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LIQUID DISTRIBUTION PROPERTIES OF CONVENTIONAL AND HIGH CAPACITY STRUCTURED PACKINGS†

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Large scale air/water experiments have been carried out to observe the effects of variation in gas and liquid loads and packed height on the liquid distribution quality of a high capacity corrugated sheet structured packing (Montz Pak B1-250M) and to compare it with that of its conventional counterpart (Montz Pak B1-250). The liquid distribution performance of both packings appeared to be consistently good and, surprisingly, the high capacity version performed better than the conventional packing, but at the expense of a more pronounced wall flow, which however appeared to be less sensitive to high gas loads.

Keywords: distillation; structured packing; liquid distribution; maldistribution.

INTRODUCTION

It is well known that achieving a good quality of liquid distribution is crucial for performance of corrugated sheet structured packings (Kister, 1992; Moore and Rukovena, 1987; Olujic and de Graauw, 1989; Stichlmair and Fair, 1998). By practical experiences and the research work done in late 1980s and beginning 1990s, the sources and the nature of large scale liquid maldistribution have been revealed (Olujic and de Graauw, 1990; Potthoff and Stichlmair, 1991; Olujic *et al.*, 1992a, b; Potthoff, 1992; Stoter, 1993). The often insufficient quality of initial distribution appeared to be a major cause of malfunction of packed columns and since then the high performance liquid distributors are preferred to ensure utilizing the full potential of a structured packing as a vapour/liquid contacting device.

Nowadays, high capacity packings (Montz-pak M, Mellapak Plus and Flexipac HC series) are getting more and more attention (Olujic *et al.*, 2001), because this new generation structured packings allow revamping the columns equipped with conventional packings. A key feature of these packings is a significantly lower pressure drop, which was achieved by avoiding the sharp vapour flow direction changes at the transitions between packing elements. This occurred simply by bending the bottom part of corrugations to vertical. This alone or in combination with similar bends in upper part of corrugations creates a smoother transition for both phases, i.e. shifts the build-up of liquid to higher vapour loads and consequently enables operation with a significantly higher capacity than that achieved with the conventional counterparts of the same size. This has been proven in both hydraulic and total reflux tests (Olujic *et al.*, 2001; Pilling and Spiegel, 2001; Olujic *et al.*, 2003).

Interestingly, the total reflux experiments carried out with high capacity Montz packings, characterized by a rather long bend in the bottom part of corrugations (see Figure 1), indicated a certain loss of efficiency in the preloading region (Olujic *et al.*, 2003). Since the vapour is practically not affecting the liquid distribution in the preloading region, new flow channel geometry has been indicated as a possible source of certain deterioration in liquid distribution. In order to provide an answer to this question, an experimental study was arranged using large diameter, column hydraulics simulator available at the Delft University of Technology.

The objective of this paper is to present experimental evidence on the liquid distribution characteristics of B1-250M and to compare it with that of its conventional counterpart, Montz-pak B-250, which is the reference packing evaluated in various ways in numerous studies.

EXPERIMENTAL STUDIES

Packings Tested

Figure 1 shows photographs of a bed of B1-250M packing and the corrugated sheets of B1-250M and B1-250, indicating the main difference in the geometry of the flow channels. The size of these well known, unperforated shallow embossed packings is 250 $m^2\,m^{-3}$. Corrugated sheet height of B1-250 is approximately 0.2 m and that of B1-250M few millimetres larger. Each packing layer was assembled of three packing segments and the packing

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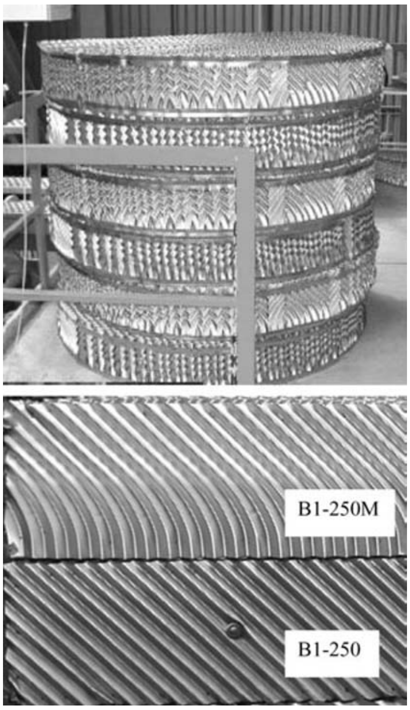

Figure 1. A bed of B1-250M (above) and corrugated sheets of B1-250M and B1-250.

layers were stacked to form a bed of desired height. According to the common practice, each subsequent layer was rotated by 90° to the previous one.

