HALO® — 15 YEARS OF INNOVATION — 2006-2021
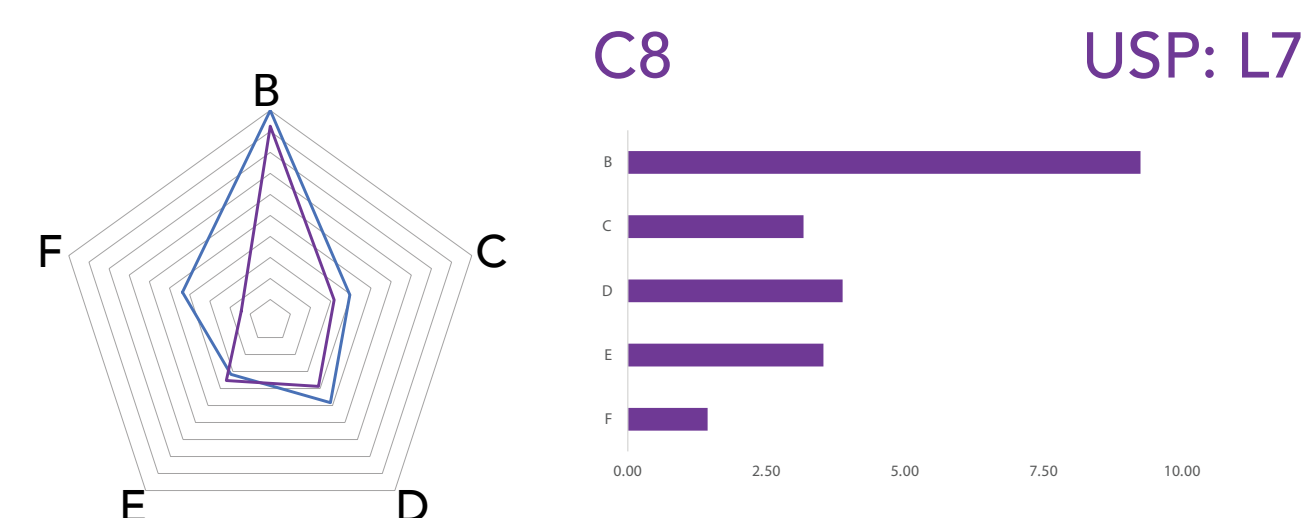
C18 — USP: L1

- Retention mainly governed by hydrophobicity, can offer other attributes but to a lesser extent
- RPLC workhorse for majority of routine assays
- Universal phase for acids, bases and neutral solutes

C8 — USP: L7

- Less hydrophobic compared to C18 and significant lower acidic ion exchange capabilities compared to C18
- Applications: cholesterol lowering pharmaceutical (statin) compounds, flavonoids, and lipid analysis of algal oil
- Ideal for broad range of analytes

AQ-C18 — USP: L1
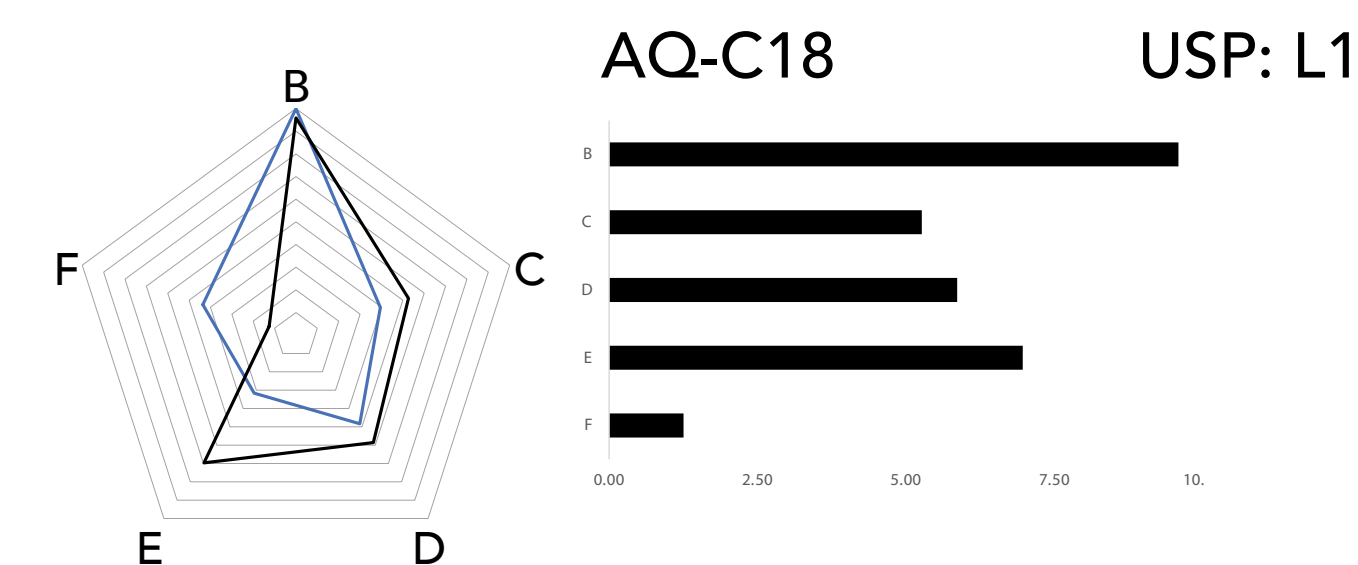
- Increased retention for polar analytes separated via RPLC and for total ion exchange capabilities
- Offers 100% aqueous compatibility
- Applications: polar pesticides, polar organic acids and separations that employ 100% water conditions e.g. pharmaceutical separation of nucleobases in 100% water 0.1%TFA <1.2 min

