HALO 5

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HALO® 5

New 5-micron HALO-5 columns based on Fused-Core particle technology boost the performance of HPLC. Compared to other HPLC columns, HALO-5 columns have:

- the performance of a sub-3 micron column with the durability and ease of use of a 5 micron column
- improved productivity resulting from having the same thin porous layer as 2.7-micron HALO columns allowing high efficiencies at faster flow rates
- low back pressure well suited to legacy HPLC instruments
- scalable from UHPLC separations developed on 2.7-micron HALO columns

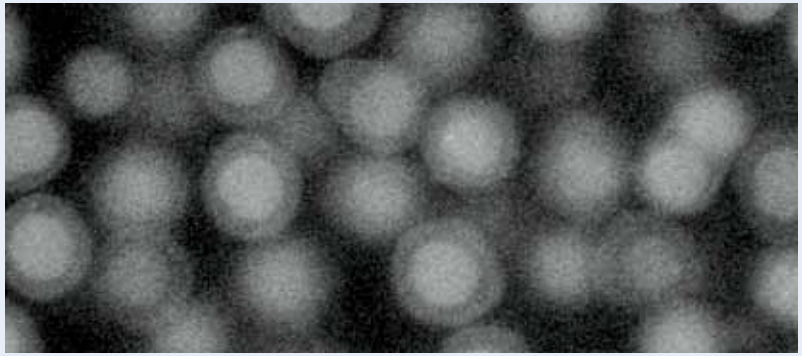
Changing the way you think about HPLC

HALO-5 columns are packed with 5-micron Fused-Core® particles. Fused-Core particle technology was developed in 2006 by a research group at Advanced Materials Technology headed by renowned chromatography scientist, Jack Kirkland. HALO was the first of the 2.7-micron "superficially porous particles", also referred to as "core-shell" particles, that were developed to make UHPLC more rugged and reliable than what was generally experienced with UHPLC columns packed with sub-2-micron particles. In the past 5 years, this technology has proven to be so valuable that it has spawned several "copy cat" brands, as well as numerous stationary phase choices based on this particle technology. What was once an academic curiosity is now firmly established as the chromatographic tool of choice for many HPLC and UHPLC applications.

Originally, HALO columns were designed and manufactured as UHPLC columns. Now, the same proven Fused-Core particle technology that has made HALO UHPLC columns such a success has been used to create a new generation of HPLC columns with extraordinary performance, the HALO-5 HPLC columns. Although the use of UHPLC is growing rapidly, the high cost and complexity of UHPLC, plus the large installed base of traditional HPLC equipment means that HPLC separations will continue to be the dominant method for liquid chromatography separations for years to come. To meet the need for improved HPLC performance, HALO-5 was developed to boost the speed and resolution capability of HPLC to near-UHPLC levels.

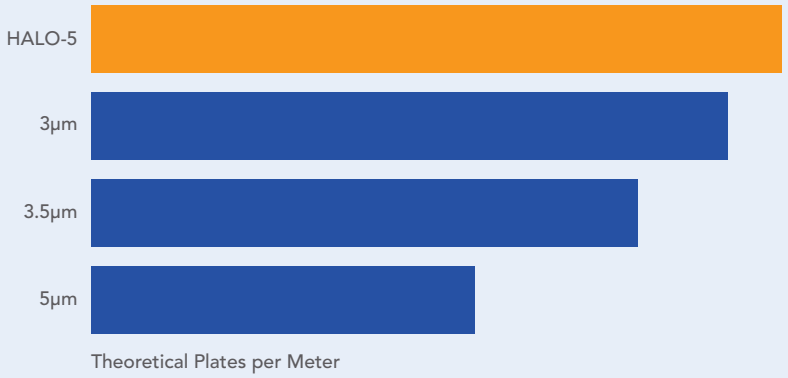
As the name implies, Fused-Core particles are manufactured by fusing a porous silica layer onto a solid silica particle. The extremely small particle size distribution and the short diffusion path of these porous "halo" particles (*Figure 1*) reduce both eddy diffusion and axial dispersion and, thereby, minimizes peak broadening.

