CHEMICAL ENGINEERING PROGRESS SYMPOSIUM SERIES ABSTRACTS

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ADSORPTION, DIALYSIS, AND ION EXCHANGE, Vol. 55, No. 24, 1959

Basic Principles Involved in the Macroseparation of Adjacent Rare Earths from Each Other by Means of Ion Exchange, J. E. Powell and F. H. Spedding. The separation of rare-earth mixtures by ion exchange with ammonium ethylenediaminetetraacetate and ammonium *N*-hydroxyethylethylenediaminetriacetate as eluting agents has been discussed in detail. It has been shown how simple countercurrent separation theory can be applied to more complex systems, and experimental data have been presented for some of the groups of rare-earth species that are separated with difficulty. **Gaseous Diffusion Through Microporous and Adsorbent Membranes,** Karl Kammermeyer. General knowledge about gaseous diffusion plants is limited. No commercial installations have as yet materialized which utilize barrier separation. This paper discusses the definition of barrier, permeability as a mass transfer coefficient, effect of variables on permeability, the correlation between adsorption isotherm and surface flow, and the applications of barrier separation. **Dialysis,** J. A. Lane and J. W. Riggle. Methods and equations are presented for estimating the over-all dialysis coefficients for the dialysis of a single electrolyte or a single electrolyte and many nonelectrolytes from the physical properties of the dialysis membrane and the diffusion coefficient of the dialyzing material. A differential equation is presented. The conditions under which each integrated form may be used for the design of commercial equipment are illustrated. The possibility of making a separation by means of dialysis between two different-sized solute molecules also is explored. **Molecular Separations by Solution Ultrafiltration,** W. E. Henderson and C. M. Sliepcevich. The purpose of this investigation was to determine the factors which control the retention of nonelectrolytes by ultrafiltration membranes having heterogeneous pore structures. This investigation was also extended to a ternary solution. Proposed mechanisms for the observed effects were tested by correlating the experimental data. **Applications of Ion Exchange Membranes in Electrodialysis,** E. A. Mason and Walter Juda. Various typical examples of membrane-cell configurations used for electrodialysis are presented to show the versatility of application of these new materials. Included are the dilution or concentration of electrolytes, the separation of electrolytes and nonelectrolytes, metathesis reactions, oxidation-reduction reactions, acid-base reactions, and the separation of ions of like charge. **Gas and Vapor Flow in Microporous Barriers,** Karl Kammermeyer and Lenard O. Rutz. Gaseous flow through any microporous membrane or barrier will not take place unless accompanied by some flow in a condensed phase. If a membrane possesses a fine enough microporous structure to act as a barrier in gaseous flow, it represents a capillary system with a sufficiently high adsorptive capacity to give rise to adsorbed or surface flow. The term *condensed flow* is used to describe this phenomenon in a generic manner. **Filtration of Strong Electrolytes,** Ernest J. Breton, Jr., and C. E. Reid. Physical separations of some sort are important steps in many chemical processes, ranging from the removal of suspended materials from liquids by sedimentation, filtration, or centrifuging to the removal of dissolved molecules by crystallization or distillation. In this work electrical resistance measurements were made of specific ions across cellulose acetate membranes. **Design of Electrodialysis Equipment,** E. A. Mason and T. A. Kirkham. The principles of operation, design, and cost evaluation of equipment using ion exchange membranes for electrodialysis applications are discussed. Design equations for prediction of electrical resistance, transfer-area requirements, and energy consumption are presented.

Metathesis Reactions by Means of Ionic Membranes, G. P. Monet. Metathesis reactions can be carried out by electrodialysis used with ionic membranes. Experimental techniques are described for measuring the potential drop across a unit cell and for measuring the selectivity and resistance of a single ionic membrane. At present metathesis applications appear limited because of the poor selectivity of ionic membranes in acidic and basic solutions. **Ultrafiltration of Salt Solutions Through Ion Exchange Membranes,** J. G. McKelvey, Jr., K. S. Spiegler, and M. R. J. Wyllie. Ion exchange resin membranes were used in the ultrafiltration of sodium chloride solutions of various concentrations. The experiments were conducted in a special ultrafilter which was electrically insulated and contained silver-silver chloride electrodes for streaming potential measurements, and a thermal-convection type of arrangement for continuous mixing of the solution. **Selective Adsorption of Toluene From *n*-Heptane by Silica Gel,** E. R. Schmelzer, M. C. Molstad, and P. F. Hagerty. The transfer of a component to a fixed bed of adsorbent is widely prevalent in chemical operations. The method is employed for purposes of purification, recovery, separation, or analysis. Examples of such usage include the dehumidification of gases, the clarification of oils and syrups, the elimination of noxious gases from the respiratory atmosphere, the fractionation of hydrocarbons, and the chromatographic analysis of multicomponent and complex mixtures.

