized-bed adsorber," *AIChE J.*, **38**(6), 879–886 (1992).
- Juang, R.S. and J.Y. Su, "Sorption of copper and zinc from aqueous sulfate solutions with bis(2-ethylhexyl)-phosphoric acid-impregnated macroporous resin," *Ind. Eng. Chem. Res.*, **31**(12), 2774–2779 (1992).
- Juang, R.S. and J.Y. Su, "Separation of zinc and copper from aqueous sulfate solutions using bis(2-ethylhexyl)-phosphoric acid-impregnated macroporous resin," *Ind. Eng. Chem. Res.*, **31**(12), 2779–2783 (1992).
- Leitao, A., et al., "Modeling of solid-liquid adsorption: Effects of adsorbent loads on model parameters," *Can. J. Chem. Eng.*, **70**(4), 690–698 (1992).
- Lin, S.H., "Concentration-dependent diffusion of dye in adsorptive dyeing systems," *J. Chem. Technol. Biotechnol.*, **54**(4), 387–392 (1992).
- Lu, C.S. and S.D. Huang, "Removal of organophosphorus pesticides from aqueous solution by using adsorptive bubble separation techniques," *Sep. Sci. Technol.*, **27**(13), 1733–1742 (1992).
- McKay, G., J.C. Kelly, and I.F. McConvey, "The adsorption of pollutants from aqueous effluents using a two-resistance mass-transfer model," *Adsorpt. Sci. Technol.*, **8**(1), 13–33 (1992).
- Medrzycka, K.B., "The effect of surfactant adsorption on the evaporation of volatile hydrocarbons from their aqueous solutions," *Sep. Sci. Technol.*, **27**(8), 1077–1092 (1992).
- Mellah, A., et al., "Adsorption of organic matter from a wet phosphoric acid using activated carbon: Equilibrium study," *Chem. Eng. Process.*, **31**(3), 191–194 (1992).
- Milonjic, S.K., M.R. Boskovic, and T.S. Ceranic, "Adsorption of uranium(VI) and zirconium(IV) from acid solutions on silica gel," *Sep. Sci. Technol.*, **27**(12), 1643–1660 (1992).
- Narsimhan, G. and F. Uraizee, "Kinetics of adsorption of globular proteins at an air-water interface," *Biotechnol. Prog.*, **8**(3), 187–196 (1992).
- Payne, G.F. and N. Maity, "Solute adsorption from water onto a 'modified' sorbent in which the hydrogen binding site is protected from water: Thermodynamics and separations," *Ind. Eng. Chem. Res.*, **31**(8), 2024–2033 (1992).
- Radeke, K.H. and G. Hartmann, "On the temperature dependence of adsorption of organic materials from aqueous solution," *Adsorpt. Sci. Technol.*, **8**(3), 153–156 (1992).

1.5 Liquid-Phase Adsorption

1992

- Balkose, D. and H. Baltacioglu, "Adsorption of heavy metal cations from aqueous solutions by wool fibers," *J. Chem. Technol. Biotechnol.*, **54**(4), 393–398 (1992).
- Bhutani, M.M., A.K. Mitra, and R. Kumari, "Sorption and radiochemical study of Cr(VI) ions at a stannic oxide/solution interface," *Adsorpt. Sci. Technol.*, **8**(1), 44–56 (1992).
- Bruckner, P., et al., "Adsorption and immersion of benzene in active carbons," *Adsorpt. Sci. Technol.*, **8**(1), 57–68 (1992).
- Do, D.D., S.G. Hu, and T.S. Nguyen, "Separation of dipeptides on a reverse-phase column: Effect of non-linear intrinsic adsorption kinetics," *Biochem. Eng. J.*, **49**(3), B41–B49 (1992).

