OPERATION OF A HIGHLY EFFICIENT BATCH-TYPE THERMAL DIFFUSION COLUMN WITH A PERFORATED PARTITION

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Inzhenerno-Fizicheskii Zhurnal, Vol. 11, No. 3, pp. 359–361, 1966

UDC 66.066+621.039.341.6

An experimental apparatus based on the physical model in [1] is described. Experimental data relating to the separation of a typical liquid are given.

The physical model proposed in [1] was used to design an experimental apparatus for the highly efficient separation of binary liquid mixtures. It differs

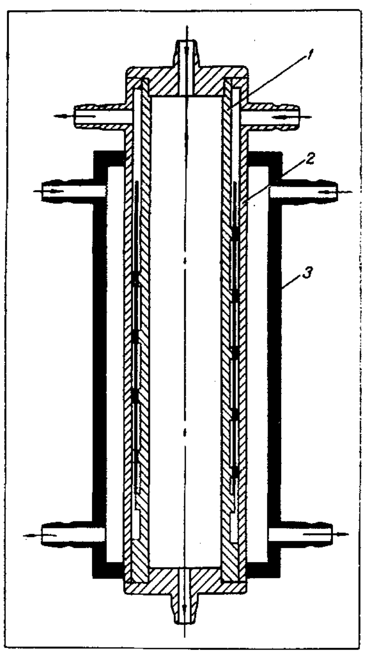

Fig. 1. Diagram of apparatus.

from the apparatus described in [1] in that, first, it operates with the partition in a rigidly fixed position and, second, the partition can be made of steel, brass, copper, plexiglas, etc., i.e., any material which can be mechanically worked. Moreover, the present design permits the use of molded partitions, made of ceramic, for instance.

The column consists of three brass tubes (1, 2, 3 in Fig. 1). Through the first circulates water from a thermostat at a temperature of 20° C. The second and third tubes comprise the jacket, within which the water from the "hot" thermostat circulates. The working space lies between the first and second tubes. This space contains a brass perforated partition 150 mm high, with perforations 2 mm in diameter, and with a free flow section of 20%. The height of the working space is 170 mm. For the accurate positioning of the partition the outer surface of the first cylinder has projections which fit into recesses in the partition, as Fig. 1 shows. To secure uniformity of the gap over the height of the column the outer surfaces of the first cylinder and partition have a helical ridge, the height of which is equal to the distance from the wall of the column to the partition, i.e., the total height of the two helical ridges + the thickness of the partition.

In our investigations the height of the helical ridge was constant (0.2 mm). The distance between the walls was 0.9 and 2 mm.

The helical ridge also acts as a guide for the convective flow of the liquid. Since the first cylinder, partition, and second cylinder fit flush with one another along the surface of the helical ridge, the liquid inside the working space is confined to the space not occupied by this ridge, i.e., can only follow the direction of the helical ridge. This produces an orderly movement of the liquid inside the working space.

In the top part of the column the concentration of the investigated mixture was kept constant by continuous circulation of the mixture of initial composition. The samples were taken from the bottom of the column. The apparatus operated in a batchwise manner. As before, the investigated liquid was an aqueous solution of sucrose with an initial concentration of 4.1%. The samples were analyzed on a RPL-2 refractometer.

With the same temperature gradient of 350 deg/cm we investigated the separation in time for two different distances between the column walls: 0.9 and 2 mm. The partition thickness was 0.5 and 1.6 mm, respectively. The experimental results are given in Fig. 2.

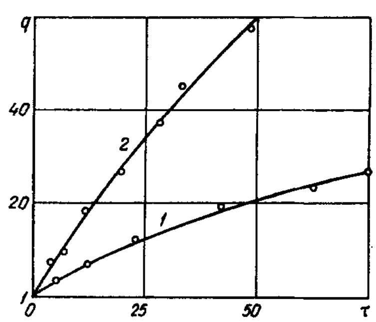

Fig. 2. Separation coefficient q as a function of time τ (hr) for a temperature gradient of 350 deg/cm: 1) Distance between column walls 0.9 mm and partition thickness 0.5 mm; 2) distance between column walls 2 mm and partition thickness 1.6 mm.

After 72 hr of operation of a column with a distance of 0.9 mm between the walls the separation coefficient, determined as

$$q = \frac{c_1/c_2 \text{ (enriched end)}}{c_1/c_2 \text{ (depleted end)}} \tag{1}$$

was 25.8.

When the partition thickness was increased from 0.5 to 1.6 mm, i. e., almost trebled, and, hence, the distance between the column walls was increased to 2 mm, the separation coefficient after 45 hr of operation of the column was 58.3, which is more than twice the separation coefficient for a column with a distance of 0.9 mm between the walls. After 45 hr of operation of a column with a distance of 0.9 mm between the walls the value of q was only 19. Thus, when the partition thickness was trebled the separation coefficient was also trebled, despite the fact that the distance between the column walls was increased. These data clearly confirm the conclusion derived from the theory [2] for columns with perforated partitions, which predicts an increase in separation efficiency with reduction in d_h/δ_p owing to the reduced proportion of molar transfer through the partition holes.

In the next series of experiments we investigated the effect of the temperature gradient on separation. With a distance of 2 mm between the walls and a partition thickness of 1.6 mm we investigated the separation for two temperature gradients: 200 and 350 deg/ /cm. The results of this investigation are given in Fig. 3. The figure shows that with increase in temperature gradient the separation efficiency was greatly increased. After 45 hr of operation the separation coefficient for 350 and 200 deg/cm was 58.3 and 6, respectively. Thus, an approximate doubling of the temperature gradient increases the separation coefficient by a factor of almost ten.

The investigations are being continued and their results will appear in future publications.

NOTATION

Here c_1 and c_2 denote the percentage concentration by weight of the first and second components; q is the separation coefficient; d_h is the diameter of the partition holes, mm; δ_p is the partition thickness, mm.

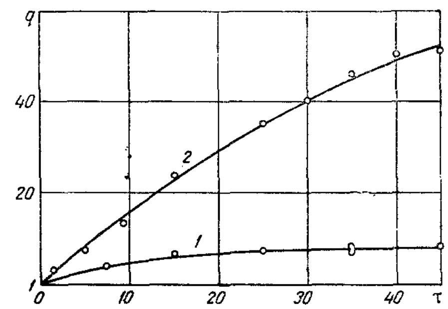

Fig. 3. Separation coefficient q as a function of time τ (hr) for two temperature gradients (1) 200; 2) 350 deg/cm) for distance between walls 2 mm and partition thickness 1.6 mm.

REFERENCES

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6 April 1966

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