Versatile Hybrid Silica Based HPLC Column

YMC-Triart

UHPLC & HPLC Columns

- 6 chemistries for different selectivity
- Great chemical and thermal durability
- UHPLC (up to 100 MPa) and HPLC columns
- Available in high durability semi-preparative columns

Particle size

1.9 µm
3 µm
5 µm

YMC-Triart C18
Suitable as a first choice column with excellent durability

YMC-Triart C18 ExRS
Alternative selectivity to standard C18 columns

YMC-Triart C8
Effective for fast analysis of compounds with low polarity or for separation of isomers

YMC-Triart Phenyl
Effective for separation of compounds with long conjugated system by utilizing π-π interaction

YMC-Triart PFP
Effective for separation of polar compounds or isomers by polar interaction

YMC-Triart Diol-HILIC
Effective for separation of highly polar compounds

YMC CO., LTD.
http://www.ymc.co.jp

PB-0071E

YMC-Triart

YMC-Triart is next-generation organic hybrid silica based columns, emphasizing versatility. The main features are superior durability, peak shape across all kind of compounds and reproducibility.
Having the same selectivity across different particle sizes, smooth method transfer between UHPLC and HPLC can be performed. Moreover, various bonded phases supplement performance of C18 phase, and allow separations which C18 columns cannot achieve.

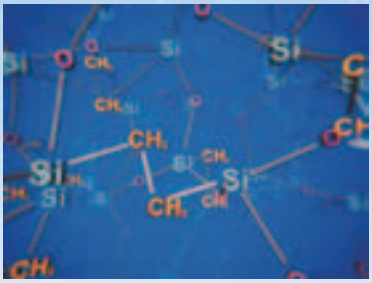
Various product lineup enables wide range of separation from UHPLC to HPLC analysis and even to preparative separation.

Features

- Effective for method screening with various chemistries
- Great chemical durability provided by hybrid particles
- Superior peak shapes for a wide range of compounds and in various conditions
- UHPLC compatible column with operating pressure up to 100 MPa packed with 1.9 µm particle
- Available in highly-durable semi-preparative column
- Smooth method transfer from UHPLC to HPLC analysis and even to HPLC purification

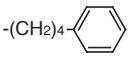
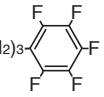
Versatile hybrid base material

YMC-Triart is based on novel organic/inorganic hybrid particles. The particle combines high mechanical stability and high efficiency derived from silica based packing material and high chemical stability derived from polymer based packing material. The granulation process utilizing microreactor technology enables continuous and highly controlled production of hybrid particles. The particle has uniform pore size distribution and smooth surface as well as uniform particle size. This feature greatly contributes to excellent peak shape and separation reproducibility.