1 HALO PARTICLE



This SEM photograph of "sliced" Fused-Core particles clearly shows the structure; a solid core surrounded by a porous "halo".

2 SIGNIFICANTLY HIGHER EFFICIENCY



Note: N/Meter values were calculated at the optimum mobile phase linear velocity for each of these stationary phases

HALO-5 columns deliver more efficiency per column length compared to HPLC columns packed with totally porous particles 3 µm and larger.

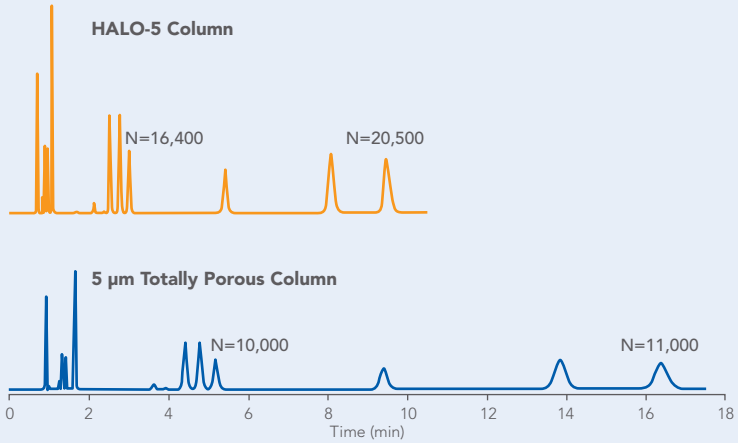
3 HALO-5 PROVIDES FASTER SEPARATIONS AND HIGHER RESOLUTION

Conditions:

Columns:	4.6 x 150 mm, C18
Mobile Phase:	52% 20 mM Potassium Phosphate pH 2.5: 48% 50/50 ACN/MeOH
Flow rate:	2.0 mL/min
Injection Volume:	2 µL
Temperature:	35 °C
Pressure:	HALO-5 column = 240 bar 5 µm column = 210 bar
Detection:	254 nm

Peak Identities:

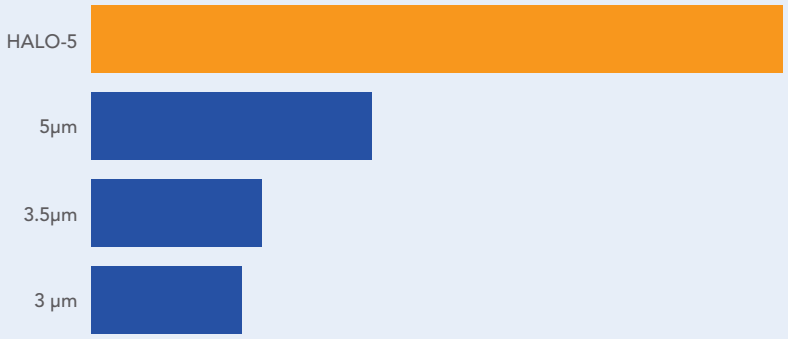
1. Acetaminophen
2. Aspirin
3. Salicylic acid
4. Tolmetin
5. Ketoprofen
6. Naproxen
7. Fenoprofen
8. Diclofenac
9. Ibuprofen



HALO-5 column separates this mixture of NSAIDs in less than 60% of the time and with better resolution than a typical HPLC column packed with totally porous 5 micron particles.