EUERBY-MODIFIED TANAKA PLOTS OF HALO® REVERSED PHASE SMALL MOLECULE CHEMISTRIES
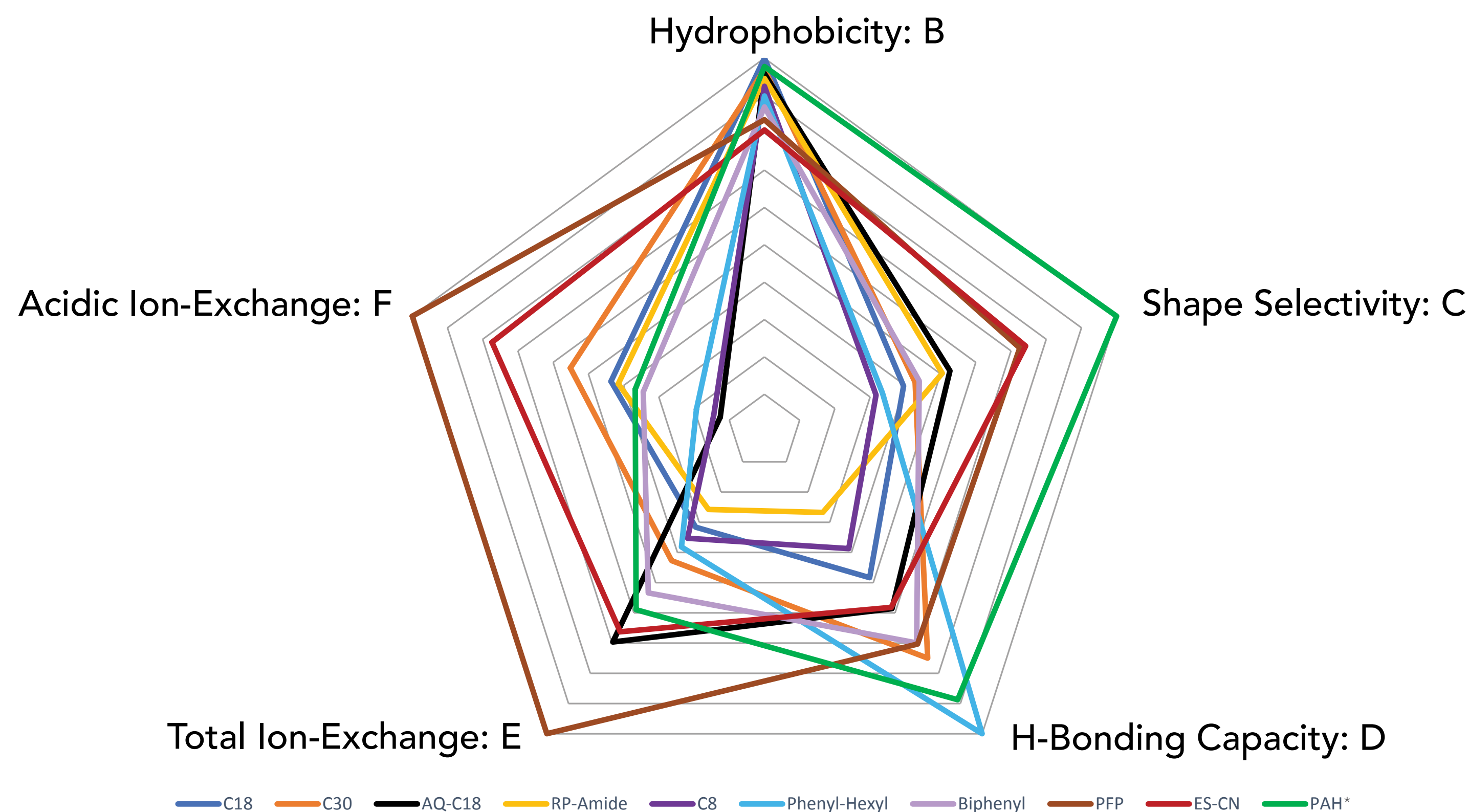
The Euerby-modified Tanaka plot is identical minus the A parameter, as the hydrophobicity parameter (B) entails this same information. The following radar plots visually compare ten of our HALO® columns for reversed phase separations, normalized at each axis for comparative purposes.

EUERBY-MODIFIED TANAKA PLOTS

The Tanaka test was first developed to determine differences between C18 stationary phases. Six different parameters/column properties (A,B,C,D,E,F) are determined based on the retention factors (k) of certain solute(s) and their respective selectivity factors under different isocratic and pH conditions.

Briefly, the parameters represented are:

A: amount of alkyl chains
B: hydrophobicity
C: shape selectivity
D: hydrogen bonding capacity
E: total ion-exchange capacity (pH>7)
F: acidic ion-exchange capacity (pH<3)

Hydrophobicity: B
Shape Selectivity: C
H-Bonding Capacity: D
Total Ion-Exchange: E
Acidic Ion-Exchange: F

Legend: C18, C30, AQ-C18, RP-Amide, C8, Phenyl-Hexyl, Biphenyl, PFP, ES-CN, PAH*

- Note: the reciprocal value was represented for elution order changes:
  (i) C8 – shape selectivity; (ii) Biphenyl – H- bonding capacity; and (iii) PFP – total ion-exchange.
- This global view of all the HALO® columns may be useful when trying to select a column based upon the five attributes.