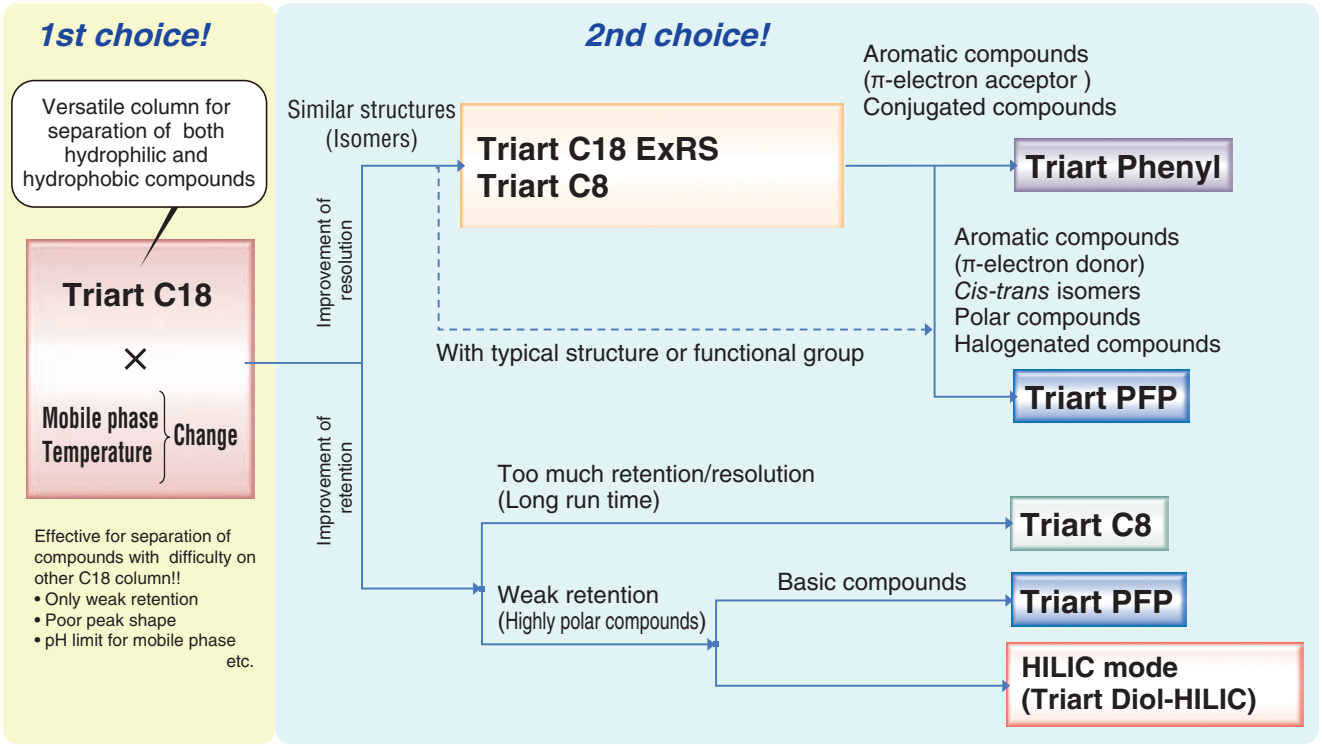
Contents

Specifications

Product name	Triart C18	Triart C18 ExRS	Triart C8	Triart Phenyl	Triaty PFP	Triart Diol-HILIC
Functional group	-$C_{18}H_{37}$ (Standard type)	-$C_{18}H_{37}$ (high density bonding)	-C_8H_{17}	-$(CH_2)_4$- 	-$(CH_2)_3$- 	-CH_2CHCH_2 OH OH
Separation mode	Reversed-phase					HILIC
Base	Organic/inorganic hybrid silica					
Particle size (μm)	1.9, 3, 5					
Pore size (nm)	12	8	12			
Bonding	Trifunctional					
Carbon content (%) ※	20	25	17	17	15	12
Endcapping	Yes				No	
Usable pH range	1.0~12.0	1.0~12.0	1.0~12.0	1.0~10.0	1.0~8.0	2.0~10.0
100% aqueous compatibility	○	×	×	○	○	–
USP Classification	L1	L1	L7	L11	L43	L20

※ Containing 8% for hybrid silica base material.

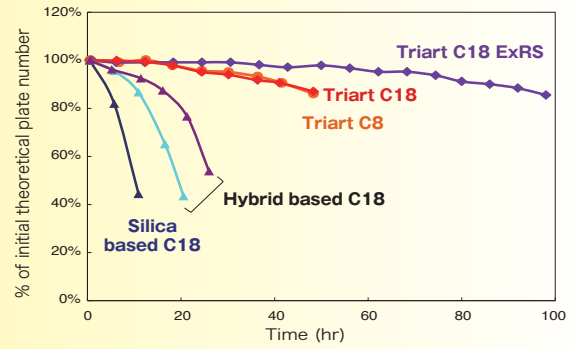
YMC-Triart column selection guide



Excellent durability

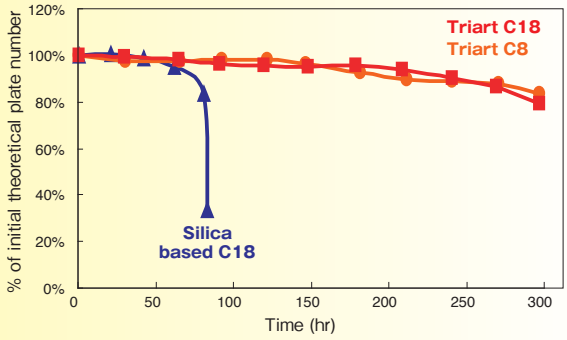
[Durability in high pH]

Phosphate buffer (pH 11.5), 40℃



Column	: 5 µm, 150 X 4.6 mmI.D.
Eluent	: 50 mM K_2HPO_4-K_3PO_4 (pH 11.5)/methanol (90/10)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Sample	: benzyl alcohol

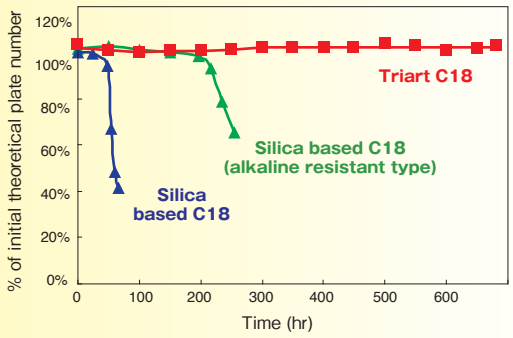
Triethylamine (pH 11.5), 40℃



Column	: 5 µm, 150 X 4.6 mmI.D.
Eluent	: 50 mM triethylamine (pH 11.5)/methanol (90/10)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Sample	: benzyl alcohol

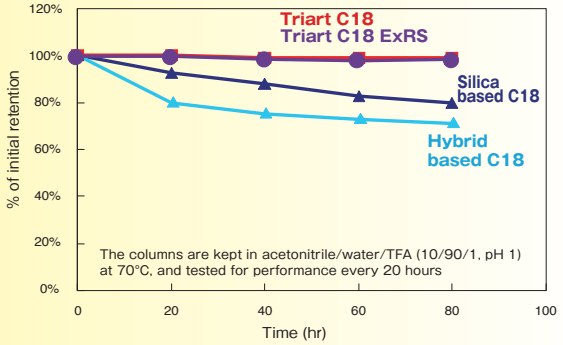
[Durability in high temperature]

pH 6.9, 70℃



Column	: 5 µm, 50 X 2.0 mmI.D.
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 6.9)/acetonitrile (90/10)
Flow rate	: 0.2 mL/min
Temperature	: 70℃
Sample	: phenol

pH 1, 70℃

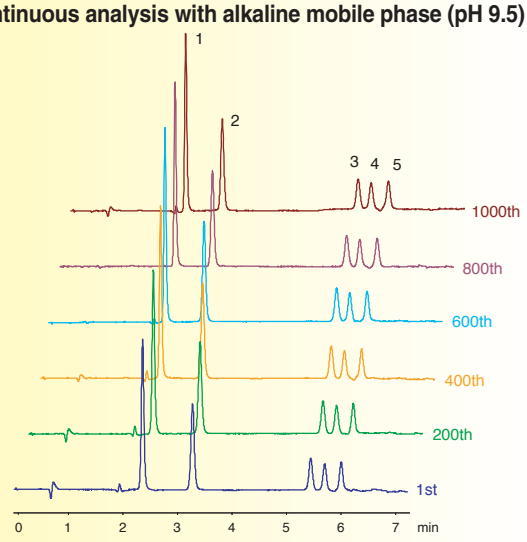


Test conditions	Column	: 5 µm, 50 X 2.0 mmI.D.
	Eluent	: acetonitrile/water (60/40)
	Flow rate	: 0.2 mL/min
	Temperature	: 37℃
	Sample	: butyl benzoate