NUCLEAR ENGINEERING—PART VI, Vol. 55, No. 23, 1959

Recovery of Radioactive Cesium at Hanford, B. F. Judson, R. L. Moore, H. H. Van Tuyl, and R. W. Wirta. Methods are being developed for recovering radioactive cesium present in high-level waste streams from Hanford's plutonium separations plants. Precipitates would be converted to a stable, radiochemically pure cesium salt, packaged for shipment as a radiation source. A survey of the potential market for radiation sources has been initiated to determine whether enough demand can be forseen for Hanford's operation of a cesium recovery plant. **Control-Rod Drive Mechanism for the Argonne Low Power Reactor,** W. J. Kahn. The control-rod drive mechanism for the Argonne Low Power Reactor (ALPR) is a rack-and-pinion type that operates in contact with the primary reactor fluid. The mechanism is located above the reactor, with the pinion drive shaft extending through a pressure-breakdown, collected-leakage seal. This paper will describe the characteristics of the drive mechanism and its design, development, and testing. **Radiolytic and Pyrolytic Decomposition of Organic Reactor Coolants,** D. R. de Halas. A rate law has been derived for the combination of radiolytic and pyrolytic damage to organic coolants in a dynamic system. Based on obser-

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vations of the radiolytic damage in the test loop and of the behavior of the radiolytic tars toward heat, this law provides a simple method of determining the maximum utilizable temperature for an organic coolant. **Some Aspects of the Use of an Organic Coolant in a Heavy-Water-Moderated Power Reactor,** Malcolm J. McNelly. Organic materials have been assessed as a possible alternative to the heavy water coolant in a natural-uranium-fueled heavy-water-moderated power reactor. These materials provide scope for appreciable cost reduction in this reactor system. **Studies on Characteristics of Savannah River Wastes,** Bernard Manowitz, C. W. Pierce, and Samuel Zwickler. Laboratory and pilot plant studies were carried out at Brookhaven National Laboratory in support of the Savannah River program on the storage and concentration of liquid wastes. Vertical temperature distribution, over-all heat transfer coefficients, and foaming characteristics were observed during storage. The foaming and scaling characteristics of low-level wastes were followed for evaluation of waste-concentration criteria. **Blending VS. Reenrichment for Slightly Enriched Uranium,** Donald Kallman and John E. Brennan. Although the A.E.C. has contemplated tthe reenrichment of irradiated but decontaminated uranium, there may be economic advantage to the power plant operator to blend irradiated fuels with highly enriched uranium instead. **Nuclear Safety Considerations in the Storage and Handling of Fuel Elements,** Norman Ketzlach. Calculation methods to determine design criteria for nuclear safety specifications in the storage and handling of slightly enriched fuels are presented. The importance of understanding the reactor theory involved in interpreting results of calculation so that they may safely be applied to plant process conditions cannot be over-emphasized. The importance of standardization of transportation specifications for shipping large quantities of these fuels is also been indicated. **Heat Transfer Characteristics of Polyphenyl Coolants,** M. Silberberg and D. A. Huber. In support of the Organic Moderated Reactor Experiment, heat transfer characteristics of several polyphenyls were investigated in a laboratory heat transfer loop. The operation conditions were as follows: fluid temperatures, 480° to 770°F.; heater surface temperatures, 565° to 875°F.; fluid velocities, 5 to 25 ft./sec.; heat fluxes, 40,000 to 290,000 B.t.u./(hr.)(sq.ft.); and Reynolds number, 20,000 to 300,000. Heat transfer correlations obtained by a digital-computer technique are discussed. **Corrosion-Screening of Component Materials for Potassium Soda Heat-Exchange Systems,** Samuel J. Basham, John H. Stang, and Eugene M. Simons. Sixty-one materials, including high-temperature alloys, pure metals, cermets, and ceramics, which might be useful for special components are discussed. In high-temperature sodium-potassium flow systems were screened in tilting-furnace corrosion experiments. Post-test corrosion evaluations were based on metallographic examinations of the specimens, specimen weight-change measurements, container compatibility examinations, and specimen surface-roughness changes. The materials were divided into three classes according to corrosion resistance. **Boiling Pressure Drop in Thin Rectangular Channels,** N. C. Sher and S. J. Green. Methods for predicting boiling and nonboiling pressure drop in thin rectangular channels, independently of the void data, have been developed for 2,000 lb./sq. in. abs. Void data, obtained at Battelle by the use of rectangular channel at 2,000 lb./sq. in. abs., have been reviewed. These data generally show that the homogeneous model is adequate for boiling at 2,000 lb./sq. in. abs. at qualities above 10%. Techniques for utilizing experimental void data in pressure drop data analyses have been developed. **Two-**