*PAH applicated phase available in ENVIROCLASS product line

Phenyl-Hexyl — USP: L11
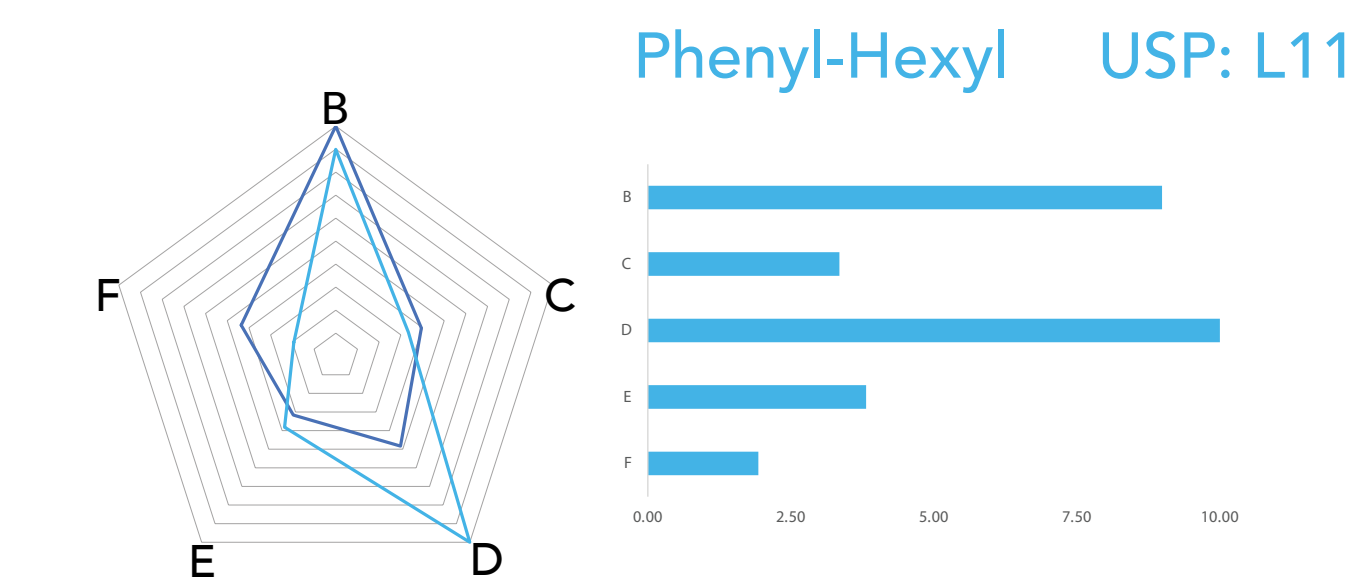
- Less hydrophobicity characteristics than C18
- Ideal for separation of aromatic compounds
- Phenyl moiety offers pi-pi interactions – with the highest H-bonding capacity compared to the other nine HALO® RP phases
- Significantly decreased acidic ion exchange and slightly higher total ion exchange (pH>7) compared to C18
- Applications: penicillins, anti-coagulants, and fluoroquinolone drugs

C30 — USP: L62
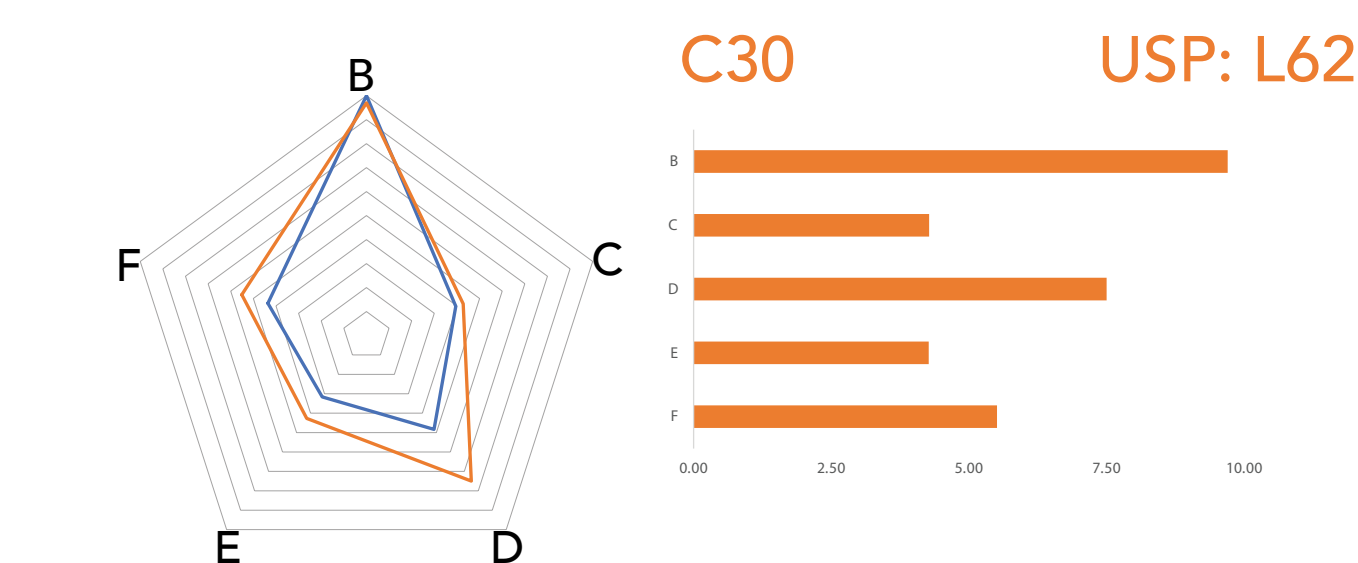
- Shape selectivity advantages compared to C18.
- Larger H-bonding capacity and increased ion exchange capabilities in both acidic and basic conditions compared to C18
- Applications: isomer separations, fat/water soluble vitamins, carotenoids, lipids, anti-inflammatory, anti-lymphatic and anti-allergy steroids