- Roy, D., K.T. Valsaraj, and S.A. Kottai, "Separation of organic dyes from wastewater by using colloidal gas aphrons," *Sep. Sci. Technol.*, **27**(5), 573–588 (1992).
- Rudisill, E.N., J.J. Hacsakaylo, and M.D. LeVan, "Coadsorption of hydrocarbons and water in BPL activated carbon," *Ind. Eng. Chem. Res.*, **31**(4), 1122–1130 (1992).
- Saleem, M., et al., "Selective adsorption of uranium on activated charcoal from electrolytic aqueous solutions," *Sep. Sci. Technol.*, **27**(2), 239–254 (1992).
- Sanciolo, P., I.H. Harding, and D.E. Mainwaring, "The removal of chromium, nickel, and zinc from electroplating wastewater by adsorbing colloid flotation with a sodium dodecylsulfate/dodecanoic acid mixture," *Sep. Sci. Technol.*, **27**(3), 375–388 (1992).
- Saska, M., et al., "Continuous separation of sugarcane molasses with a simulated moving-bed adsorber: Adsorption equilibria, kinetics, and application," *Sep. Sci. Technol.*, **27**(13), 1711–1732 (1992).
- Silem, A., et al., "Adsorption of organic matter from a wet phosphoric acid using activated carbon: Batch-contact time study and linear driving force models," *Can. J. Chem. Eng.*, **70**(3), 491–498 (1992).
- Sircar, S. and M.B. Rao, "Kinetics and column dynamics for adsorption of bulk liquid mixtures," *AIChE J.*, **38**(6), 811–820 (1992).
- Tinge, J.T. and A.A.H. Drinkenburg, "Absorption of gases into activated carbon-water slurries in a stirred cell," *Chem. Eng. Sci.*, **47**(6), 1337–1346 (1992).
- Urano, K. and H. Tachikawa, "Process development for removal and recovery of phosphorus from wastewater by a new adsorbent: Desorption of phosphate and regeneration of adsorbent," *Ind. Eng. Chem. Res.*, **31**(6), 1510–1513 (1992).
- Urano, K., H. Tachikawa, and M. Kitajima, "Process development for removal and recovery of phosphorus from wastewater by a new adsorbent: Recovery of phosphate and aluminum from desorbing solution," *Ind. Eng. Chem. Res.*, **31**(6), 1513–1515 (1992).
- Valsaraj, K.T., "Adsorption of trace hydrophobic compounds from water on surfactant-coated alumina," *Sep. Sci. Technol.*, **27**(12), 1633–1642 (1992).
- Zamzow, M.J. and J.E. Murphy, "Removal of metal cations from water using zeolites," *Sep. Sci. Technol.*, **27**(14), 1969–1984 (1992).
- Goto, A., et al., "A test of uranium recovery from seawater with a packed bed of amidoxime fiber adsorbent," *Sep. Sci. Technol.*, **28**(6), 1273–1286 (1993).
- Gusler, G.M., T.E. Browne, and Y. Cohen, "Sorption of organics from aqueous solution onto polymeric resins," *Ind. Eng. Chem. Res.*, **32**(11), 2727–2735 (1993).
- Hawash, S., J.Y. Farah, and M.S. El-Geundi, "Investigation of nickel ion removal by means of activated clay," *Adsorpt. Sci. Technol.*, **9**(4), 244–257 (1993).
- Kapoor, A. and T. Viraraghavan, "Adsorption of mercury from wastewater by fly ash," *Adsorpt. Sci. Technol.*, **9**(3), 130–147 (1993).
- Lameloise, M.L. and V. Viard, "Modelling and simulation of a glucose-fructose simulated moving bed adsorber," *Food Bioprod. Process.*, **71**(C1), 27–32 (1993).
- Lee, S.Y., et al., "Multicomponent liquid-phase diffusion and adsorption in porous catalyst particles," *Chem. Eng. Sci.*, **48**(3), 595–608 (1993).
- Leitao, A. and A. Rodrigues, "Modelling of solid-liquid adsorption: Effects of adsorbent heterogeneity," *Chem. Eng. J.*, **51**(3), 159–166 (1993).
- Lin, S.H., "Adsorption of disperse dye by powdered activated carbon," *J. Chem. Technol. Biotechnol.*, **57**(4), 387–391 (1993).
- Lin, S.H., "Adsorption of disperse dye by various adsorbents," *J. Chem. Technol. Biotechnol.*, **58**(2), 159–164 (1993).
- Luo, C.S. and S.D. Huang, "Adsorption of copper ion with metal hydroxide from ammonia solution," *Sep. Sci. Technol.*, **28**(6), 1253–1272 (1993).
- Otu, E.O., J.J. Byerley, and C.W. Robinson, "Kinetic modelling of gold cyanide multi-cycle adsorption and elution using activated carbon in the presence of foulants," *Can. J. Chem. Eng.*, **71**(6), 925–933 (1993).
- Petersen, F.W., J.S.J. van Deventer, and L. Lorenzen, "The interaction between metal cyanides, fine particles and porous adsorbents in an agitated slurry," *Chem. Eng. Sci.*, **48**(16), 2919–2926 (1993).
- Pizzio, L.R., C.V. Caceres, and M.N. Blanco, "Tungsten adsorption on to alumina from ammonium meta- and para-tungstate solutions: UV-visible spectra of the solutions," *Adsorpt. Sci. Technol.*, **9**(1), 36–47 (1993).
- Quach, T., D.F.A. Koch, and F. Lawson, "Adsorption of gold cyanide on gangue minerals," *Chem. Eng. Aust.*, **18**(3), 6–9 (1993).
- Rauf, M.A., M.T. Hussain, and S.M. Hasany, "Adsorption of Europium on manganese dioxide from binary mixtures of aqueous sulfuric acid and methanol," *Sep. Sci. Technol.*, **28**(13), 2237–2246 (1993).
- Reunanen, J., et al., "Column adsorption in multi-solute water," *Chem. Eng. Process.*, **32**(5), 291–300 (1993).
- Rivera-Utrilla, J., et al., "Removal of tannic acid from aqueous solutions by activated carbons," *Chem. Eng. J.*, **52**(1), 37–40 (1993).
- Rorrer, G.L., T.Y. Hsien, and J.D. Way, "Synthesis of porous-magnetic chitosan beads for removal of cadmium ions from waste water," *Ind. Eng. Chem. Res.*, **32**(9), 2170–2178 (1993).
- Saleem, M., et al., "Selective adsorption of europium on activated charcoal from aqueous solutions," *Adsorpt. Sci. Technol.*, **9**(1), 1–16 (1993).
- Saleem, M., et al., "Surface characterization and thermodynamics of adsorption of Pr, Nd and Er on alumina from aqueous solution," *Adsorpt. Sci. Technol.*, **9**(1), 17–29 (1993).
- Simpson, E.J., et al., "Sorption equilibrium isotherms for volatile organics in aqueous solution: Comparison of head-space gas chromatography and on-line UV stirred cell results," *Ind. Eng. Chem.*

1993

Bakoyannakis, D.N., et al., "Studies of alizarine adsorption from solution on to aluminium hydroxide gels," *J. Chem. Technol. Biotechnol.*, **58**(3), 247–254 (1993).

Chatzopoulos, D., A. Varma, and R.L. Irvine, "Activated carbon adsorption and desorption of toluene in the aqueous phase," *AIChE J.*, **39**(12), 2027–2041 (1993).

El-Geundi, M.S., "Pore diffusion model for the adsorption of basic dyestuffs onto natural clay in batch adsorbers," *Adsorpt. Sci. Technol.*, **9**(2), 109–120 (1993).

El-Geundi, M.S., "Branched-pore kinetic model for basic dyestuff adsorption onto natural clay," *Adsorpt. Sci. Technol.*, **9**(3), 199–211 (1993).

Fox, I. and M.A. Malati, "An investigation of phosphate adsorption by clays and its relation to the problems of eutrophication of the River Stour, Kent," *J. Chem. Technol. Biotechnol.*, **57**(2), 97–108 (1993).

Gonzalez-Pradas, E., et al., "Removal of 3-(3,4-dichlorophenyl)-1,1 dimethylurea from aqueous solution by natural and activated bentonite," *J. Chem. Technol. Biotechnol.*, **56**(1), 67–72 (1993).

