Waters
Lab Highlights
An Internal Communication of Applications and Techniques
LAH 0147 2/84
TH

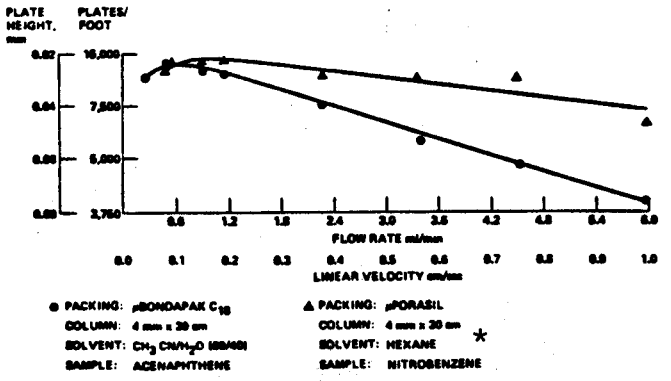
EFFICIENCY VS. FLOW RATE:
CAN A μBONDAPAK™ C_{18} COLUMN HAVE 14,000 PLATES?

Did you know that when comparing columns packed with 10 micron particles, μBONDAPAK™ C_{18} has efficiency which is unsurpassed. Unfortunately, the efficiency of this column is often misquoted and misinterpreted.

Manufacturing Specification vs. Operational Performance. Because Waters manufactures such a large number of μBONDAPAK™ C_{18} columns, the time involved for the final efficiency test by manufacturing must be as short as possible. With a short test for plate count, more columns can be tested in a day. This means more people receive their needed columns. Thus, the manufacturing specification is set at a very high flow rate which results in an efficiency value that is far below the "typical" performance which a customer would obtain. Unfortunately, many other column suppliers specify the plate count based upon an optimum flow rate.

Figure 1 has been constructed to help in explaining the type of performance which would be representative of a Waters™ column.

COLUMN EFFICIENCY *vs* FLOW RATE



* Since this data was generated the test sample and mobile phase have been changed. It is now p-anisaldehyde as the sample and methylene chloride/IPA 99.9:0.1 as the mobile phase.

The test for the μBONDAPAK™ C_{18} column is at a flow rate of 2.5 ml/min (linear velocity of 0.42 cm/sec). The manufacturing specification which must be met is greater than 4000 plates at this high flow rate. Data collected during November of 1983 resulted in an "average" column performance of 6700 plates. In Figure 1, at 2.5 ml/min, this column showed 7300 plates (only 600 plates more than the "average" during the time in November).

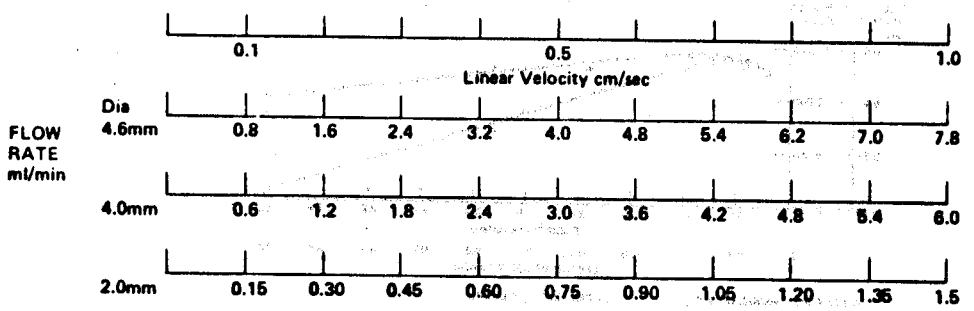
Waters
Division of MILLIPORE 34 Maple St. / Milford, MA 01757 / 617-478-2000
D.Horgan/B.Bidlingmeyer

At a more typical flow rate of 1.0 ml/min (normal usage), one could expect an operational performance of 10,000 plates per column (In figure 1 the actual value is 11,500 plates).

The optimum performance can be obtained at a linear velocity of 0.1 cm/sec or a flow rate of 0.6 ml/min. At this flow rate, one can expect optimum performance of 14,000 plates per column. Remember, for a steel column a plate-height value of 2 dp is considered the upper limit of performance. For the 30 cm μBONDAPAK™ C_{18} column, 2 dp = 0.02 mm ≈ 15,000 plates.

Proper Comparison. As mentioned, most competitors use 4.6mm ID columns. This means that at the same flow rate, the competitor column is operating at a lower linear velocity. If people wish to compare performance, they need to operate each column at the same linear velocity. Table I gives the relationship of some column diameters to the linear velocity. This table assumes the same packing density in each column. The linear velocity is marked on the top line. The corresponding flow rate for various diameter columns would be found on the respective line, e.g. a linear velocity of 0.5 cm/sec would occur at 4.0 ml/min on a 4.6 mm ID column, at 3.0 ml/min on a 4.0 mm ID column and at 0.75 ml/min on a 2.0 mm ID column.

LINEAR VELOCITY *vs* FLOW RATE



For the proper determination of linear velocity, it can be calculated from each column by the equation: $u = L/t_m$ where u is the linear velocity, L is the column length and t_m is the time for the unretained peak.