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INFLUENCE OF WEEPING ON MASS TRANSFER RATE OF DIFFERENT PLATES

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The influence of weeping on the mass transfer of different industrial plates was investigated in a 400 mm inside diameter column equipped with 4 plates. The absorption of acetone from air to tap water was measured on vibrating valve, Nutter valve, Glitch valve, sieve and turbogrid plates with varied weir heights. The weeping was determined by a direct method.

The tray efficiency (η) of the investigated plates decreased 1–5% with the increase of weeping rate, while it decreased 10–25% with the increase of weir height.

Mass transfer characteristics of the above plates, namely recovery efficiency (E), volumetric mass transfer coefficient ($K_G a$) and pressure drop related to one theoretical plate ($\Delta p/N_{th}$) were measured and compared.

Keywords: weeping, plate absorber, efficiency of absorption

INTRODUCTION

The expansion of the operative domain of plates by extending their lower limit towards the weeping regime is an important task and results in a remarkable money saving in the design of chemical plants. Therefore, it is necessary to know how much the weeping affects the mass transfer of plates.

Many authors have reported their opinions on this matter. Prince[1] supposed that when a plate operates satisfactorily hydrodynamically, it should have a reasonable efficiency, so he advised operation well above the minimum load conditions. Several authors[2–6] agreed with his opinion, although this position appears more an assumption than a result of effective investigations of tray behaviour in the weeping regime.

Kagayama *et al.*[7,8] and Wada *et al.*[9] measured the distillation efficiency using a wide range of liquid loads. Their data do not show an excessive variation of efficiency even in the presence of weeping. Brambilla *et al.*[10] have measured the column efficiency of a sieve plate column with the air humidification method. They also found that at a high weeping ratio, the column efficiency remains relatively constant. That point of view agreed with the data reported by Umholtz and Van Winkle[11] and by Anderson *et al.*[12] who have shown that the values of efficiency are still satisfactory where there is strong weeping. Zhou *et al.*[13] have carried out experiments in sieve plate columns and measured the (oxygen desorption) efficiency with an air/water system. The weeping point was determined on the basis of a comprehensive treatment of the actual effect on the weeping rate as a measure of the efficiency and the relationship between the vapour velocity and the relative weeping rate. They found that a 15% reduction in efficiency occurs at the lower operating limit. Banik[14] established a greater reduction in tray efficiency is obtained, if the weeping is localised mainly near the inlet weir, as is often the case on large trays.

The purpose of this work was to investigate the mass transfer behaviour of different industrial type plates in the weeping regime, which is defined as a domain between dump point (gas velocity corresponding to the beginning of the liquid flow over the weir) and the weeping point (gas velocity corresponding to liquid flow only over the weir).

EXPERIMENTAL

Experiments were carried out using a pilot scale column of 400 mm inside diameter and 350 mm tray spacing with four plates (Figure 1). Different types of plate constructions were investigated and compared (Figure 2 and Table 1). More details about the investigated plates can be found in References 15 and 16.

Hydrodynamic parameters were tested by an air/water system, while mass transfer was measured by absorption of the acetone-air/water system.

Measurement of Acetone-Air/Water Equilibrium

In the literature there are no available VLE data for the acetone-air/water system in the range of gas content $Y = 20$–$3000\,\mathrm{mg\,m^{-3}}$ (liquid content $X = 300$–$1300\,\mathrm{mg\,l^{-1}}$) at the experimental column temperature, $t = 8$–$15°\mathrm{C}$ and pressure $p = 1$ bar. On the basis of the distillation VLE data collection of Gmehling *et al.*[17] only some points could be calculated at 25°C using Raoult's law. The activity coefficient was determined by extrapolation of data[17].

Laboratory experiment was built to measure the