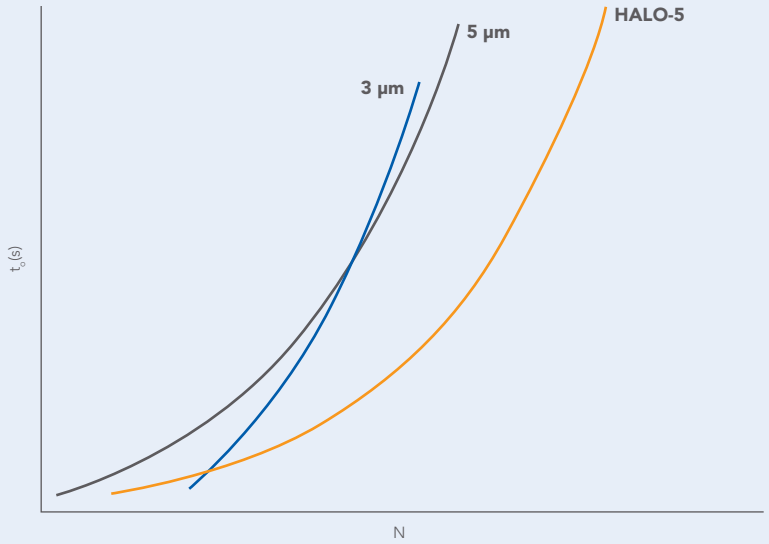
It is well known that columns packed with larger particles deliver more theoretical plates (efficiency) per unit of column back pressure than columns packed with smaller particles. What distinguishes HALO-5 columns is that they have a plates per pressure ratio that is significantly higher than what is seen with other columns packed with the same size totally porous particles. This places a powerful tool into the hands of a chromatographer that must separate very complex mixtures and needs a large number of theoretical plates to do it. This is especially important when using HPLC equipment with limited pressure capability. For a given operating pressure, HALO-5 columns will deliver twice the efficiency of a column packed with 5 micron totally porous particles.

4 HIGHEST PLATES PER COLUMN BACK PRESSURE



Columns packed with larger size particles will deliver more efficiency per unit of column back pressure. HALO-5 columns have a plates per pressure ratio that is significantly higher than what is seen with other columns packed with the same size totally porous particles. This characteristic of HALO-5 columns can be very useful when faced with developing a separation of a very complex mixture, especially when using HPLC equipment with limited pressure capability.

5 KINETIC PLOT COMPARISONS



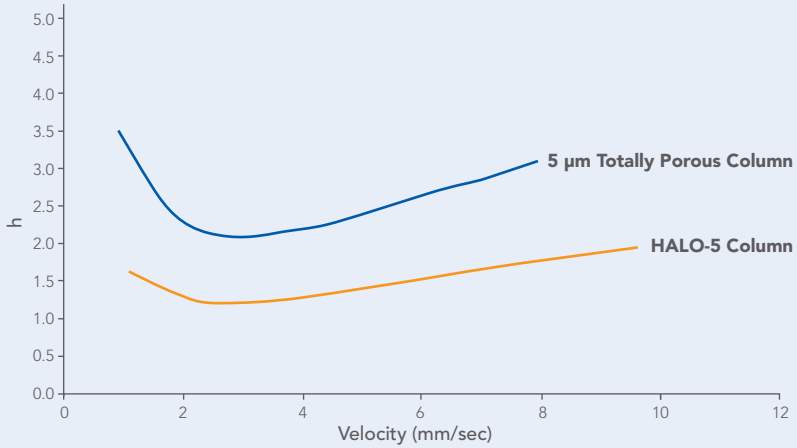
Kinetics plots are used to compare columns packed with different particles and particle sizes. This Kinetic plot compares columns of various lengths packed with HALO-5, 5 micron totally porous and 3 micron totally porous particles and shows that HALO-5 columns provide more column plates (N) for a given analysis time (t_o) than columns packed with totally porous 5 and 3 micron particles.

One of the distinguishing characteristics of Fused-Core particles is the unusually narrow size distribution (dp90/dp10 < 1.15) compared to totally porous particles (dp90/dp10 ~ 1.5). The unusually narrow particle size distribution plus the high density of Fused-Core particles, facilitate the packing of columns with remarkably good reduced plate heights, h. It has generally been assumed that a reduced plate height of 2 was the practical limit that could be achieved with packed columns and few commercial columns even achieve h values less than 2.5. HALO-5 columns typically have h values less than 1.3 particle diameters. This explains why HALO-5 columns exceed the efficiency of HPLC columns packed with the more typical totally porous 5-micron particles and provide comparable efficiencies to 3-micron totally porous particles at half the pressure.