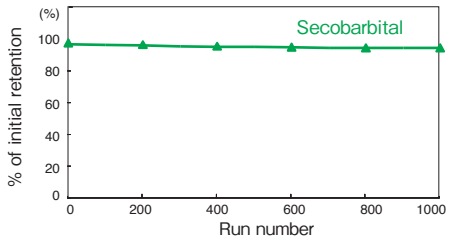
With innovative surface modification on organic hybrid silica, Triart columns show great chemical durability and they can be used over a wide pH range. Even at high-pH or high-temperature conditions, the lifetime of Triart C18, C18 ExRS and C8 is more than 10 times greater than that of conventional C18 columns and a few times greater than commercially available high alkaline-resistant C18 columns. When using under alkaline condition, organic buffers such as triethylamine make the column life longer than phosphate buffer. In addition, Triart is ideally suited for preparative purifications of various compounds or peptide analysis in the cases where trifluoroacetic acid (TFA) is frequently used, because it has high resistance to acids.

[Long column lifetime under chemically harsh conditions]

Continuous analysis with alkaline mobile phase (pH 9.5)



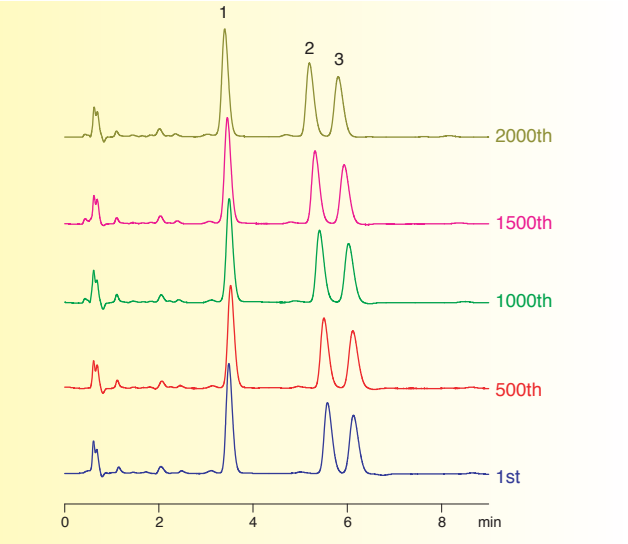
Barbiturates
1. Barbital
2. Phenobarbital
3. Hexobarbital
4. Pentobarbital
5. Secobarbital

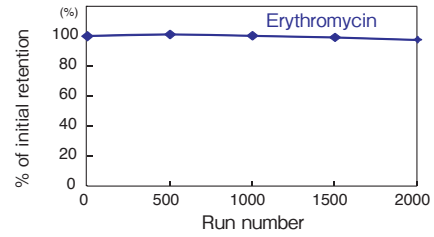


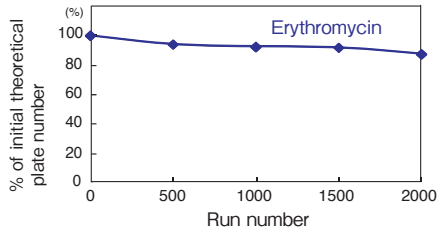
Column	: YMC-Triart C18 5 µm, 50 X 2.0 mmI.D.
Eluent	: A) 20 mM $HCOONH_4$-NH_3 (pH 9.5) B) methanol 0-90%B (0-7 min)
Flow rate	: 0.2 mL/min
Temperature	: 25℃
Detection	: UV at 240 nm
Injection	: 1 µL

Triart shows great durability under alkaline mobile phase conditions, which is difficult for conventional silica columns. This assures stable analysis over a long period of time.

Continuous analysis at pH 7.9, 70℃ -Erythromycin antibiotics-





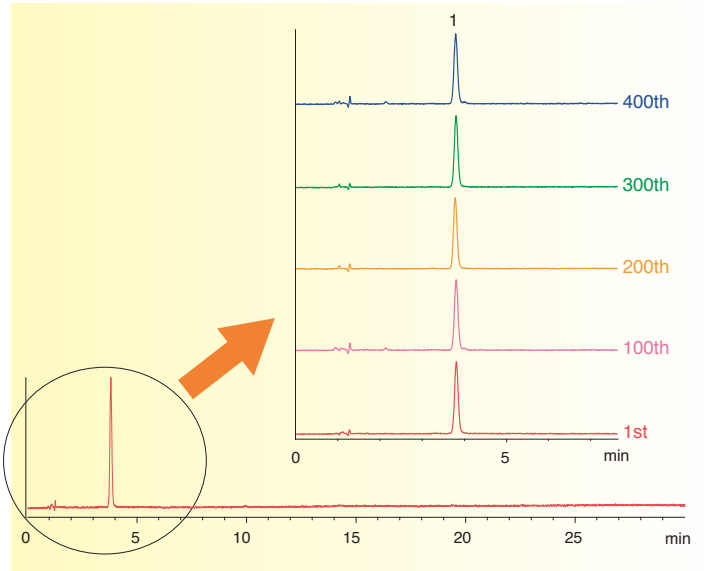


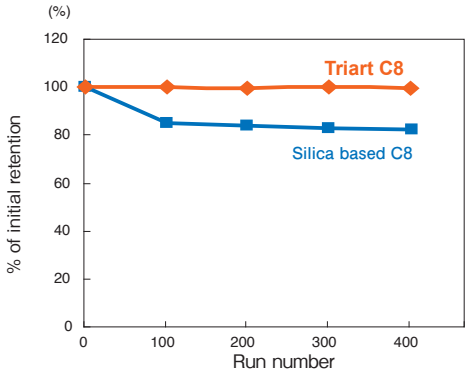
1. Erythromycin
2. Erythromycin ethylsuccinate
3. Erythromycin estolate

Erythromycins are shown to be easily degraded under acidic (< pH 6.5) condition. Higher pH is preferable. In addition, higher temperature tends to show better peak shape. Enhanced chemical durability of Triart C18 enables highly reproducible analysis under high pH and high temperature.