- Res.*, **32**(10), 2269–2276 (1993).
- Sircar, S., “Gibbsian thermodynamics and column dynamics for adsorption of liquid mixtures,” *Ind. Eng. Chem. Res.*, **32**(10), 2430–2437 (1993).
- “Various, Application of gas and liquid phase adsorption (topic issue),” *Sep. Sci. Technol.*, **27**(14), 1822–2040 (1992).
- Yang, O.B., et al., “Use of activated carbon fiber for direct removal of iodine from acetic acid solution,” *Ind. Eng. Chem. Res.*, **32**(8), 1692–1697 (1993).

1.6 Ion Exchange, Chromatography, etc.

1992

- Alexandratos, S.D. and P.T. Kaiser, “Reaction kinetics of polystyrene-based phosphinic acid ion exchange/redox resins with metal ions,” *Solvent Extr. Ion Exch.*, **10**(3), 539–550 (1992).
- Anon., “Advances in ion exchange,” *Chem. Eng.* (N.Y.), September, 63–71 (1992).
- Anon., “Ion exchange for esterification,” *Chem. Eng. (Rugby, Engl.)*, 10 December, 14–15 (1992).
- Barker, P.E., et al., “Bioreaction-separation on continuous chromatographic systems,” *Biochem. Eng. J.*, **50**(2), B23–B28 (1992).
- Bartle, K.D., J.M. Taylor, and A. Williams, “Release of nitrogen compounds from coal during high temperature pyroprobe gas chromatography with selective detection (letter),” *Fuel*, **71**(6), 714–715 (1992).
- Baum, R., “New techniques for Fullerene separations,” *Chem. Eng. News*, 28 September, 43–44 (1992).
- Bauza, R., et al., “Separation of mono-, di-, and tri-stearin from an industrial mixture of glycerides by normal- and reverse-phase HPLC,” *Sep. Sci. Technol.*, **27**(5), 645–662 (1992).
- Bhandari, V.M., V.A. Juvekar, and S.R. Patwardhan, “Sorption studies on ion exchange resins: Sorption of strong acids on weak base resins,” *Ind. Eng. Chem. Res.*, **31**(4), 1060–1073 (1992).
- Bhandari, V.M., V.A. Juvekar, and S.R. Patwardhan, “Sorption studies on ion exchange resins: Sorption of weak acids on weak base resins,” *Ind. Eng. Chem. Res.*, **31**(4), 1073–1080 (1992).
- Bhandari, V.M., V.A. Juvekar, and S.R. Patwardhan, “Modified shrinking core model for reversible sorption on ion-exchange resins,” *Sep. Sci. Technol.*, **27**(8), 1043–1064 (1992).
- Bhattacharyya, D.K. and N.C. Dutta, “Role of hydrous titanium oxide on the uptake of several tracer cations, and separation of carrier-free Te(125m) from Sb(125) and I(132) from Te(132),” *Sep. Sci. Technol.*, **27**(3), 399–408 (1992).
- Bhutani, M.M., A. Santosh, and A.K. Mitra, “Use of carrier technique for preconcentration of microamounts of Cr(VI): A radio-indicator study,” *Sep. Sci. Technol.*, **27**(4), 535–546 (1992).
- Binous, H. and B.J. McCoy, “Chromatographic reactions of three components: Application to separations,” *Chem. Eng. Sci.*, **47**(17), 4333–4344 (1992).
- Bricio, O., J. Coca, and H. Sastre, “A comparative study of kinetic models for ion-exchange using macroporous resins and concentrated solutions,” *Solvent Extr. Ion Exch.*, **10**(2), 381–400 (1992).
- Bridges, S. and P.E. Barker, “Modelling continuous chromatographic separations,” *Chem. Eng. Sci.*, **47**(5), 1299–1306 (1992).
- Brooks, C.A. and S.M. Cramer, “Steric mass-action ion exchange: Displacement profiles and induced salt gradients,” *AIChE J.*, **38**(12), 1969–1978 (1992).
- Calvarin, L., B. Roche, and H. Renon, “Anion exchange and aggregation of dicyanocobalamin with quaternary ammonium salts in apolar environment,” *Ind. Eng. Chem. Res.*, **31**(7), 1705–1709 (1992).
- Carta, G., et al., “Chromatography of reversibly reacting mixtures: Mutarotation effects in sugar separations,” *Chem. Eng. Sci.*, **47**(7), 1645–1658 (1992).
- Cavender, M.R., H.L. Chiang, and K. Myers, “Optimize ion exchange resins replacement,” *Chem. Eng. Prog.*, **88**(9), 56–59 (1992).
- Chase, H.A. and N.M. Draeger, “Expanded-bed adsorption of proteins using ion-exchangers,” *Sep. Sci. Technol.*, **27**(14), 2021–2040 (1992).
- Chiarizia, R., E.P. Horwitz, and M.L. Dietz, “Acid dependency of the extraction of selected metal ions by a strontium-selective extraction chromatographic resin: Calculated vs. experimental curves,” *Solvent Extr. Ion Exch.*, **10**(2), 337–362 (1992).
- Clark, W.M., “Electrophoresis-enhanced extractive separation,” *Chemtech*, **22**(7), 425–429 (1992).
- Clifton, M.J., H. Roux-de Balmain, and V. Sanchez, “Electrohydrodynamic deformation of the sample stream in continuous-flow electrophoresis with an AC electric field,” *Can. J. Chem. Eng.*, **70**(6), 1058–1063 (1992).
- de Bokx, P.K., P.C. Baarslag, and H.P. Urbach, “Calculation and experimental verification of solute retention in liquid chromatography using binary eluents,” *Sep. Sci. Technol.*, **27**(7), 875–900 (1992).
- De Lucas, A., J. Zarca, and P. Canizares, “Ion-exchange equilibrium of Ca^{2+} , Mg^{2+} , K^{+} , Na^{+} , and H^{+} ions on Amberlite IR-120: Experimental determination and theoretical prediction of the ternary and quaternary equilibrium data,” *Sep. Sci. Technol.*, **27**(6), 823–842 (1992).
- Durao, M.I.G., C.A.V. Costa, and A.E. Rodrigues, “Saturation and regeneration of ion exchangers with volume changes,” *Ind. Eng. Chem. Res.*, **31**(11), 2564–2572 (1992).
- Eccles, H. and H. Greenwood, “Chelate ion-exchangers: The past and future applications, a user’s view,” *Solvent Extr. Ion Exch.*, **10**(4), 713–728 (1992).
- Economopoulos, N., et al., “A plant kinetic study of alcoholic fermentation using reversed-flow gas chromatography,” *Sep. Sci. Technol.*, **27**(15), 2055–2070 (1992).
- El-Naggar, I.M. and H.F. Aly, “Kinetics of Cs^{+} , Sc^{3+} , and Eu^{3+} exchange on crystalline atimonic acid,” *Solvent Extr. Ion Exch.*, **10**(1), 145–158 (1992).
- Georgiev, J.K. and A.L. Zahariev, “Degree of separation in a gas thermal diffusion column depending on the parameters of the gas mixture, the geometry, and the column productivity,” *Sep. Sci. Technol.*, **27**(6), 717–740 (1992).
- Georgiev, J.K. and A.L. Zahariev, “Optimization and calculation of gas thermal diffusion column,” *Sep. Sci. Technol.*, **27**(7), 917–936 (1992).
- Giddings, J.C., “Optimization of transport-driven continuous SPLITT fractionation,” *Sep. Sci. Technol.*, **27**(11), 1489–1504 (1992).
- Granger, J. and J. Dodds, “Two different configurations of flow field-flow fractionation for size analysis of colloids,” *Sep. Sci. Technol.*, **27**(13), 1691–1710 (1992).
- Gu, T., et al., “Modeling of gradient elution in multicomponent non-linear chromatography,” *Chem. Eng. Sci.*, **47**(1), 253–262 (1992).
- Heininger, M.W. and C.E. Meloan, “A selective reagent for the removal and recovery of chromate, molybdate, tungstate, and vana-