PFP — USP: L43
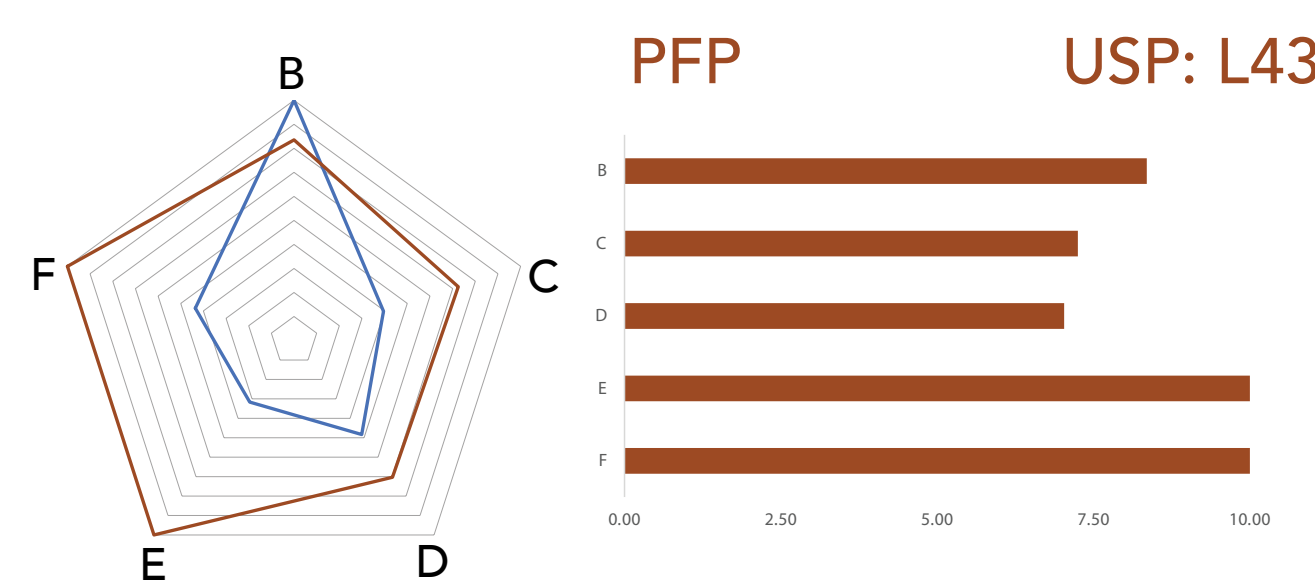
- Versatility to be employed in both RP and HILIC separations and unique characteristics in comparison to C18 phase - key to include in method development/column screening work
- Highest ion exchange and total ion exchange attributes with greater shape selectivity and less hydrophobicity relative to C18
- Applications: basic drugs, mycotoxin screening, tranquilizers

RP-Amide — USP: L60
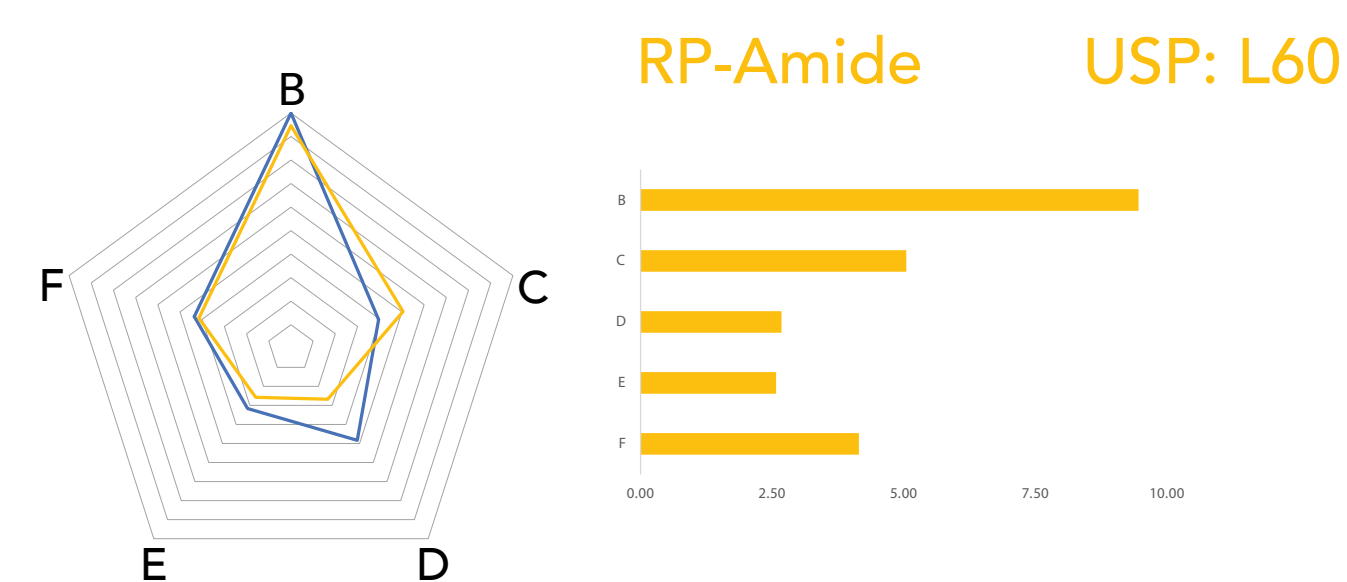
- Unique selectivity characteristics relative to C18 – increased shape selectivity and decreased hydrogen bonding capacity
- Ideal for basic compounds and 100% aqueous compatible
- Applications: antibiotics, cholesterol lowering drugs, phenolic acids in food and beverages, active ingredients in sunscreen, melatonin and related compounds