Column	: YMC-Triart C18 3 µm 50 X 2.0 mmI.D.
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 7.9)/acetonitrile/methanol (40/45/15)
Flow rate	: 0.2 mL/min
Temperature	: 70℃
Detection	: UV at 210 nm
Injection	: 1 µL

Continuous analysis at pH 2.0, 55℃ -Carvedilol-





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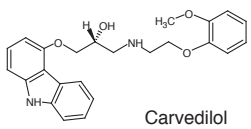


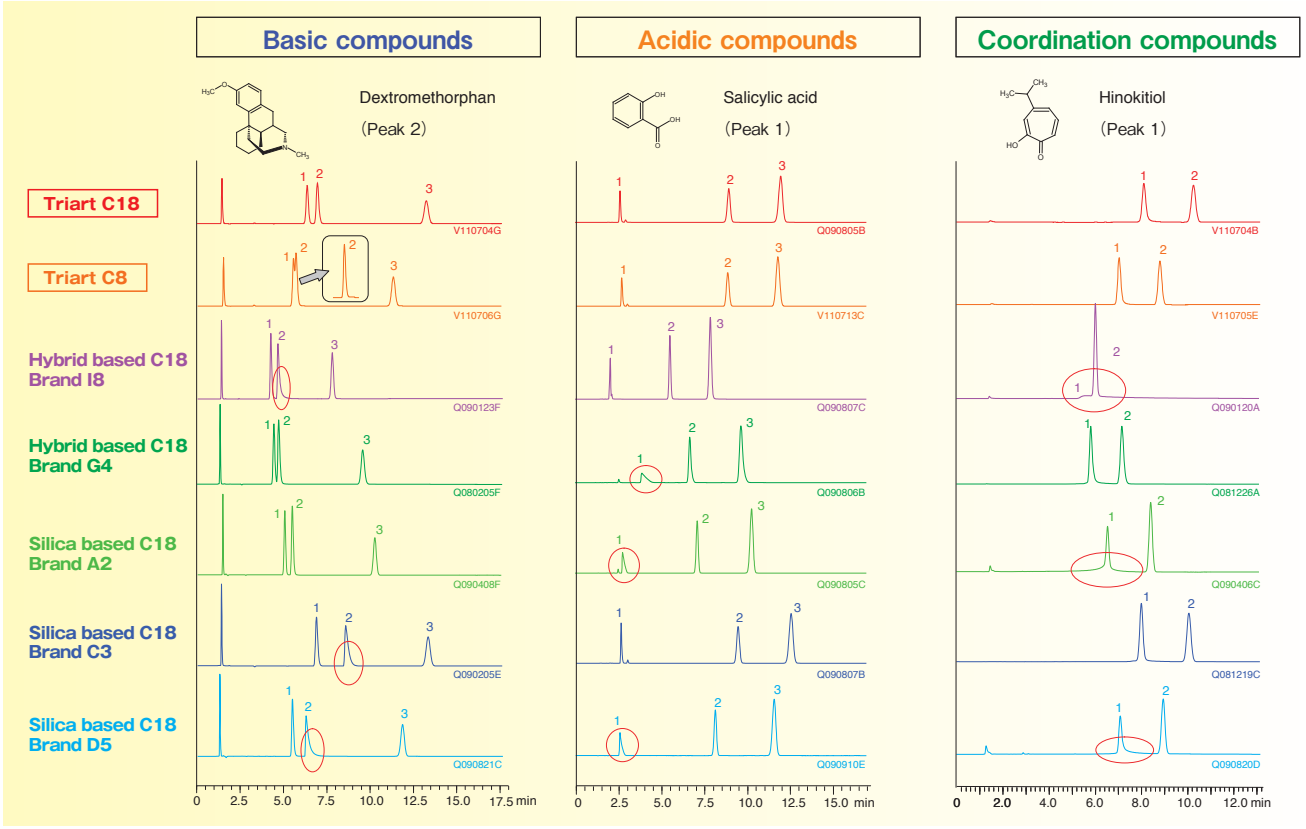
Carvedilol

Analyses of carvedilol are performed continuously, referring the Japanese Pharmacopoeia 16th Edition which specifies to use a C8 column. Under severe condition of pH 2 for mobile phase and 55℃ for column temperature, the retention time is decreased over analyses on a conventional silica based monomeric C8 column. On the other hand, no change is observed in retention time of Triart C8 even after 400 injections (200 hours). Triart C8 provides stable analysis under harsh conditions just as same as Triart C18.