- date from aqueous solution," *Sep. Sci. Technol.*, **27**(5), 663–670 (1992).
- Heininger, M.W. and C.E. Meloan, "A resin with selectivity for the removal and recovery of chromate from contaminated water," *Solvent Extr. Ion Exch.*, **10**(1), 159–172 (1992).
- Horwitz, B.P., R. Chiarizia, and M.L. Dietz, "A novel strontium-selective extraction chromatographic resin," *Solvent Extr. Ion Exch.*, **10**(2), 313–336 (1992).
- Hossain, M.M. and D.D. Do, "The effects of denaturation in the displacement chromatographic behaviour of proteins," *Biochem. Eng. J.*, **49**(3), B29–B39 (1992).
- Huang, S.Y. and J.D. Jin, "Operation strategy for displacement chromatography: Selection of optimum mobile phase for separation of weak adsorptive nucleotides," *Chem. Eng. Sci.*, **47**(1), 21–30 (1992).
- Jaeger, M.J., P. Kalle, and U.H. Kurzweg, "Separation of gases by enhanced upstream diffusion," *Sep. Sci. Technol.*, **27**(6), 691–702 (1992).
- Kaur, P., et al., "Studies on the sorption behaviour of some amino acids on silica gel pretreated with alkalis in relation to chromatography," *Adsorpt. Sci. Technol.*, **8**(3), 157–173 (1992).
- Kim, S.U., et al., "Peak compression in stepwise pH elution with flow reversal in ion exchange chromatography," *Ind. Eng. Chem. Res.*, **31**(7), 1717–1730 (1992).
- Kinugasa, T., K. Watanabe, and H. Takeuchi, "Activity and conformation of lysozyme in reversed micellar extraction," *Ind. Eng. Chem. Res.*, **31**(7), 1827–1829 (1992).
- Larson, K.A. and J.M. Wiencek, "Liquid ion exchange for mercury removal from water over a wide pH range," *Ind. Eng. Chem. Res.*, **31**(12), 2714–2722 (1992).
- Lee, K.N. and W.K. Lee, "A theoretical model for the separation of glucose and fructose mixtures by using a semicontinuous chromatographic refiner," *Sep. Sci. Technol.*, **27**(3), 295–312 (1992).
- Leung, B.K.O. and M.J. Hudson, "A novel weak-base anion-exchange resin which is highly selective for the precious metals over base metals," *Solvent Extr. Ion Exch.*, **10**(1), 173–190 (1992).
- Levy, D., et al., "Immobilization of quaternary ammonium anion exchangers in sol-gel glasses," *Sep. Sci. Technol.*, **27**(5), 589–598 (1992).
- Lewandowski, R. and M.L. Lameloise, "Study of exclusion equilibrium between a sucrose-NaCl solution and an ion exchange resin," *Chem. Eng. Process.*, **31**(4), 207–212 (1992).
- McCormick, C.A., M.O. Toll, and W.H. Marshall, "A low cost microprocessor-controlled electrofusion and electroporation system," *J. Chem. Technol. Biotechnol.*, **54**(2), 159–170 (1992).
- Mezhov, E., A.V. Samatov, and L.V. Troyanovskiy, "Extraction of trivalent actinides and lanthanides from nitric acid solutions by ion flotation," *Sep. Sci. Technol.*, **27**(5), 599–612 (1992).
- Mijangos, F. and M. Diaz, "Metal-proton equilibrium relations in a chelating iminodiacetic resin," *Ind. Eng. Chem. Res.*, **31**(11), 2524–2532 (1992).
- Miyabe, K. and M. Suzuki, "Chromatography of liquid-phase adsorption on octadecylsilyl-silica gel," *AIChE J.*, **38**(6), 901–910 (1992).
- Mohammad, A.W., D.G. Stevenson, and P.C. Wankat, "Pressure drop correlations and scale-up of size exclusion chromatography with compressible packings," *Ind. Eng. Chem. Res.*, **31**(2), 549–561 (1992).
- Mozersky, S.M., "Calculation of particle mass from sedimentation field-flow fractionation data: The buoyancy factor," *Sep. Sci. Technol.*, **27**(12), 1505–1524 (1992).
- Oi, T., et al., "Fractionation of strontium isotopes in cation-exchange chromatography," *Sep. Sci. Technol.*, **27**(5), 631–644 (1992).
- Olson, K.C. and R.L. Gehant, "Applications of ultrafast HPLC to process development of recombinant DNA-derived proteins," *Biotechnol. Prog.*, **8**(6), 562–566 (1992).
- Panneman, H.J. and A.A.C.M. Beenackers, "Solvent effects on the hydration of cyclohexene catalyzed by a strong acid ion exchange resin: Solubility of cyclohexene in aqueous sulfonate mixtures," *Ind. Eng. Chem. Res.*, **31**(4), 1227–1231 (1992).
- Park, C.M., and W. Meyer, "Separation of ^{137}Cs , ^{90}Sr , and ^{232}Th in aqueous solution by using a multistage countercurrent batch contactor ion-exchange system," *Sep. Sci. Technol.*, **27**(2), 223–238 (1992).
- Samanta, S.K., M. Ramaswamy, and B.M. Misra, "Studies on cesium uptake by phenolic resins," *Sep. Sci. Technol.*, **27**(2), 255–268 (1992).
- Savkovic-Stevanovic, J., et al., "Reaction distillation with ion exchangers," *Sep. Sci. Technol.*, **27**(5), 613–630 (1992).
- Sengupta, A.K. and Y. Zhu, "Metals sorption by chelating polymers: A unique role of ionic strength," *AIChE J.*, **38**(1), 153–157 (1992).
- Shmidt, J.L. and H.Y. Cheh, "Free flow electrophoresis with multiple gating electrodes," *Sep. Sci. Technol.*, **27**(4), 419–426 (1992).
- Soldatov, V.S., "Mathematical modelling of ion exchange equilibria," *J. Chem. Technol. Biotechnol.*, **55**(3), 298–300 (1992).
- Stichlmair, J., J. Schmidt, and R. Proplesch, "Electroextraction: A novel separation technique," *Chem. Eng. Sci.*, **47**(12), 3015–3022 (1992).
- Tsuji, M. and S. Komarneni, "An extended method for analytical evaluation of distribution coefficients on selective inorganic ion exchangers," *Sep. Sci. Technol.*, **27**(6), 813–822 (1992).
- Velayudhan, A. and M.R. Ladisch, "Effect of modulator sorption in gradient elution chromatography: Gradient deformation," *Chem. Eng. Sci.*, **47**(1), 233–240 (1992).
- Viard, V. and M.L. Lameloise, "Modelling glucose-fructose separation by adsorption chromatography on ion exchange resins," *J. Food Eng.*, **17**(1), 29–48 (1992).
- Williams, P.S., et al., "Continuous SPLITT fractionation based on a diffusion mechanism," *Ind. Eng. Chem. Res.*, **31**(9), 2172–2181 (1992).
- Williams, P.S., T. Koch, and J.C. Giddings, "Characterization of near-wall hydrodynamic lift forces using sedimentation field-flow fractionation," *Chem. Eng. Commun.*, **111**, 121–148 (1992).
- Yang, B.L. and S. Goto, "Separation and concentration of adenosine triphosphate and adenosine monophosphate by using two chromatographic columns," *Sep. Sci. Technol.*, **27**(4), 547–556 (1992).
- Yoshida, H., K. Shimizu, and T. Kataoka, "Recovery of amine and paints from electrodeposition wastewater by an H-form ion exchanger: Desorption process," *Ind. Eng. Chem. Res.*, **31**(3), 934–941 (1992).