Biphenyl — USP: L11
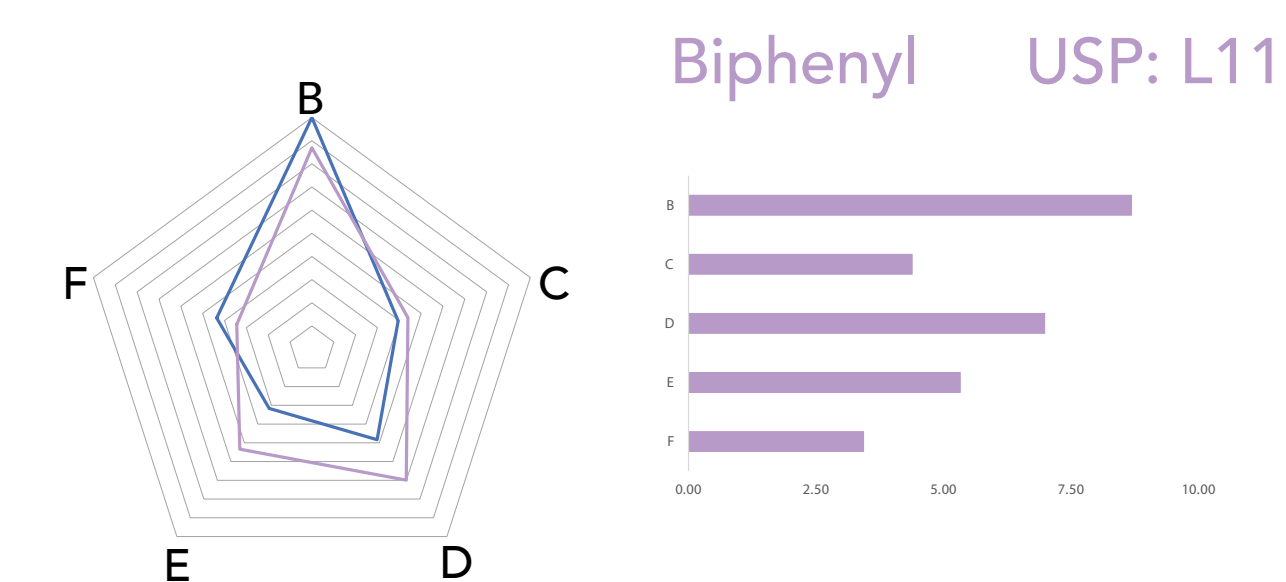
- Challenging separations that utilizes hydrogen bonding capacity, increased total ion exchange, pi-pi interactions, and relatively less hydrophobic characteristics and acidic ion exchange compared to C18
- Alternate selectivity to alkyl phases and 100% aqueous compatible
- Applications: opiates, polar and non-polar pesticides and via LC-MS