Column	: YMC-Triart C8 5 µm 150 X 2.0 mmI.D.
Eluent	: phosphate buffer (pH 2.0)* /acetonitrile (65/35) ** Dissolve 2.72 g of KH_2PO_4 in 900 mL water, adjust pH 2.0 with H_3PO_4 , and add water to make 1000 mL*
Flow rate	: 0.28 mL/min *(adjust the flow rate so that the retention time of carvedilol is about 4 min)*
Temperature	: 55℃
Detection	: UV at 240 nm
Injection	: 4 µL
(The Japanese Pharmacopoeia 16th; Related substances)	

Great peak shapes without adsorption/peak tailing

【Comparison of chromatographic behavior】

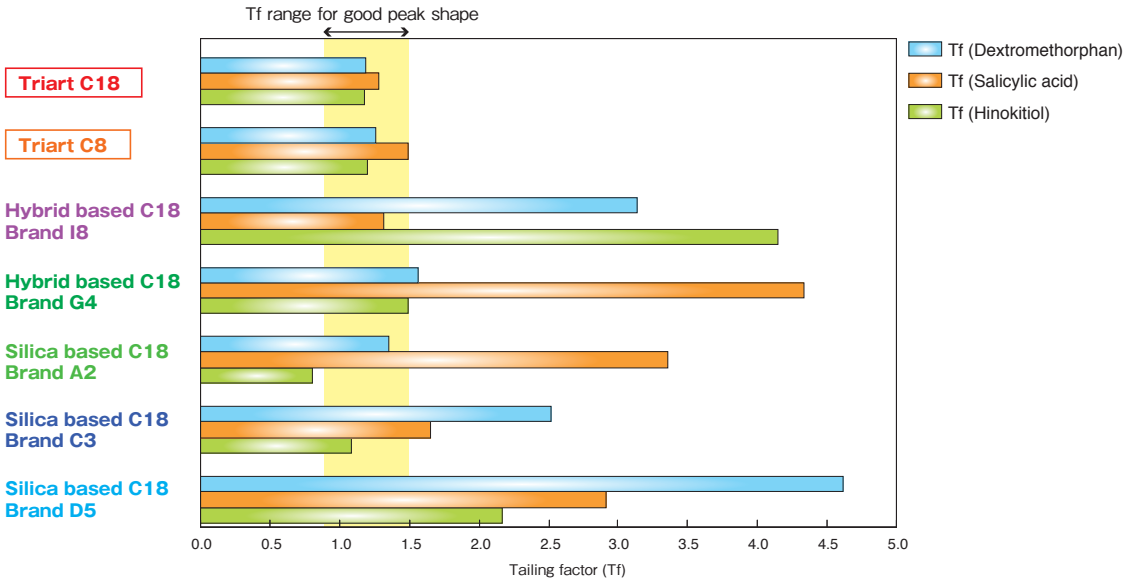


Column	: 150 X 3.0 mmI.D. or 150 X 4.6 mmI.D.
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 6.9)/acetonitrile (65/35)
Flow rate	: 0.425 mL/min for 3.0 mmI.D., 1.0 mL/min for 4.6 mmI.D.
Temperature	: 40℃
Detection	: UV at 235 nm
Sample	: 1. Chlorpheniramine 2. Dextromethorphan 3. Propyl paraben (I.S.)

Column	: 150 X 3.0 mmI.D. or 150 X 4.6 mmI.D.
Eluent	: 10 mM CH_3COOH-CH_3COONH_4 (pH 4.2)/acetonitrile (75/25)
Flow rate	: 0.425 mL/min for 3.0 mmI.D., 1.0 mL/min for 4.6 mmI.D.
Temperature	: 40℃
Detection	: UV at 254 nm
Sample	: 1. Salicylic acid 2. Methyl paraben (I.S.) 3. Cinnamic acid

Column	: 150 X 3.0 mmI.D. or 150 X 4.6 mmI.D.
Eluent	: acetonitrile/0.1% H_3PO_4 (40/60)
Flow rate	: 0.425 mL/min for 3.0 mmI.D., 1.0 mL/min for 4.6 mmI.D.
Temperature	: 40℃
Detection	: UV at 254 nm
Sample	: 1. Hinokitiol 2. Methyl benzoate (I.S.)

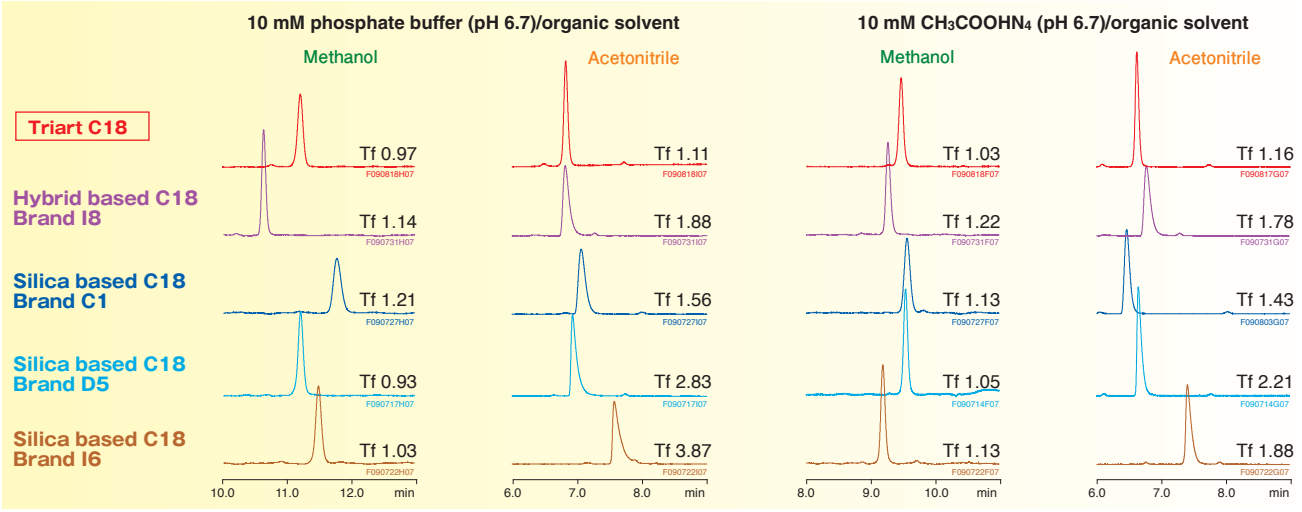
【Comparison of tailing factor】

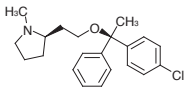


The peak tailing or fronting of ionic compounds are often caused by adsorption to residual silanol groups and/or surface impurities resulting from base materials or manufacturing process. Triart, based on hybrid silica material with little metal impurities and rigorously endcapped, provides symmetrical peak shapes for all types of compounds.