1993

- Ashrafizadeh, S.N., M.E. Weber, and J.H. Vera, "Cation exchange with reverse micelles," *Ind. Eng. Chem. Res.*, **32**(1), 125–132 (1993).
- Bender, D.R., A.M. DeMarco, and J.A. McCauley, "Compound separation by cyclic, selective dissolution: Isolation of diastereomeric, 1-beta-methylcarbapenem key intermediates," *Sep. Sci. Technol.*, **28**(5), 1169–1176 (1993).

- Besirli, N. and B.M. Baysal, "Ion-exchange studies with some complex ions on ion-exchange resins," *Solvent Extr. Ion Exch.*, **11**(3), 541–554 (1993).
- Bhandari, V.M., V.A. Juvekar, and S.R. Patwardhan, "Sorption of dibasic acids on weak base resins," *Ind. Eng. Chem. Res.*, **32**(1), 200–206 (1993).
- Blazy, P., et al., "Selective recovery of rhenium from gas-scrubbing solutions of molybdenite roasting using direct precipitation and separation on resins," *Sep. Sci. Technol.*, **28**(11), 2073–2096 (1993).
- Carta, G. and A.E. Rodrigues, "Diffusion and convection in chromatographic processes using permeable supports with a bidisperse pore structure," *Chem. Eng. Sci.*, **48**(23), 3927–3935 (1993).
- Chen, J. and H.Y. Wang, "Bioprocess monitoring of dissolved oxygen using a computerized pulsing membrane electrode," *Biotechnol. Prog.*, **9**(1), 75–80 (1993).
- Chiarizia, R., et al., "Uptake of metal ions by a new chelating ion-exchange resin: Acid dependencies of transition and post-transition metal ions," *Solvent Extr. Ion Exch.*, **11**(5), 967–986 (1993).
- Choudhary, V.R. and S. Mayadevi, "Adsorption of methane, ethane, ethylene, and carbon dioxide on high silica pentasil zeolites and zeolite-like materials using gas chromatography pulse technique," *Sep. Sci. Technol.*, **28**(13), 2197–2210 (1993).
- Egawa, H., et al., "Recovery of uranium from seawater: Long-term stability tests for high-performance chelating resins containing amidoxime groups and evaluation of elution process," *Ind. Eng. Chem. Res.*, **32**(3), 540–547 (1993).
- Egawa, H., et al., "Recovery of uranium from seawater: System arrangements for the recovery of uranium from seawater by spherical amidoxime chelating resins utilizing natural seawater motions," *Ind. Eng. Chem. Res.*, **32**(4), 709–715 (1993).
- El-Naggar, I.M., et al., "Ion-exchange equilibrium of the $\text{Cu}^{2+}/\text{H}^{+}$, $\text{Zn}^{2+}/\text{H}^{+}$ and $\text{Pb}^{2+}/\text{H}^{+}$ ions on hydrated ferric oxide," *Solvent Extr. Ion Exch.*, **11**(4), 683–692 (1993).
- Felinger, A. and G. Guiochon, "The change of pressure drop during large-scale chromatography of viscous samples," *Biotechnol. Prog.*, **9**(5), 450–455 (1993).
- Fernandez, A., C. Suarez, and M. Diaz, "Kinetics of metal ion exchange in iminodiacetic resins at low concentrations," *J. Chem. Technol. Biotechnol.*, **58**(3), 255–260 (1993).
- Fish, B.B., R.W. Carr, and R. Aris, "Optimization of the countercurrent moving-bed chromatographic separator," *AIChE J.*, **39**(10), 1621–1627 (1993).
- Fries, W. and D. Chew, "Ion exchange to remove heavy metals," *Chemtech*, **23**(2), 32–35 (1993).
- Goncalves, M.C. and F. Galembeck, "Counterion fractionation in the osmosedimentation of polyelectrolytes," *Sep. Sci. Technol.*, **28**(5), 1145–1156 (1993).
- Gonzalez-Patino, F., J. Catalan, and M.A. Galan, "Affinity chromatography: Effect of particle size on adsorption equilibrium and mass transfer kinetics," *Chem. Eng. Sci.*, **48**(9), 1567–1574 (1993).
- Gustafsson, N.O., et al., "Measurement of diffusion coefficients in gels using holographic laser interferometry," *Biotechnol. Prog.*, **9**(4), 436–441 (1993).
- Haas, P.A., "A new apparatus for continuous countercurrent flow of solids and liquids," *Sep. Sci. Technol.*, **28**(8), 1579–1594 (1993).