Phase Steam-Water Pressure Drops, H. S. Isbin, R. H. Moen, R. O. Wickey, D. R. Mosher, and H. C. Larson. Frictional pressure drops for steam-water mixtures have been determined for the following ranges of conditions: pressure, 25 to 1,415 lb./sq. in. abs.; total flow rate, 454 to 4,350 lb./hr.; and quality from about 0.008 to 0.98. The steam-water mixtures were synthesized by mixing steam and water, and pressure drops were measured for adiabatic flow in horizontal pipes 0.484- and 1.062-in. I.D. The data are compared to standard correlations, and a new restricted correlation is suggested which takes into account the pressure and flow rate dependencies. **Free-Convection Heat Transfer to Water and Mercury in an Enclosed Cylindrical Tube,** J. P. Hartnett, W. E. Welsh, Jr., and F. W. Larsen. Local free-convection heat transfer results are reported for water and mercury with uniform heat flux. The system was found to be inherently quasisteady with the temperature oscillations more pronounced with mercury as the working fluid. Experimental data were also obtained with the tube inclined 30 deg. from the vertical, and the resulting heat transfer performance was found to be significantly increased. **Auxiliary Equipment for Radiochemical Processing,** W. E. Unger. Most radiochemical processing equipment are basically similar to their industrial counterparts. The principal distinguishing differences are details of design, the quality standards to which radiochemical equipment is fabricated, and the massive shielding peculiar to the latter. Examples of both specially designed items, and the adaptation of commercial equipment, including valves, filters, centrifuges, samplers, and carrier-chargers, are described. **Flow Generation, Measurement, and Control,** J. Dunn and H. M. Jones. The design criteria for equipment in a remotely operated aqueous separations plant are presented. Improved materials of construction, seal design, and methods of remote replacement have made it possible to adapt submerged regenerative and deep-well turbine pumps, driven by motors located above and sealed from the tanks, to chemical-separations service. Description of a typical flow-system installation is presented, together with a detailed description of the rotameter-transmitter, amplifier-converter, recorder-controller, and control valve. **Treatment of Radioactive Wastes with Ion Transfer Membranes: Removal of Bulk Electrolytes,** E. A. Mason, E. J. Parsi, and A. J. Giuffrida. Use of anion transfer membranes in electrolytic cells was investigated as a means of removing and separating bulk electrolytes from cationic fission products. Nitric acid and aluminum nitrate were used as typical electrolytes, and sodium was used as a tracer representing cationic species. Deacidification of nitric acid and precipitation of hydrous aluminum oxide in granular form were accomplished. The mechanism of deacidification, effect of operating variables, and stability of membranes to chemical and radiation attack are discussed. A brief cost estimate is included.

ERRATUM

The term k_e in Equations (13) and (15) and in Figure 3 of "Estimation of Stage Efficiency of Simple Agitated Vessels Used in Mixer-Settler Extractors" by Robert E. Treybal appearing on page 202 of the June, 1958, issue should be replaced by (mk_e), where $m = dc_e/dc_D$, the notation being the same as in the paper.

This change results in a slight improvement in the over-all agreement of observed and calculated efficiencies. The correction has been incorporated in the paper "The Economic Design of Mixer-Settler Extractors," page 474 of the December, 1959, issue.