ES-CN — USP: L10
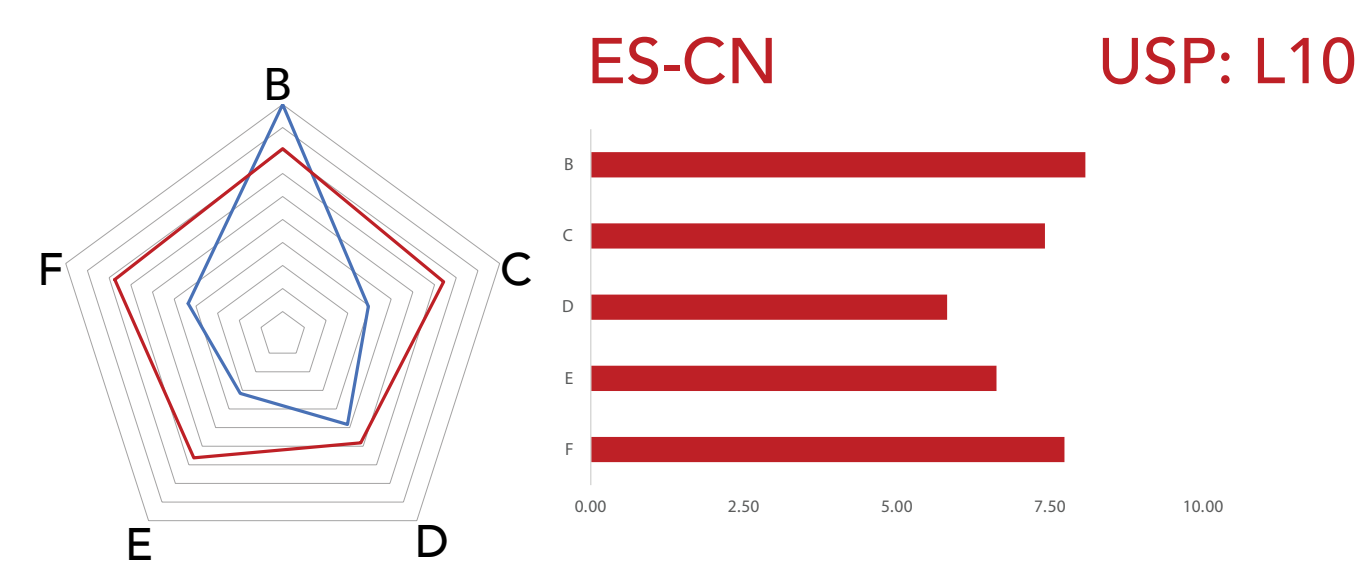
- Less hydrophobic, increased ion exchange capabilities, shape selectivity, lone pair of electrons of the phase's CN moiety provide unique RP interactions - compared to C18
- Ideal for polar analytes and 100% aqueous compatibility making it a must have for method development/column screening
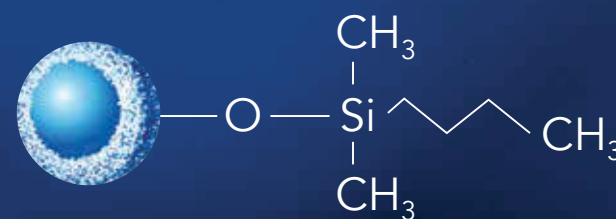- Applications: ß-lactam antibiotics, NSAIDs and penicillins

advanced materials technology

BIOCLASS: Designed for Biomolecule Characterization

PROTEIN
PARTICLE SIZES: 2.7 µm, 3.4 µm
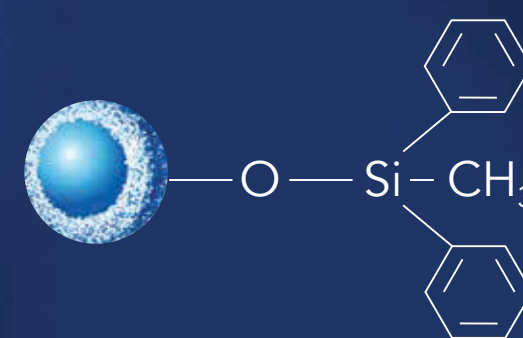*PORE SIZES: 1000 Å, 400 Å*
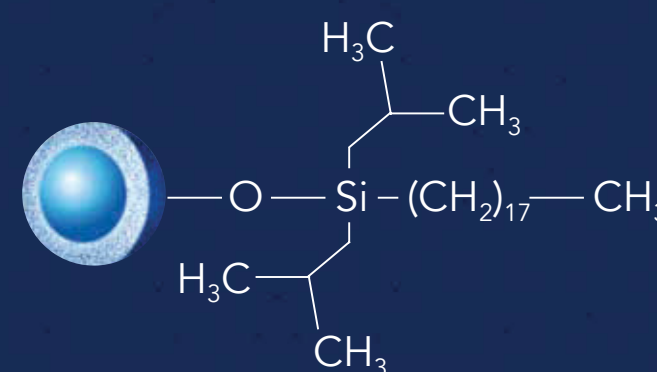
C4
USP: L26

ES-C18
USP: L1
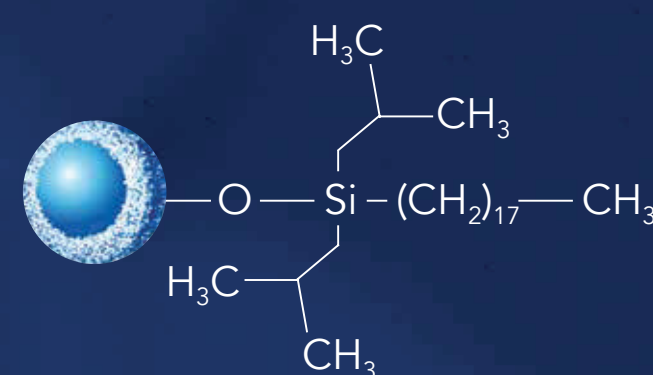
Diphenyl
USP: L11

PEPTIDE
PARTICLE SIZES: 2 µm, 2.7 µm, 5 µm
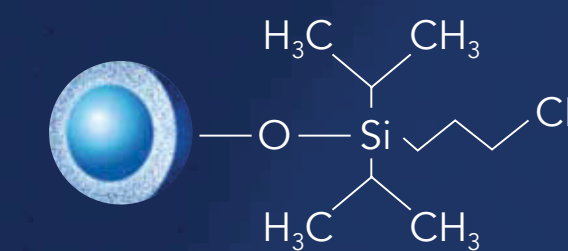*PORE SIZES: 160 Å*

