References

1. KING, R. P. Simulation of flotation plants. *Trans. Soc. Min. Engrs AIME*, vol. 258. 1975. pp. 286-293.
2. KING, R. P. The use of simulation in the design and modification of flotation plants. *FLOTATION. A. M. GAUDIN MEMORIAL VOLUME. Fuerstenau, M. C. (ed.)*. New York, AIME 1976. vol. 2, p. 937.
3. KING, R. P. A model for the design and control of flotation plants. *APPLICATION OF COMPUTER METHODS IN THE MINERAL INDUSTRY. Salamon, M. D. G., and Lancaster, F. J. (eds.)*. Johannesburg, South African Institute of Mining and Metallurgy, 1973. pp. 341-350.
4. KING, R. P., *et al.* A pilot-plant investigation of a flotation model. Johannesburg, National Institute for Metallurgy, *Report No. 1573.* 1974.
5. KING, R. P., *et al.* Application of a flotation model to an industrial plant. Johannesburg, National Institute for Metallurgy, *Report no. 1562.* 1973.
6. KING, R. P., and JOCHENS, P. R. Characterization of the flotation properties of fluorspar from small-scale batch and pilot-plant tests. Johannesburg, National Institute for Metallurgy, *Report no. 1553.* 1973.
7. MOYS, M. H., *et al.* Estimation of parameters in the distributed-constant flotation model. Johannesburg, National Institute for Metallurgy, *Report no. 1567.* 1973.
8. MOYS, M. H., *et al.* Computer programme for the estimation of parameters in flotation. Johannesburg, National Institute for Metallurgy, *Report no. 1528.* 1973.
9. KING, R. P. On-line digital computer control of slurry conditioning in mineral flotation. *Automatica*, vol. 10. 1974. pp. 5-14.
10. BUCHALTER, E. M. Ph.D. Thesis, University of Natal, 1973.
11. CRAMER, L. C. M.Sc. Thesis, University of Natal, 1974.
12. WOODBURN, E. T., KING, R. P., and COLBORN, R. P. The effect of particle-size distribution on the performance of a phosphate flotation process. *Metall. Trans.*, vol. 2. 1971. p. 3163.
13. KING, R. P., and HAINES, A. K. A pilot-plant investigation of a kinetic model for flotation. National Institute for Metallurgy, *Report no. 1847.* 1967.
14. TOMLINSON, H. S., and FLEMING, M. G. *Proceedings of the 6th International Mineral Processing Congress, Cannes*, 1963. Oxford, Pergamon Press, 1965. p. 563.
15. KING, R. P., *et al.* A computer programme for the simulation of the performance of a flotation plant. Revised report. Johannesburg, National Institute for Metallurgy, *Report no. 1436.* 1973.
16. HUTCHINSON, P., and LUSS, D. Lumping of mixtures with many parallel first order reactions. *Chem. Engng J.*, vol. 1. 1970.
17. DAVY, W. An experimental investigation of the conditioning of an apatite ore for flotation. M.Sc. Thesis, University of Natal, 1973.

Discussion: Mathematical unification of an equation for solute recoveries in countercurrent decantation

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The above article by E. Barnea, which appeared in the January 1978 issue of the *Journal* (vol. 78, no. 6, pp. 143-145), calls for comment in view of the author's claims for the novelty of his proof.

He states in his article that its main purpose is to give a mathematically acceptable proof by induction of the 'recently proposed' equation

$$C_n = \frac{C_o - C_w}{1 + R + R^2 + \ldots R^n} + C_w,$$

(equation 1 in his paper)

as well as to simplify this into the form

$$C_n = \frac{R-1}{R^{n+1}-1}(C_o - C_w) + C_w.$$

(equation 3 in his paper)

This analysis of countercurrent multistage separation processes was first published in the early 1930s by Kremser[1], and by Souders and Brown[2] for the specific case of absorption from a gas. They also proved the equations derived by induction. The application of these equations to washing, or CCD as it is known in mineral processing, is trivial and is given in undergraduate texts on chemical engineering[3, 4] and elsewhere[5].

I do not disagree with the mathematical logic of Barnea's paper but, contrary to his claim, there is nothing new about it at all. His paper is, however, a good illustration of an observation attributed to King Solomon[6]: 'What has been done before will be done again'.

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References

1. KREMSER, A. Theoretical analysis of absorption processes. *Natl Petroleum News*, vol. 22. 1930. p. 43.
2. SOUDERS, M. and BROWN, G. G. Fundamental design of absorbing and stripping columns for complex vapours. *Ind. Engng Chem.*, vol. 24. 1932. p. 519.
3. MCCABE, W. L., and SMITH, J. C. *Unit operations of chemical engineering.* New York, McGraw Hill, 1956.
4. COULSON, J. M., and RICHARDSON, J. F. *Chemical engineering*, vol. II. New York, McGraw Hill, 1955.
5. CLOETE, F. L. D., *et al.* Hydrometallurgy, theory and practice. Johannesburg, South African Institute of Mining and Metallurgy, Vacation School, Aug. 1976, Lecture X.
6. *Ecclesiastes* 1:9.