- Hamdi, A.E.N.H., et al., "Surfactant based on aromatic extract sulfonate," *Ind. Eng. Chem. Res.*, **32**(8), 1710–1716 (1993).
- Hashim, M.A., K.H. Chu, and P.S. Tsan, "Ion-exchange equilibria of conalbumin and myoglobin," *Food Bioprod. Process.*, **71**(C4), 273–278 (1993).
- Hayashita, T., et al., "Effect of ring-size variation within dibenzocrown ether resins upon ion-pair sorption of alkali-metal cations from aqueous and aqueous methanol solutions," *Sep. Sci. Technol.*, **28**(17), 2607–2620 (1993).
- Heinrich, J., M.J. Clifton, and H. Wagner, "Use of in-situ conductivity measurements to calculate the flow field and heat transfer in continuous-flow electrophoresis," *Int. J. Heat Mass Transfer*, **36**(15), 3703–3710 (1993).
- Hejtmanek, V. and P. Schneider, "Axial dispersion under liquid-chromatography conditions," *Chem. Eng. Sci.*, **48**(6), 1163–1168 (1993).
- Horwitz, E.P., et al., "Uptake of metal ions by a new chelating ion-exchange resin: Acid dependencies of actinide ions," *Solvent Extr. Ion Exch.*, **11**(5), 943–966 (1993).
- Huhn, G.F., et al., "Purification of nucleoside-5'-diphosphates: A new ion-exchange method," *Sep. Sci. Technol.*, **28**(11), 1959–1970 (1993).
- Iritani, E., M. Iwata, and T. Murase, "Concentration of proteinaceous solutions with superabsorbent hydrogels," *Sep. Sci. Technol.*, **28**(10), 1819–1836 (1993).
- Jepson, B.E., M.A. Novotny, and W.F. Evans, "Dimethylsulfoxide augmented calcium isotope effect with polymer-bond 18-crown-6 in a chromatographic chemical exchange system," *Sep. Sci. Technol.*, **28**(1), 507–518 (1993).
- Jones, I.L. and G. Carta, "Ion exchange of amino acids and dipeptides on cation resins with varying degree of cross-linking: Equilibrium," *Ind. Eng. Chem. Res.*, **32**(1), 107–117 (1993).
- Jones, I.L. and G. Carta, "Ion exchange of amino acids and dipeptides on cation resins with varying degree of cross-linking: Intraparticle transport," *Ind. Eng. Chem. Res.*, **32**(1), 117–125 (1993).
- Kaneko, H., M. Tsuji, and Y. Tamaura, "Thermodynamic study of $\text{M}^{3+}/\text{H}^{+}$ exchange systems on titanium antimonate cation exchanger," *Solvent Extr. Ion Exch.*, **11**(4), 693–712 (1993).
- Keh, H.J. and F.R. Yang, "Boundary effects on osmophoresis: Motion of a vesicle in an arbitrary direction with respect to a plane wall," *Chem. Eng. Sci.*, **48**(20), 3555–3564 (1993).
- Keh, H.J. and F.R. Yang, "Boundary effects of osmophoresis: Motion of a vesicle normal to a plane wall," *Chem. Eng. Sci.*, **48**(3), 609–616 (1993).
- Komatsu, Y., Y. Fujiki, and T. Sasaki, "Ion-exchange separation of sodium and potassium ions on dihydrogen tetratitanate hydrate fibers at various temperatures," *Solvent Extr. Ion Exch.*, **11**(1), 159–169 (1993).
- Konishi, Y., et al., "Recovery of zinc, cadmium, and lanthanum by biopolymer gel particles of alginic acid," *Sep. Sci. Technol.*, **28**(9), 1691–1702 (1993).
- Kraaijeveld, G. and J.A. Wesselingh, "The kinetics of film-diffusion-limited ion exchange," *Chem. Eng. Sci.*, **48**(3), 467–474 (1993).
- Lee, C.K. and J. Hong, "Cyclic operation of forced flow electrokinetic separation for simultaneous separation and concentration of charged molecules," *Sep. Sci. Technol.*, **28**(5), 1211–1232 (1993).
- Lee, W.C., "Analysis of preparative chromatography by local equilibrium model," *Chem. Eng. Commun.*, **122**, 69–84 (1993).
- Lee, W.C., G.J. Tsai, and G.T. Tsao, "Analysis of chromatography by plate theory," *Sep. Technol.*, **3**(4), 178–197 (1993).
- Liu, H.S., S.S. Wang, and H.W. Hsu, "Double-substrate interactive model," *Chem. Eng. Sci.*, **48**(11), 2169–2172 (1993).
- Locke, B.R. and P. Arce, "Modeling electrophoretic transport of polyelectrolytes in beds of nonporous spheres," *Sep. Technol.*, **3**(2), 111–120 (1993).