Superior peak shapes across various mobile phases

[Peak shape comparison of basic compound]



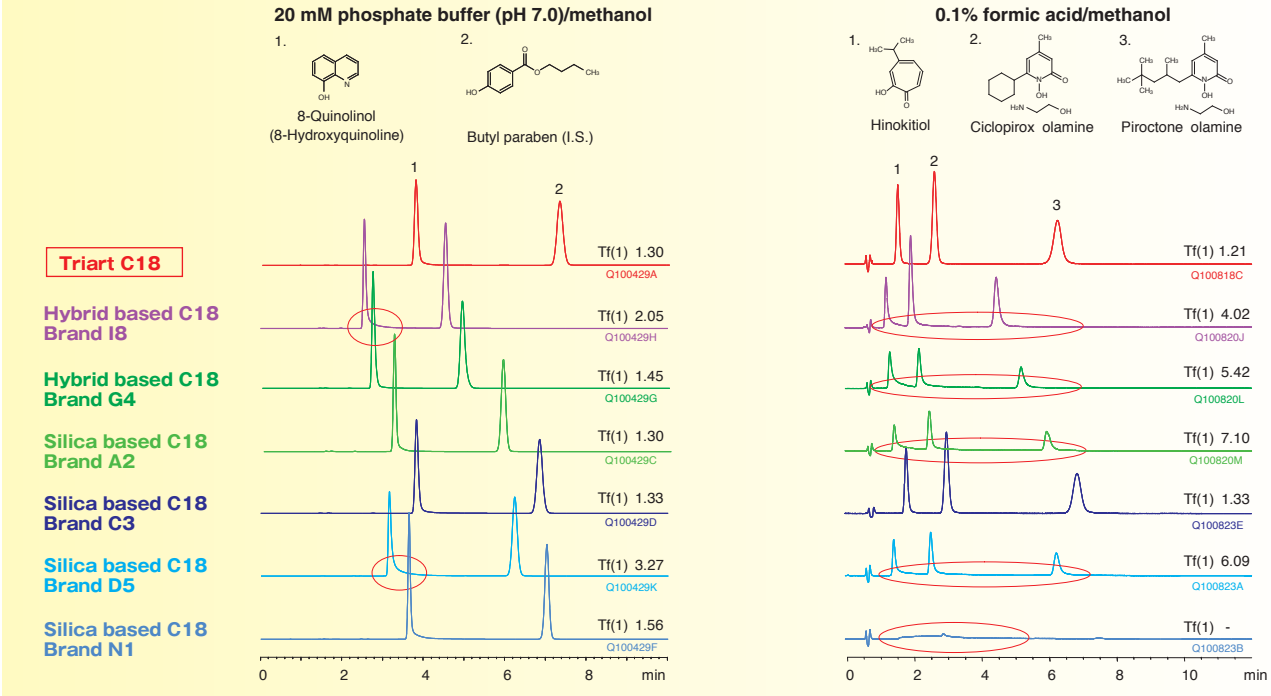


Clemastine

Column	: 5 µm, 50 X 2.0 mmI.D. or 50 X 2.1 mmI.D.
Eluent	: A) 10 mM KH_2PO_4-K_2HPO_4 (pH 6.7) or 10 mM CH_3COONH_4 (pH 6.7) B) methanol or acetonitrile 5-90%B (0-10 min), 90%B (10-15 min)
Flow rate	: 0.2 mL/min
Temperature	: 25℃
Detection	: UV at 230 nm

Clemastine is a well known basic compound which can easily tail on conventional ODS columns. Triart C18 can analyze clemastine without any peak deterioration with any kinds of buffer/solvent combinations.

[Peak shape comparison of coordination compounds]

