

THE SANDWICH PACKING – A NEW TYPE OF STRUCTURED PACKING TO INCREASE CAPACITY AND MASS TRANSFER OF DISTILLATION COLUMNS

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The sandwich packing is a combination of different layers of a structured packing with a higher specific surface as flooded layer and lower specific surface as de-entrainment layer. With this combination it's possible to flood the high-surface packing i.e. to increase hold-up and intensify mass-transfer without flooding the whole tower or to adjust the residence time in a reactive distillation system.

The principle of the sandwich packing is known since a few years, see e.g. [1]. The development of the sandwich packing is the result of cooperation between the companies BASF AG Ludwigshafen and Julius Montz GmbH Hilden. Both companies investigated the hydraulic and thermodynamic behaviour of the new packing during the last years. The investigations pointed out, that the sandwich packing increases the capacity as well as the efficiency of a distillation column. But for larger column diameters the hydraulic performance was not optimal. With the development of the "sandwich packing of the 2. generation" this problem was solved. The performance of the packing was improved by introducing small downcomers in the flooded layer. The downcomers lead the liquid trough the flooded layer of the packing in defined ways. The downcomers have an area of about 8 percent of the column area. In the flooded layer of 500 mm in diameter 7 downcomers with 60 mm diameter are extanted, every downcomer includes 7 holes with a diameter of 3.5 mm. Figure 1 shows a typical combination of a flooded and a de-entrainment layer with downcomers in the flooded layer. One element of the sandwich packing has a height of about 250 mm (about 50 mm flooded layer and 200 mm de-entrainment layer). The heights of the layers are the result of a first design, there was no optimization of the layer heights.

Hydraulic measurements of the new packing were done in test columns with air and water of 500, 900 and 1500 mm in diameter for liquid loads from 0 to 100 m/h and F-factors up to 7 $Pa^{0.5}$. The pressure drop and the entrainment were investigated for different combinations of flooded and de-entrainment layers. Figure 2 shows a typical result for the pressure drop of the combination Montz Pak 750T/250M in a column with 500 mm diameter. Illustrated is the pressure drop for a packing of 3 flooded layers and 4 de-entrainment layers as function of the F-factor for liquid loads from 0 to 50 m/h.

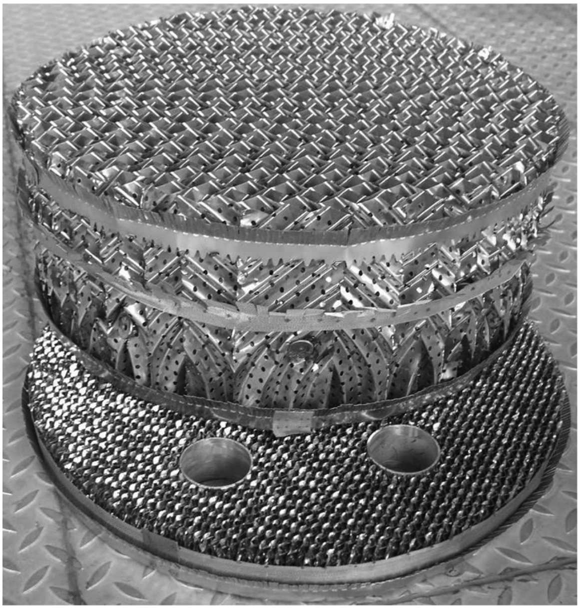

Figure 1. The sandwich packing of the 2. generation – combination of a Montz Pak 750T as flooded layer and a Montz Pak 250 M as de-entrainment layer (500 m diameter)

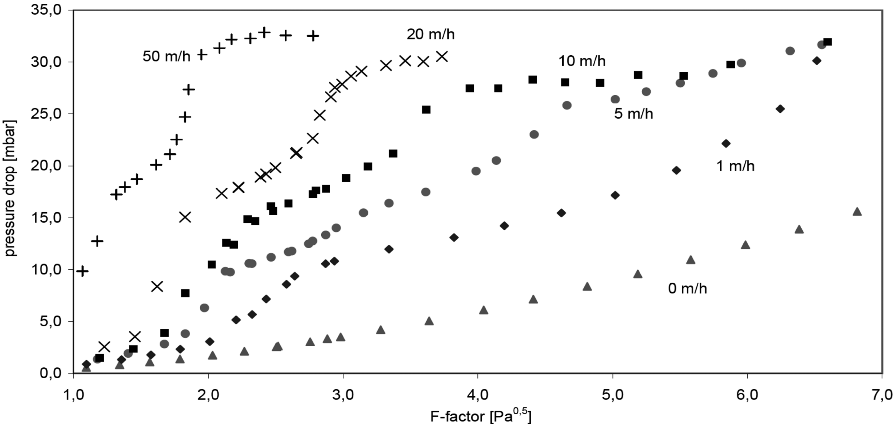

Figure 2. Pressure drop of the sandwich packing combination Montz Pak 750T/250M for liquid loads from 0 to 50 m/h, measured in an air/water-column with 500 mm column diameter

The curves show the sudden increase of the pressure drop, when the flooding of the layer with the higher surface starts. The increase of the pressure drop indicates the increase of the liquid hold-up in the packing. From this point up to flooding of the deentrainment layer the sandwich packing works at its designated range. Below this point the sandwich packing works as a normal structured packing.