- Lumetta, G.J., et al., "Preliminary evaluation of chromatographic techniques for the separation of radionuclides from high-level radioactive waste," *Solvent Extr. Ion Exch.*, **11**(4), 663-682 (1993).
- Luo, R.G. and J.T. Hsu, "Intraparticle protein diffusion effect on gradient elution chromatography," *Sep. Technol.*, **3**(4), 221-229 (1993).
- Mak, A.N.S., et al., "Continuous ion exchange in a pulsed packed column containing structured packing: Mass-transfer-controlled kinetics," *Chem. Eng. Sci.*, **48**(4), 701-714 (1993).
- Mandralis, Z.I. and D.L. Feke, "Fractionation of suspensions using synchronized ultrasonic and flow fields," *AIChE J.*, **39**(2), 197-206 (1993).
- Marando, M.A. and W.M. Clark, "Two-phase electrophoresis of proteins," *Sep. Sci. Technol.*, **28**(8), 1561-1578 (1993).
- Marquez, N., et al., "Experimental conditions for HPLC analysis of ethoxylated alkyl phenol surfactants in microemulsion systems: Gradient mode for extended EON range as found in analysis of oligomer fractionation," *Sep. Sci. Technol.*, **28**(15), 2387-2400 (1993).
- McFann, G.J., et al., "Carbon dioxide regeneration of block copolymer micelles used for extraction and concentration of trace organics," *Ind. Eng. Chem. Res.*, **32**(10), 2336-2344 (1993).
- Metwally, M.S. and T.M. Samy, "Selectivity of $M^{+}H^{+}$ ion-exchange absorption on sulfonic resins in ternary solutions," *Sep. Sci. Technol.*, **28**(13), 2273-2278 (1993).
- Ming, F. and J.A. Howell, "Parameter estimation for a column adsorption model incorporating axial dispersion: Application to a novel monolithic ion-exchange column," *Food Bioprod. Process.*, **71**(C4), 267-272 (1993).
- Nash, K.L., "A review of the basic chemistry and recent developments in trivalent f-elements separations," *Solvent Extr. Ion Exch.*, **11**(4), 729-786 (1993).
- Oi, T., et al., "Fractionation of calcium isotopes in cation-exchange chromatography," *Sep. Sci. Technol.*, **28**(11), 1971-1984 (1993).
- Park, W.K. and E.D. Michaels, "Displacement band chromatography of hydrogen sulfites for enrichment of sulfur isotopes," *Sep. Sci. Technol.*, **28**(1), 477-486 (1993).
- Pazourek, J., et al., "Rapid separation of micron-sized particles by field-flow fractionation using earth's gravitational field," *Sep. Sci. Technol.*, **28**(10), 1859-1874 (1993).
- Perona, J.J., "Model for Sr-Cs-Ca-Mg-Na ion-exchange equilibria on chabazite," *AIChE J.*, **39**(10), 1716-1720 (1993).
- Quinta Ferreira, R.M. and A.E. Rodrigues, "Diffusion and catalytic zero-order reaction in a macroreticular ion exchange resin," *Chem. Eng. Sci.*, **48**(16), 2927-2950 (1993).
- Robinson-Piergiorgio, P.S., L.J. Crane, and D.R. Nau, "Solid-phase extraction columns: A tool for teaching biochromatography," *Chem. Eng. Educ.*, **27**(1), 34-37 (1993).
- Rogers, R.D., A.H. Bond, and C.B. Bauer, "Metal ion separations in polyethylene glycol-based aqueous biphasic systems (review paper)," *Sep. Sci. Technol.*, **28**(5), 1091-1126 (1993).
- Romdhane, I.H. and R.P. Danner, "Polymer-solvent diffusion and equilibrium parameters by inverse gas-liquid chromatography," *AIChE J.*, **39**(4), 625-635 (1993).
- Rudge, S.R., S.K. Basak, and M.R. Ladisch, "Solute retention in electrochromatography by electrically induced sorption," *AIChE J.*, **39**(5), 797-808 (1993).
- Sarmidi, M.R. and P.E. Barker, "Simultaneous biochemical reaction and separation in a rotating annular chromatograph," *Chem. Eng. Sci.*, **48**(14), 2615-2624 (1993).
- Sarmidi, M.R. and P.E. Barker, "Saccharification of modified starch to maltose in a continuous rotating annular chromatograph (CRAC)," *J. Chem. Technol. Biotechnol.*, **57**(3), 229-236 (1993).
- Sato, K., et al., "Temperature gradient method for continuous counter-current gas-liquid chromatography," *Sep. Sci. Technol.*, **28**(7), 1409-1420 (1993).
- Scenna, N.J. and P.A. Aguirre, "A thermodynamic methodology for process synthesis and its application to dual-purpose desalination plants: Extraction vs back pressure turbines," *Chem. Eng. Res. Des.*, **71**(1), 77-84 (1993).
- Schisla, D.K., et al., "Polydisperse tube diameters compromise multiple open tubular chromatography," *AIChE J.*, **39**(6), 946-953 (1993).
- Seidel-Morgenstern, A. and G. Guiochon, "Theoretical study of recycling in preparative chromatography," *AIChE J.*, **39**(5), 809-819 (1993).
- Seidel-Morgenstern, A. and G. Guiochon, "Modelling of the competitive isotherms and the chromatographic separation of two enantiomers," *Chem. Eng. Sci.*, **48**(15), 2787-2798 (1993).
- Sharma, C.S., P.K. Goswami, and N.N. Dutta, "Studies on facilitated transport of carbon monoxide using a novel iron(II) complex," *Sep. Sci. Technol.*, **28**(9), 1789-1797 (1993).
- Stenger, H.G., K. Hu, and D.R. Simpson, "Chromatographic separation and concentration of sulfur dioxide in flue gases," *Ind. Eng. Chem. Res.*, **32**(11), 2736-2739 (1993).
- Suwondo, E., et al., "Optimization of a liquid chromatographic separation process," *Comput. Chem. Eng.*, **17**(supplement), S135-S140 (1993).
- Tao, Z. and C. Wang, "Determination of ion exchange equilibrium constants for weakly dissociating ion exchange resins," *Solvent Extr. Ion Exch.*, **11**(4), 713-728 (1993).
- Tarnopolsky, Y., M. Roman, and P.R. Brown, "A new approach to scaling up electrophoresis," *Sep. Sci. Technol.*, **28**(1), 719-732 (1993).
- Tsuji, M., S. Komarneni, and M. Abe, "Ion-exchange selectivity for alkali metal ions on a cryptomelane-type hydrous manganese dioxide," *Solvent Extr. Ion Exch.*, **11**(1), 143-158 (1993).
- Warner-Schmid, D., S. Hoshi, and D.W. Armstrong, "Removal of organic compounds from water via cloud-point extraction with permethyl hydroxypropyl-beta-cyclodextrin," *Sep. Sci. Technol.*, **28**(4), 1009-1018 (1993).
- Whitley, R.G., K.E. Van Cott, and N.H.L. Wang, "Analysis of nonequilibrium adsorption/desorption kinetics and implications for analytical and preparative chromatography," *Ind. Eng. Chem. Res.*, **32**(1), 149-159 (1993).
- Yamamoto, S., T. Suehisa, and Y.J. Sano, "Preparative separation of proteins by gradient-elution and stepwise-elution chromatography: Zone-sharpening effect," *Chem. Eng. Commun.*, **119**, 221-230 (1993).
- Yonemoto, T., et al., "A novel continuous rotating annular liquid chromatograph with a multichannel peristaltic pump for variable eluent withdrawal," *Sep. Sci. Technol.*, **28**(17), 2587-2606 (1993).
- Zhong, G.M. and F. Meunier, "Interference theory: Moment solution for two-component nonequilibrium adsorption chromatography," *Chem. Eng. Sci.*, **48**(24), 4105-4108 (1993).
- Zhong, G.M. and F. Meunier, "Interference theory: Moment solution for three-component nonequilibrium adsorption chromatography," *Chem. Eng. Sci.*, **48**(24), 4109-4114 (1993).
- Zhong, G.M. and F. Meunier, "Linear perturbation chromatography theory: Moment solution for two-component nonequilibrium adsorption," *Chem. Eng. Sci.*, **48**(7), 1309-1316 (1993).
- Zhu, J., Z. Ma, and G. Guiochon, "The thickness of shock layers in