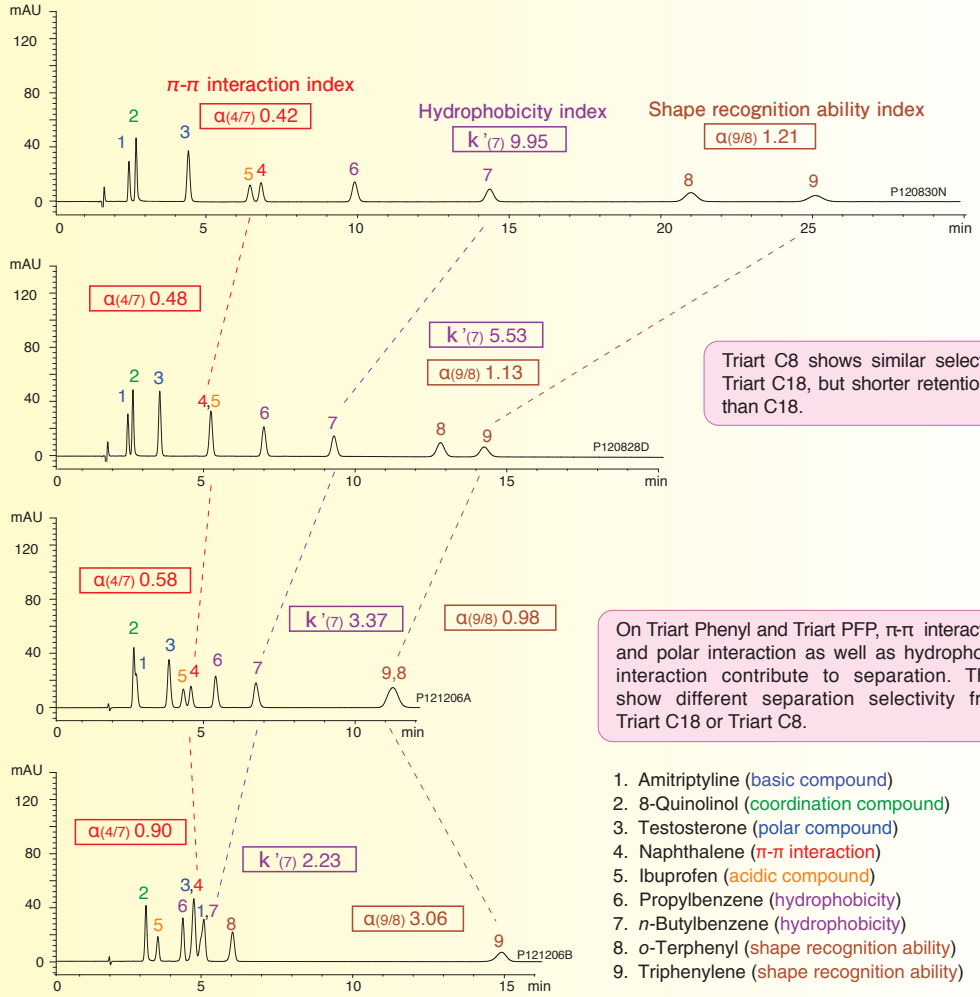


Column	: 5 µm or 3 µm, 150 X 4.6 mmI.D
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 7.0)/ methanol (35/65)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Detection	: UV at 254 nm
Injection	: 10 µL

Column	: 5 µm or 3 µm, 50 X 2.0 mmI.D. or 50 X 2.1 mmI.D
Eluent	: methanol/water/formic acid (65/35/0.1)
Flow rate	: 0.2 mL/min
Temperature	: 40℃
Detection	: UV at 310 nm
Injection	: 1 µL

Triart C18 is able to provide excellent peak shapes for coordination compounds which are often absorbed to a column, resulting from a strong interaction with impurities such as metal ion.

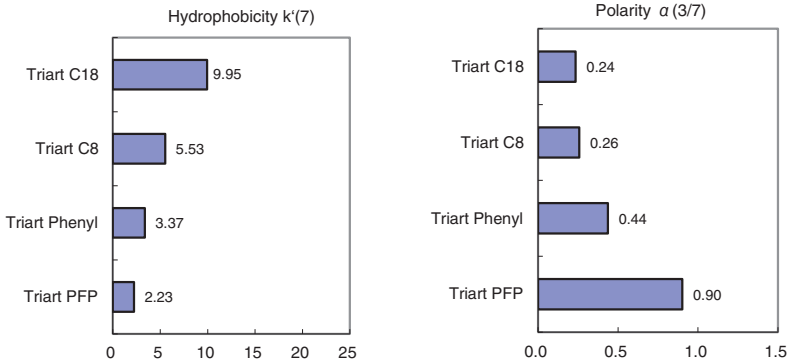
Comparison of separation selectivity among YMC-Triart

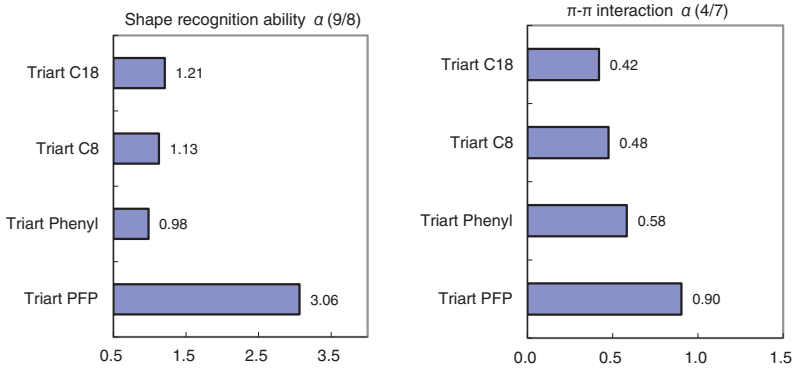


Triart C8 shows similar selectivity to Triart C18, but shorter retention times than C18.

On Triart Phenyl and Triart PFP, π-π interaction and polar interaction as well as hydrophobic interaction contribute to separation. They show different separation selectivity from Triart C18 or Triart C8.

1. Amitriptyline (basic compound)
2. 8-Quinolinol (coordination compound)
3. Testosterone (polar compound)
4. Naphthalene (π-π interaction)
5. Ibuprofen (acidic compound)
6. Propylbenzene (hydrophobicity)
7. *n*-Butylbenzene (hydrophobicity)
8. *o*-Terphenyl (shape recognition ability)
9. Triphenylene (shape recognition ability)





Column	: 5 µm, 150 X 3.0 mmI.D.
Eluent	: 20 mM H_3PO_4-KH_2PO_4 (pH3.1)/ methanol (25/75)
Flow rate	: 0.425 mL/min
Temperature	: 40℃
Detection	: UV at 265 nm
Injection	: 4 µL

A mixture that consists of compounds with various characteristics is analyzed with reversed-phase Triart columns. In addition to hydrophobic interaction, secondary interactions such as π-π interaction and polar interaction are different from column to column. Those parameters have great impact on retention capacity (k') and separation factor (α). By utilizing the difference in separation characteristics, wide range of compounds can be well-separated with Triart.