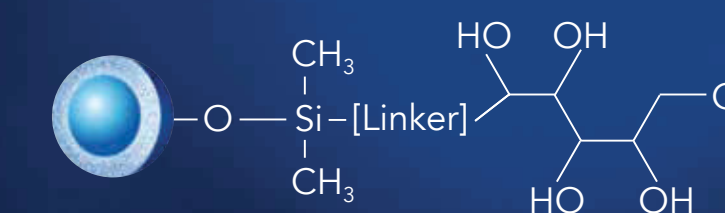**ES-C18**
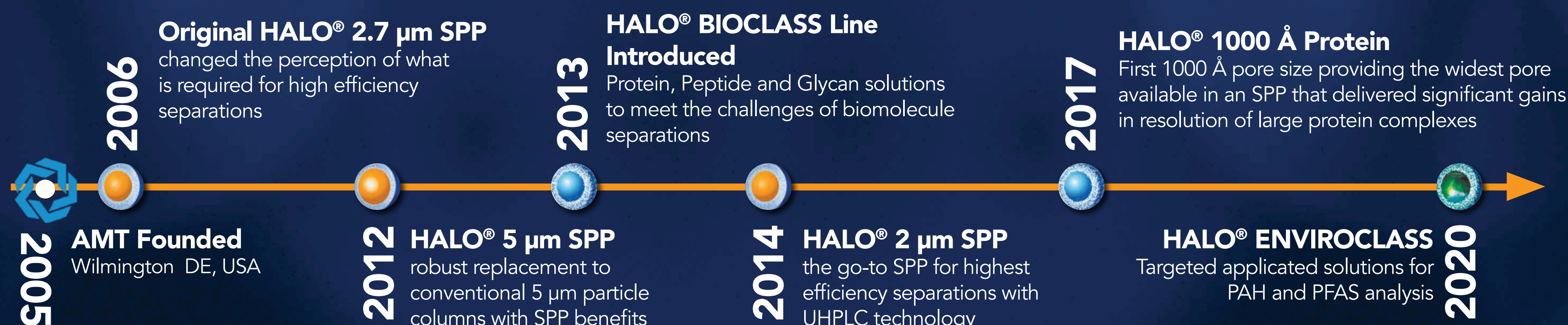USP: L1

Phenyl-Hexyl
USP: L11
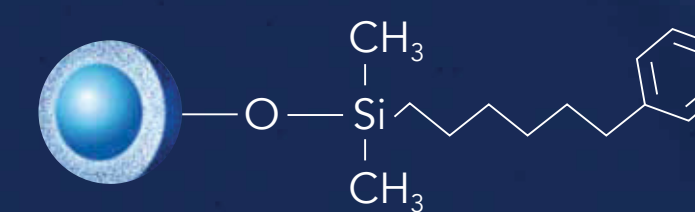
ES-CN
USP: L10

GLYCAN
PARTICLE SIZES: 2.7 µm
PORE SIZES: 90 Å

Glycan
USP: L95

THE ORIGINAL PARTICLE WHICH FORGED A NEW PATH IN HPLC SEPARATIONS

15 YEARS OF INNOVATION
2006 - 2021
HALO®

2005 — **AMT Founded** Wilmington DE, USA

2006 — **Original HALO® 2.7 µm SPP** changed the perception of what is required for high efficiency separations

2012 — **HALO® 5 µm SPP** robust replacement to conventional 5 µm particle columns with SPP benefits

2013 — **HALO® BIOCLASS Line Introduced** Protein, Peptide and Glycan solutions to meet the challenges of biomolecule separations

2014 — **HALO® 2 µm SPP** the go-to SPP for highest efficiency separations with UHPLC technology

2017 — **HALO® 1000 Å Protein** First 1000 Å pore size providing the widest pore available in an SPP that delivered significant gains in resolution of large protein complexes

2020 — **HALO® ENVIROCLASS** Targeted applicated solutions for PAH and PFAS analysis

HALO® INNOVATION | As separation demands evolve so does Advanced Materials Technology's industry leading innovation.

What began in 2006 at AMT with the 2.7 µm C18 HALO® particle that proved the possibility for high efficiency separations with conventional HPLC's has revolutionized the chromatography world!

The innovation continues by forging a new path through manipulations of the particle morphology which has advanced the chromatographic separations in the biopharmaceutical and environmental industries.

The timeline above represents AMT's commitment to delivering innovative tools to enhance the separation resolution afforded by the column technology.

SMALL MOLECULE: Designed for smaller molecule separations; <5000 Da where speed and resolution are critical.
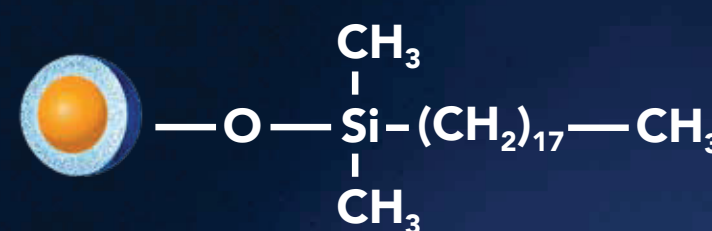
PARTICLE SIZES: 2 µm, 2.7 µm, 5 µm   *PORE SIZES: 90 Å*
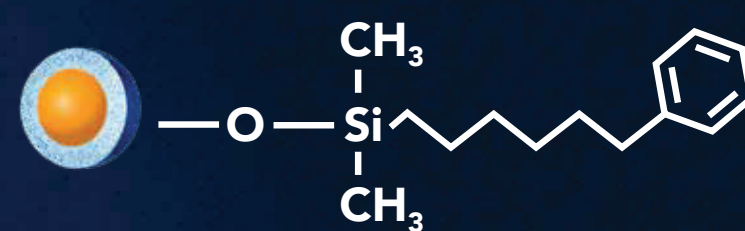
REVERSED PHASE
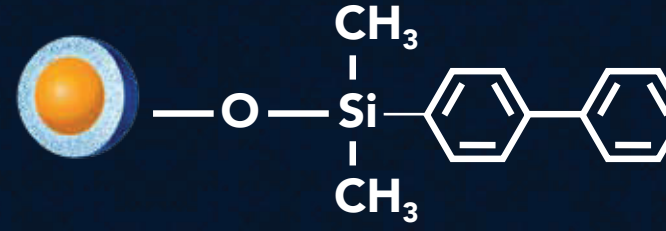
C18
USP: L1
Fs: 0