6 VAN DEEMTER PLOT COMPARISONS

Conditions:

Columns:	4.6 x 150 mm
Mobile Phase:	50% Acetonitrile, 50% Water
Temperature:	30° C
Sample:	1-Cl-4-nitrobenzene



This comparison of van Deemter plots for HALO-5 and a totally porous 5 micron particle demonstrates the extraordinarily low reduced plate height that is obtained from HALO-5 columns. The unusually narrow particle size distribution of the HALO-5 Fused-Core particles facilitate the packing of columns with efficiencies (theoretical plates) that are significantly larger than what would be expected from the size of the particles.

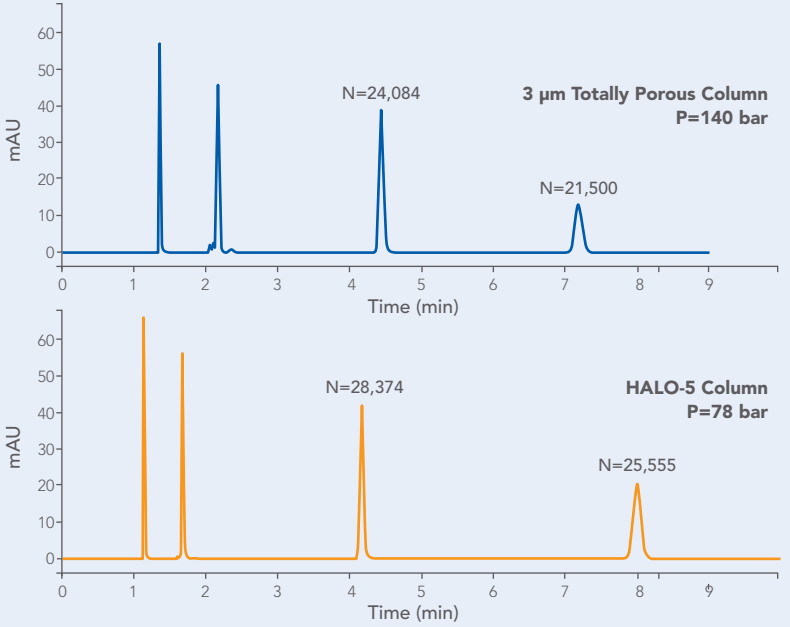
7 HALO-5 COLUMNS PROVIDE HIGHER EFFICIENCY AT LOWER PRESSURE COMPARED TO 3µm COLUMNS

Conditions:

Column:	4.6 x 150 mm, C18
Mobile phase:	HALO-5 column = 50% Acetonitrile, 50% Water
	3 µm column = 60% Acetonitrile, 40% Water
Flow rate:	1.0 mL/min
Temperature:	30° C

Peak Identities:

1. Uracil
2. Phenol
3. 1-Cl-4-nitrobenzene
4. Naphthalene



HALO-5 columns generate over 17% more plates than an HPLC column of the same dimension packed with 3 µm totally porous particles, but generates less than 60% of the back pressure.

The van Deemter plot in Figure 6 also illustrates another advantage offered by HALO-5 columns. Notice that the HALO-5 plot is much "flatter" than the 5-micron totally porous particle column. This means that HALO-5 columns can be run at high mobile phase velocity to achieve very fast separations without having to accept large losses in resolution, since column efficiency degrades very little at accelerated mobile phase flow rates.

HALO 5 Phases

C18 & C8

Excellent performance for a broad range of analyte polarities. Separations are due primarily to hydrophobic interactions and differences in hydrophobicity among analytes.

C18 will strongly retain non-polar and moderately polar analytes. C8 provides similar selectivity to C18 but with less retention.