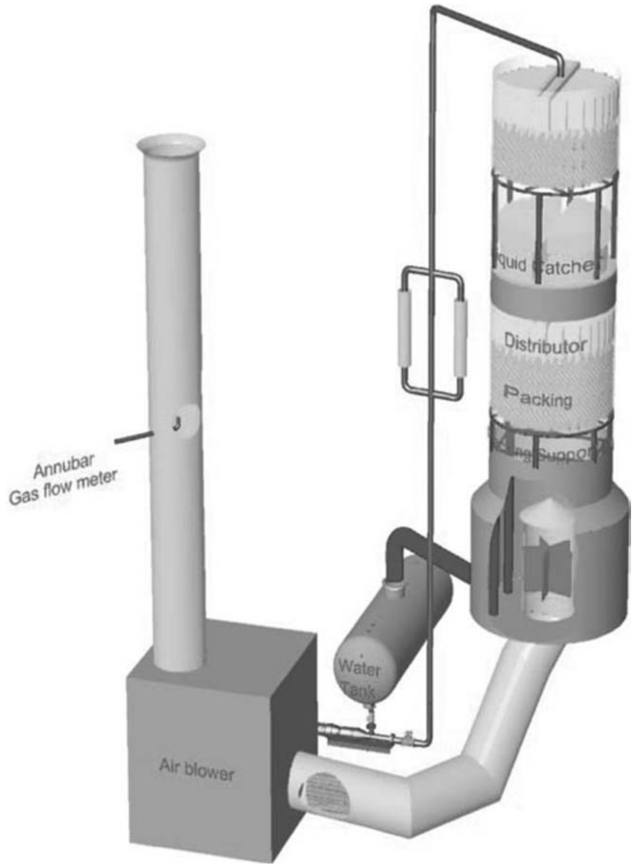

Figure 2. 3D image of the TU Delft column hydraulics' simulator. This figure is available in colour online via www.icheme.org/cherd

Experimental Set-up

The necessary experiments were performed using the large diameter column hydraulics' simulator available at the Delft University of Technology. Figure 2 shows a 3D drawing of this installation. The heart of the experimental set-up is a 1.4 m ID column consisting of a number of flanged Plexiglas sections, which allows installation of beds with heights up to 6 m. The transparent part of the column is supported by stainless steel column sump, which is made broader (1.8 m ID) to accommodate gas inlet distributor, which distributed air delivered by a powerful, electronically controlled blower (capacity, up to 8 $m^3\ s^{-1}$). Water from the supply tank was pumped through the pipes containing a magnetic flow meter by a centrifugal pump (110 $m^3\ h^{-1}$) to the top of the column, at an elevation of approximately 10 m.

Liquid was distributed using a narrow trough distributor containing 152 drip tubes which is an equivalent to 100 drip points per metre square. The essential piece of equipment used in this study was the liquid collecting system, shown in Figure 3. Liquid distribution measurements were conducted using a flanged short column segment containing three equidistantly placed moving rods, each with a movable funnel (50 mm × 50 mm) at the end. The rectangular funnels were equipped with electrodes at different heights to indicate the level of liquid in the funnel by switching on the corresponding lamp. At low level position the stopwatch went on and the time recording was stopped after reaching the upper level. In other words, the whole measurement work has been performed relying on the reliable, but work intensive time–volume technique. Namely, for each situation the same procedure was repeated for 25 locations (50 mm spacing) along each of three cross-sectional directions. Fortunately, the reproducibility of measurements proved to be high. Tap water was used at ambient conditions, and only in a limited number of cases the liquid distribution was measured in the presence of a counter currently flowing air stream. Although the funnel design was highly aerodynamic, liquid collecting at high gas loads occurred with difficulties. Near flooding point it appeared impossible to get reproducible measurements.

A unique feature of the liquid collecting setup is the double wall arrangement (narrow annulus at the periphery) which allows collection of the liquid leaving the bed section via column walls. The width of the annulus is 1 cm and the corresponding cross-sectional area is 0.022 m^2, which is approximately 1.5% of the test section (column) cross-sectional area.

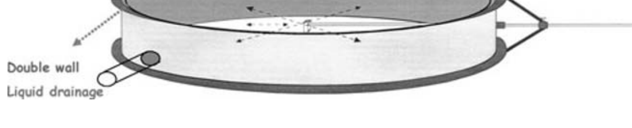

Figure 3. Schematic of the liquid collection section containing six equidistantly placed liquid drainage pipes.