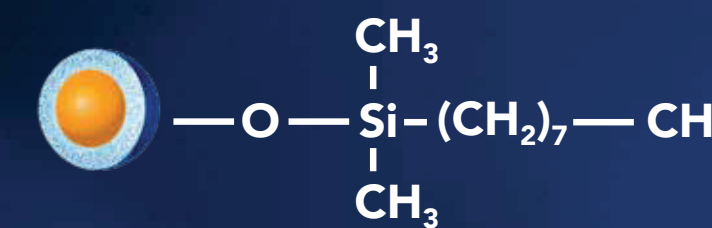**Phenyl-Hexyl**
USP: L11
Fs: 17.35

Biphenyl
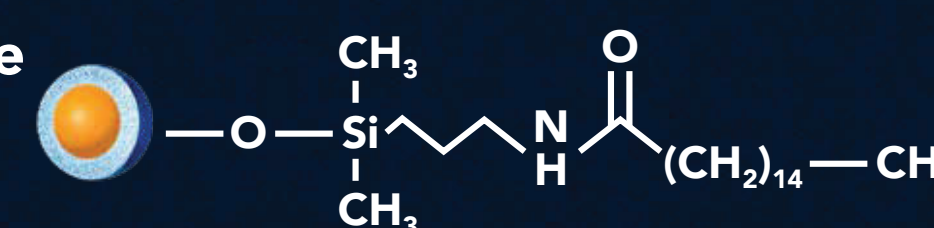USP: L11
Fs: 26.76

C8
USP: L7
Fs: 10.04

C30
USP: L62
Fs: 17.43

RP-Amide
USP: L60
Fs: 52.83

AQ-C18
USP: L1
Fs: 12.07

ES-CN
USP: L10
Fs: 22.78

PFP
USP: L43
Fs: 94.45

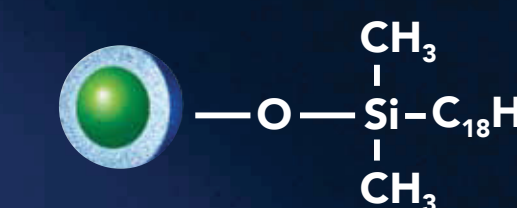## HILIC PHASES

HILIC
USP: L3
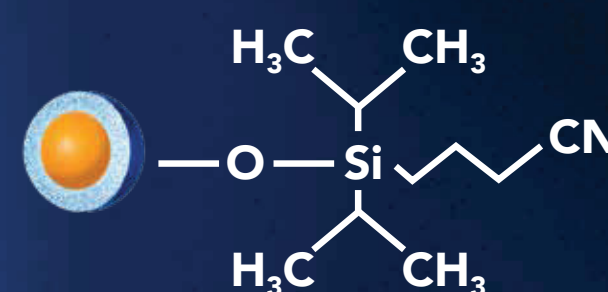
Penta-HILIC
USP: L95
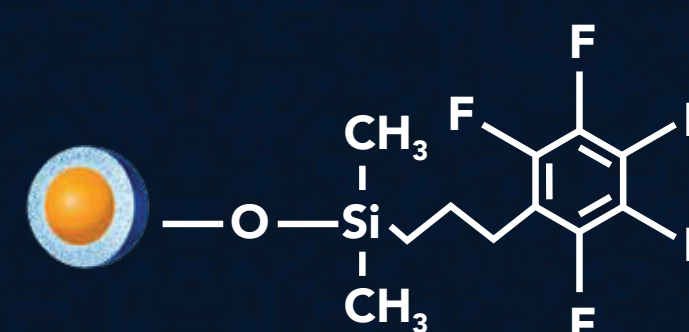
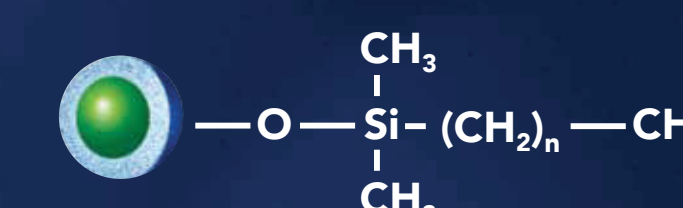# ENVIROCLASS: Applicated solution for PFAS and PAH analysis.
PARTICLE SIZE: 2.7 µm
PORE SIZES: PROPRIETARY

PFAS Analytical

PFAS Delay

PAH

advancedmaterialstechnology

INNOVATION | QUALITY | EXPERIENCE