Phenyl-Hexyl

Separations occur due both to hydrophobic and π-π interactions. Enhanced retention and selectivity for aromatic and unsaturated analytes, especially those with electron withdrawing groups and halogens. Compatible with aqueous mobile phases.

PFP

Separations take place due to multiple types and degrees of analyte interactions including hydrophobic, π-π, dipole-dipole and hydrogen bonding. Can be used in the HILIC mode with mobile phases containing greater than 80% acetonitrile. Enhanced selectivity for stereoisomers. Compatible with highly aqueous mobile phases.

ES-CN

Provides strong dipole-dipole interactions with analytes and weak hydrophobic interactions. Suitable for use in reversed-phase, HILIC, and normal-phase modes. Rapid equilibration with low bleed for high throughput LC-MS applications. Extra stable bonding with sterically protected ligand provides improved stability and performance compared to conventional CN phases, especially at low pH (1–4).

HALO 5 Specifications

- Ultra-pure, "Type B" silica
- Solid core particle with a 0.6 µm porous silica layer fused to the surface
- 90 m^2/gram surface area (equivalent to 150–200 m^2/gram totally porous particles)
- 90 Å pore size
- pH range: 2 to 9
- Maximum temperature: 60 °C
- Maximum Pressure: 9,000 psi, 600 bar

HALO 5 Phases

C18:	Octadecylsilane, exhaustively endcapped
C8:	Octylsilane, exhaustively endcapped
Phenyl-Hexyl:	Phenylhexylsilane , exhaustively endcapped
PFP:	Pentafluorophenylpropylsilane, exhaustively endcapped
ES-CN:	Cyanopropyldiisopropylsilane, exhaustively endcapped

