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Separation Science—A Vital Tool of the Chemical Engineer

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KEYNOTE ARTICLE

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WHAT HAS BEEN

Separation attempts reach back into the earliest history of mankind. Motivated by necessity, man developed methods of separation which, although crude by our standards, represented ingenious progress. Thus, food and condiment preparation had much to do with the development of processes such as leaching, solvent extraction, crystallization, evaporation, and the like.

An over-all view, even up to quite recent times, shows that advances in these operations have been made rather laboriously by improving the technology of individual and collective stage performance. Still, multistage is the rule; and this situation will continue in many phases of separation processes—especially so when the ultimate solution of a problem will have to be dictated by the dollar sign.

THE MODERN TOUCH

As is so often the case, disaster, in this instance the World War II holocaust, set off a chain of events which advanced science "sprunghaft," and set a tempo of seeking and searching which still threatens to outstrip the capabilities of man's mind. The separation of UF_6 isotopic mixtures set the stage for the coming of age of membrane separation science on a scale that had, until then, defied comprehension.

Still, the utilization of the "old" Graham-law concept necessitated stagewise operation and, at that, on a scale no process had ever experienced. Of course, necessity rather than economics was the deciding factor. It is safe to say that this real breakthrough (a much maligned word, but certainly appropriate here) opened men's eyes to the multitudinous possibilities of membrane or barrier processes. Gaseous diffusion in isotope separation, reverse osmosis in desalination, electro-osmosis in waste treatment,

molecular-sieve applications galore—so, step by step, exciting developments, even if not always economical.

Design of staged operations has received a great impetus from the advent of the digital computer. Whereas formerly the design procedure depended on assumptions and approximations, the computer now permits accurate calculations limited only by the accuracy of the data. As comprehensive computer programs become generally available, there will be little need for new methods of design calculation. But, of course, there is an ever-present need for improvement in the data. Thus, transport properties, especially interpreted on the molecular level, will be the subject of exhaustive studies. And, coupled with their proper use in increasingly refined molecular models of process phenomena, corespondingly increased accuracies will be attainable.

FLYING HIGH

Soon our earthbound conditions of operation will find extension in two directions: extreme vacuum and absence of gravity. Going into space will make these conditions available, thus creating opportunities for variation of these parameters. Whereas extreme vacuum will affect separation processes only in regard to the pressure aspects, the absence of gravity will have a more decisive bearing. Actually, most of our conventional processes will not work at all in a state of weightlessness, or will become highly inefficient under reduced gravity.

Beyond the effects of such parameters, there is however, an even more attractive goal: one-step separation processes; go or no-go systems. Is it possible? Yes, helium separation through glass; hydrogen diffusion through palladium. Esoteric? Perhaps today, but tomorrow, who knows? Once man's persistent curiosity has seen the possibilities his mind won't rest to create.

Separation science stands on the threshold of unbelievable developments, and multidisciplinary participation will be the catalyst.

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