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Everything Nicely in Equilibrium

Phase equilibrium apparatus

"The Master Column Builders" was our title three years ago, when PROCESS visited the firm Iludest/i-Fischer in the outskirts of Würzburg and subsequently outlined their work. The masters from Waldbüttelbrunn are once again attracting attention by presenting, timed perfectly for the ACHEMA, a new phase equilibrium unit.

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Photo: i-Fischer

An i-Fischer phase equilibrium unit, today standard equipment in every process technology laboratory.

In the training of process engineers, the determination of phase equilibria, and thus the calculation of separation stages for distillation, is part of the advanced subject matter, and many such students will certainly have worked with phase equilibrium equipment manufactured by i-Fischer/Iludest.

Not only are universities and laboratories counted among the customers of the duo from Waldbüttelbrunn, a team that has dedicated itself to the design and manufacturing of distillation equipment, but chemicals and petrochemicals firms also like to rely, in the tailoring of their separation plants for solvents or mineral oil fractions, on these Franconian specialists. Their recipe for success is exceptional flexibility—whether 200 litres per hour or 1000 litres per day, neither is a problem for these process engineers. "We plan each project individually according to the customer's specifications," explains Stefan Opis, CEO of Iludest and i-Fischer.

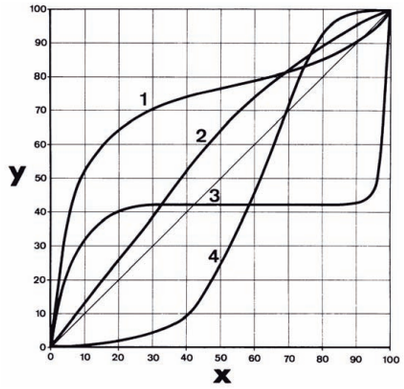
Practice instead of Theory

Beside these special constructions, they also have a range of equipment for process technology laboratories. For, unfortunately—or, as far as the duo from Waldbüttelbrunn are concerned, fortunately—the calculatory skills of the thermodynamicists are not always up to the task of working out phase equilibria for all liquid mixtures. But anyone wishing to plan a distillation column needs reliable data for a phase diagram on the basis of which the theoretical number of separation stages can be deduced. "There are, of course, data in the literature, but usually

BACKGROUND

How to construct a phase diagram

The phase equilibrium of a binary mixture is represented graphically by plotting the composition of the vapour (y) against the liquid composition of the boiling mixture (x). The concentration is expressed in mole-% of the component with the lower boiling point. A diagram of this kind can be used either for constant pressure or constant temperature. For technical purposes, the representation at constant pressure is preferred, while constant temperature is generally taken as the basis for thermodynamic calculations.



precisely the pressure/temperature/concentration combination that the process engineer needs for the design of his column is missing." Dr. H. E. Koenen, CEO of i-Fischer, is speaking from experience, for he has joint responsibility for the planning of customers' conceptional layouts. As new separation tasks are constantly emerging, phase diagram data continues to be obtained experimentally, since thermodynamic parameters are either not present at all or only insufficiently.

The standard until now has been a phase equilibrium unit capable of determining experimentally the vapour/liquid equilibria of binary or multi-component mixtures if the boiling points of the components are far enough apart. But, in cases involving calculations for mixtures whose components boil in a narrow and simultaneously low temperature range or which form azeotropic mixtures, the standard equipment reaches its limits. "The practical measurement and determination of these data proves difficult because of the phase formation of the liquids," explains Koenen. As the vapour concentration vacillates back and fore between the phases, VLE (vapour liquid equilibration) equipment does not distinguish these adjacently boiling components well enough—much like the human eye, which makes one light source out of two flashes happening in quick succession. In order to make the data accessible and reach a stable equilibrium, therefore, the relevant components have to be dissolved in a third phase, resulting in a vapour-liquid-liquid equilibrium.

This is the case in e.g. extractive distillation. The prime example in petrochemicals is the separation of butadienes from a C4 mixture. Although the addition of acetone or furfural makes the butadiene less volatile, the description of the resulting vapour-liquid-liquid equilibrium is a challenge for the process developer. The solution for this problem was found a few years ago by researchers at Alicante University with whom i-Fischer is collaborating closely under an exclusive licence. "We have now adapted the patented, scientific idea to create a device design suitable for series production and have got it ready for market release," says Koenen. At the ACHEMA, the distillation experts will have this glass equipment with them and will show that the new development not only has a high performance, but also pleases the eye. There is also a metal version for overpressure.

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