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HALO 5 Ordering Information

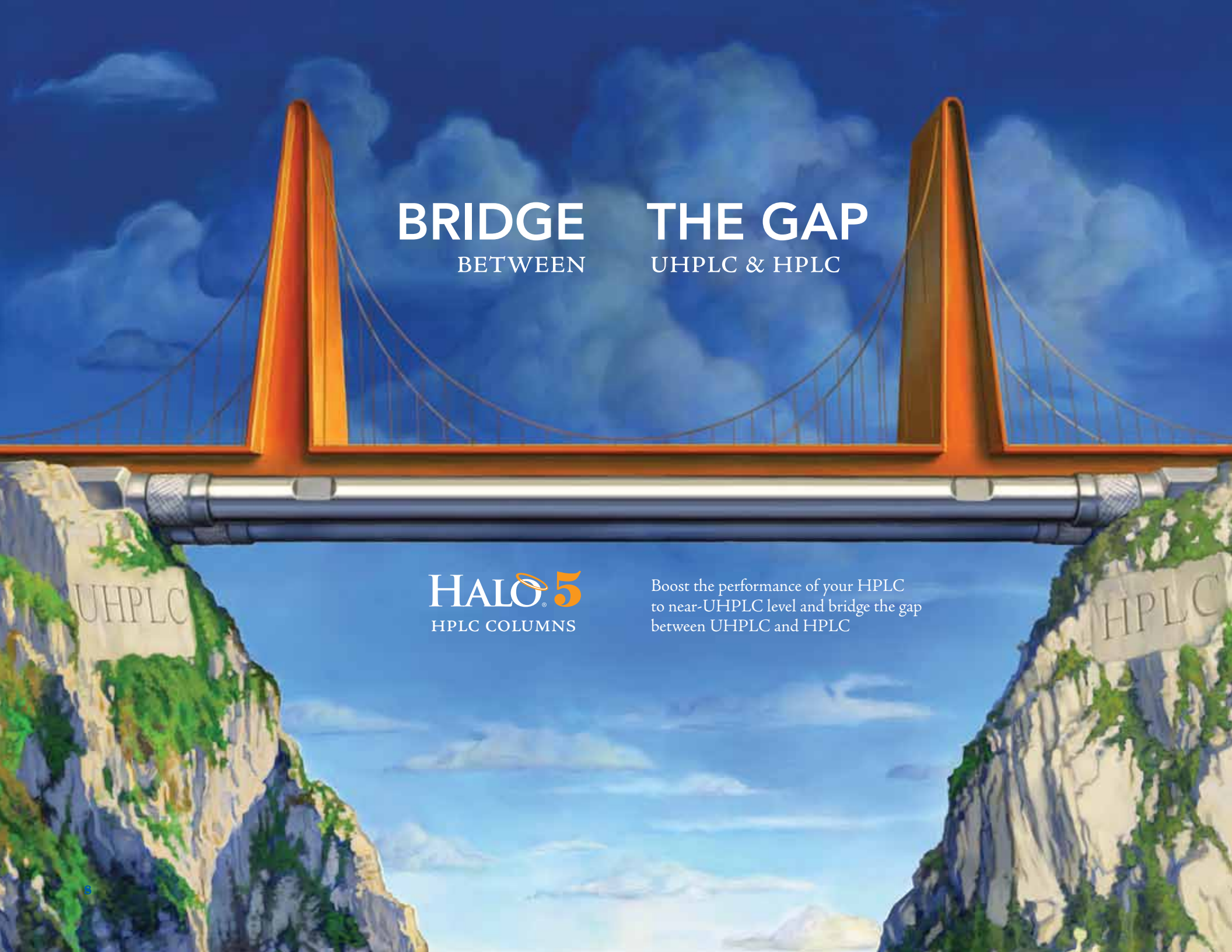
HALO 5-Columns

Dimensions (mm)	C18	C8	Phenyl-Hexyl	PFP	ES-CN
2.1 x 20	95812-202	95812-208	95812-207	95812-209	95812-204
2.1 x 30	95812-302	95812-308	95812-307	95812-309	95812-304
2.1 x 50	95812-402	95812-408	95812-407	95812-409	95812-404
2.1 x 75	95812-502	95812-508	95812-507	95812-509	95812-504
2.1 x 100	95812-602	95812-608	95812-607	95812-609	95812-604
2.1 x 150	95812-702	95812-708	95812-707	95812-709	95812-704
2.1 x 250	95812-902	95812-908	95812-907	95812-909	95812-904
3.0 x 30	95813-302	95813-308	95813-307	95813-309	95813-304
3.0 x 50	95813-402	95813-408	95813-407	95813-409	95813-404
3.0 x 75	95813-502	95813-508	95813-507	95813-509	95813-504
3.0 x 100	95813-602	95813-608	95813-607	95813-609	95813-604
3.0 x 150	95813-702	95813-708	95813-707	95813-709	95813-704
3.0 x 250	95813-902	95813-908	95813-907	95813-909	95813-904
4.6 x 30	95814-302	95814-308	95814-307	95814-309	95814-304
4.6 x 50	95814-402	95814-408	95814-407	95814-409	95814-404
4.6 x 75	95814-502	95814-508	95814-507	95814-509	95814-504
4.6 x 100	95814-602	95814-608	95814-607	95814-609	95814-604
4.6 x 150	95814-702	95814-708	95814-707	95814-709	95814-704
4.6 x 250	95814-902	95814-908	95814-907	95814-909	95814-904

Guard Cartridges

Dimensions (mm)	C18	C8	Phenyl-Hexyl	PFP	ES-CN
2.1 x 5, 3-pack	95812-102	95812-108	95812-107	95812-109	95812-104
3.0 x 5, 3-pack	95813-102	95813-108	95813-107	95813-109	95813-104
4.6 x 5, 3-pack	95814-102	95814-108	95814-107	95814-109	95814-104

Guard Cartridge Holder	94900-001


BRIDGE THE GAP
BETWEEN UHPLC & HPLC
UHPLC
HPLC
HALO 5
HPLC COLUMNS
Boost the performance of your HPLC
to near-UHPLC level and bridge the gap
between UHPLC and HPLC