The Uselessness of Total Reboiling

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It has been shown (*1*, *2*) that solvent extraction and rectification are analogous operations. The operation analogous to raffinate reflux discussed in the previous note is total reboiling (*3*). In this operation a liquid stream from the bottom of a rectifying tower is split into two streams; one is vaporized and sent back to the tower, and the other is a bottoms product. Total reboiling also is subject to the same objections; it does not aid the degree of separation and requires one extra plate in a tower. It is not widely claimed as being useful and is not discussed in any authoritative works on distillation.

In constructing a McCabe-Thiele diagram for a desired separation it may be noted that the intersection of the lower operating line with the diagonal has physical significance only for the total reboiling operation. This significance has been obtained at the expense of an extra theoretical plate. The McCabe-Thiele diagram is identical for the case of partial reboiling, which is advantageous with regard to equipment. However in this case this same intersection of the operating line with the diagonal has no physical meaning. The use of total reboiling to give a meaning to this intersection should not lead one to believe that it has practical usefulness.

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Semifluidization: Mass Transfer in Semifluidized Beds

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It is the purpose of this communication to report the preliminary performance data of a new and unique type of fluid-solid contact operation which may be termed "semifluidization."

A state of fluidization results when the flow rate of fluid passing upward through a bed of solid particles becomes sufficiently high to buoy the solid particles, provided a sufficient space of free board is available for free expansion of the bed.

The characteristics of fluidization, especially its advantages over fixed-bed operation, are extensively discussed elsewhere. However the fluidization process is not immune from some serious defects of its own, such as loss of driving potential for the transport processes within the bed due to the back mixing of the solid particles, attrition and elutriation of the solid particles, necessity of considerable free board above the bed, and erosion of the containing vessel.

The present authors have speculated about the possibilities of eliminating those defects and attaining a type of solid-fluid contactor which compromises the features of both fixed and fluidized beds by partially restricting expansion of the fluidized bed.

Such possibilities are hinted from many of the correlations of transport processes (*1*, *4*) within the solid-particles-fluid contactors, which are claimed to be equally applicable both to the fixed bed and to the fluidized bed. For instance the mass transfer factor of J_d factor correlation of Chu and his co-workers (*1*) suggests that, irrespective of the type of operation (fixed bed or fluidization), the rate of mass transfer can be altered if the porosity of the bed can be changed.

However expansion of the bed, and consequently the porosity of the conventional fluidized bed, is a function of the geometrical characteristics of the solid particles, the physical properties of the solid particles and fluid, and the flow conditions of the fluid and is not subject to arbitrary control. In other words the porosity of the fluidized beds must be treated as a dependent variable rather than an independent variable.

A typical set of available data on bed expansion is plotted in Figure 1, in which the porosity of the beds is plotted against the rate of fluid flow (*2*).

While the expansion in a conventional fluidized bed is allowed freely, in a semifluidized bed the bed expansion is restricted by a porous or sieve plate introduced above the expanding bed, thus forcing formation of a fixed bed above the fluidized bed. By adjusting the position of the movable top sieve plate one can vary the over-all bed porosity. Therefore the desired heights of fixed and fluidized sections for optimum driving potential for mass, heat, and momentum transfer can be obtained.

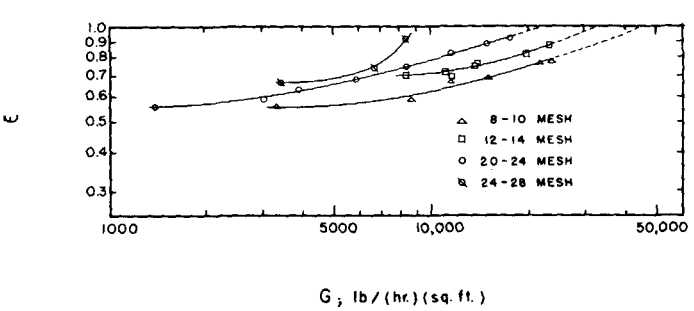

Fig. 1. Porosity of bed of benzoic-acid particle fluidized with water (*2*).

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