Measurements of the pressure drop of the sandwich packing with air/water columns of 1500 mm diameter have given new information about the influence of the column diameter on the hydraulic behaviour of the packing. It was shown, that the influence of the diameter is neglected and the sandwich packing of the 2. generation also works at larger diameters.

The efficiency of the sandwich packing was investigated in a production column of the Ludwigshafen plant site of BASF AG. A column of 500 mm in diameter was equipped with 29 elements of the sandwich packing. The measurements were done with the binary test system methylcyclohexane/n-heptane under total reflux for column pressures of 1.6 and 4 bar. Figure 3 shows the result of the measurements for 1.6 bar. Also in Figure 3 the efficiency of one element is compared with a conventional structured packing Montz-Pak 250M of the same height from efficiency test with cyclohexane/n-heptane at pressure of 1 bar [2]. Both test mixtures are recommended by [3] and are common for this kind of investigations. The results of these experiments are comparable and

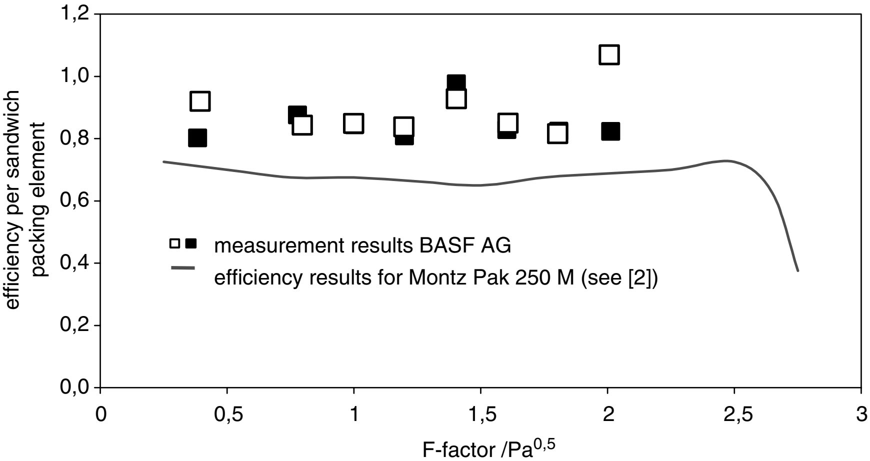

Figure 3. Efficiency of the sandwich packing (combination Montz Pak 750T/250M, column diameter of 500 mm) tested with methylcyclohexane/n-heptane at 1.6 bar pressure and compared with measurement results for the conventional Montz-Pak 250M tested with a mixture of cyclohexane/n-heptane at pressure of 1 bar

indicate an increase of the efficiency of about 30 percent compared to the conventional packing.

Every experiment was done twice. The points were repeated at another day with the same parameters to get an idea about the reproducibility of the experimental results. Both measurements are plotted in Figure 3. The reproducibility of the results is good. Also for the measurements with 4 bar column pressure the efficiency of the sandwich packing is about 30 percent higher compared to the conventional packing. The efficiency experiments in an industrial column were quite difficult. Before the results were usable different problems like the low temperature of the reflux, the control concept of the apparatuses and the taking of liquid samples out of the profile of the column had to be solved. Because of these problems it was also impossible, to do the measurements until the flooding point of the de-entrainment layer. The sandwich packing has no loss in capacity compared to the conventional packing Montz-Pak 250M.

The new results of the hydraulic and thermodynamic measurements are the basic for designs of new columns or the revamps of existing columns. Especially trayed columns are in the focus of revamps, aiming for higher throughput and/or better separation efficiency.

There are still open items for further research. The design of the downcomers should be optimized, e.g. the size and the number of the downcomers or the number and the diameter of holes in the downcomer. Another point is the minimization of the fluid bypass at the wall of the column and at the wall of the downcomers. The combinations of flooded and de-entrainment layer can be optimized. The heights of the layers can be optimized. Also more efficiency experiments with other combinations of layers or other binary test systems are possible.

LITERATURE

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