liquid chromatography," *Biotechnol. Prog.*, **9**(4), 421–428 (1993).
 Zuyi, T. and W. Changshou, "Determination of ion exchange equilibrium constants for weakly dissociating ion exchange resins," *Solvent Extr. Ion Exch.*, **11**(2), 171–186 (1993).

References

1. Ray, M.S., "Adsorptive and Membrane Separations: A Bibliographical Guide (1985–1989)," *Adsorpt. Sci. Technol.*, **7**(1), 28–64 (1990).
2. Ray, M.S., "Adsorptive and Membrane-type Separations: A Bibliographical Guide (1991)," *Adsorpt. Sci. Technol.*, **8**(3), 114–133 (1991).
3. Ray, M.S., "Membranes and Membrane-type Separations: A Bibliographical Guide (1992–1993)," *Sep. Purif. Methods*, in Press.
4. Ray, M.S., "Distillation (1980–1990): A Bibliography," *Sep. Sci. Technol.*, **27**(1), 105–128 (1992).
5. Ray, M.S., "Equilibrium-Staged Separations: A Bibliography (1991)," *Sep. Sci. Technol.*, **28**(6), 1361–1378 (1993).
6. Ray, M.S., "Equilibrium-Staged Separations: A Bibliography Update (1992–1993)," *Sep. Sci. Technol.*, **29**(17), 2367–2393 (1994).
7. Ray, M.S., "Liquid-Liquid Extraction (1992–1993): A Bibliography Update," *Sep. Sci. Technol.*, **29**(18), 2543–2556 (1994).
8. Ray, M.S., "Supercritical Extraction (1980–1993): A Bibliographic Guide," *Sep. Sci. Technol.*, **29**(16), 2209–2219 (1994).
9. Ray, M.S., *Chemical Engineering Bibliography (1967–1988)*, Noyes Publications, New Jersey, USA, 1990.
10. Ray, M.S., *Chemical Engineering Bibliography Update (1989–90)*, Chem. Eng. Dept., Curtin University, Western Australia, 1991.
11. Ray, M.S., *The Chemical Engineering Complete Annual Bibliography (1991)*, Chem. Eng. Dept., Curtin University, Western Australia, 1992.
12. Ray, M.S., *Chemical Engineering Bibliography (1992–93)*, Chem. Eng. Dept., Curtin University, Western Australia, 1991.
13. Bourton, K., *Chemical and Process Engineering Unit Operations: A Bibliographical Guide*, MacDonald and Co., London, 1967.