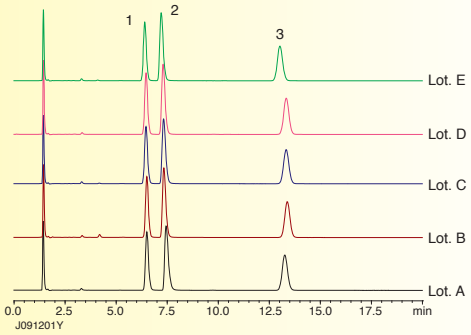
Quality control

【Excellent reproducibility】

Packing material

Triart C18 exhibits excellent lot-to-lot reproducibility for all types of compounds including basic and coordination compounds that often exhibits peak tailing or adsorption onto packing material.

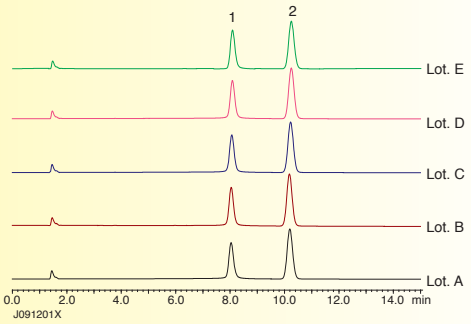
Basic compounds



1. Chlorpheniramine
2. Dextromethorphan
3. Propyl paraben (I.S.)

Column	: YMC-Triart C18 5 µm, 150 X 3.0 mmI.D.
Eluent	: 20 mM KH_2PO_4-K_2HPO_4 (pH 6.9)/acetonitrile (65/35)
Flow rate	: 0.425 mL/min
Temperature	: 40℃
Detection	: UV at 235 nm

Coordination compound

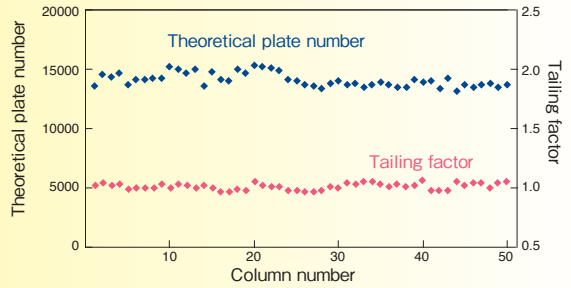


1. Hinokitiol
2. Methyl benzoate (I.S.)

Column	: YMC-Triart C18 5 µm, 150 X 3.0 mmI.D.
Eluent	: acetonitrile/0.1% H_3PO_4 (40/60)
Flow rate	: 0.425 mL/min
Temperature	: 40℃
Detection	: UV at 254 nm

Packed column

Rigorous control of theoretical plate number (N) and tailing factor (Tf) is performed on Triart C18 packed column.

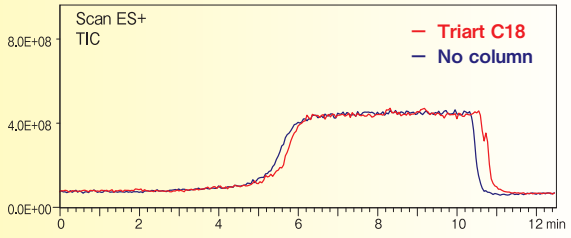


Column	: YMC-Triart C18 5 µm 150 X 4.6 mmI.D.
Eluent	: acetonitrile/water (60/40)
Flow rate	: 1.0 mL/min
Temperature	: ambient
Sample	: butyl benzoate

Effective for high-sensitive analysis using LC/MS

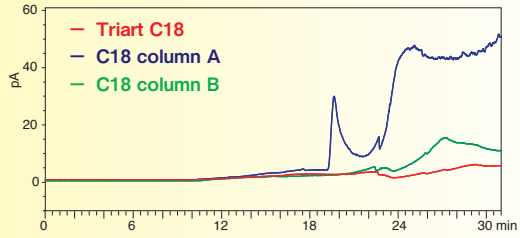
【Low bleeding】

LC/MS



Column	: 5 µm, 50 X 2.0 mmI.D.
Eluent	: A) water/formic acid (100/0.1) B) acetonitrile/formic acid (100/0.1) 5%B (0-1 min), 5-100%B (1-5 min), 100%B (5-10 min), 100-5%B (10-10.1 min), 5%B (10.1-12.5 min)
Flow rate	: 0.4 mL/min
Temperature	: 40℃
Detection	: ESI positive, TIC (Mass Range: 50-1000)

Corona* CAD*



Column	: 5 µm, 250 X 4.6 mmI.D.
Eluent	: A) water/formic acid (100/0.1) B) acetonitrile/formic acid (100/0.1) 5%B (0-5 min), 5-100%B (5-20 min), 100%B (20-30 min)
Flow rate	: 1.0 mL/min
Temperature	: 40℃
Detection	: Corona CAD

On Triart column, very low level of bleeding (leaching) is achieved thanks to the improvement of production procedure and of durability. Background noise of Triart C18 on LC/MS (TIC) is almost the same as blank run with no column. Also, baseline is almost stable on Corona CAD (Charged Aerosol Detector). These results prove that there is little bleeding from Triart C18 column. Very low background noise and high S/N ratio even with high-sensitive detectors are expected on Triart columns.

* Corona and CAD is a registered trademark of Thermo Fisher Scientific.

Highly durable column suitable as a first choice

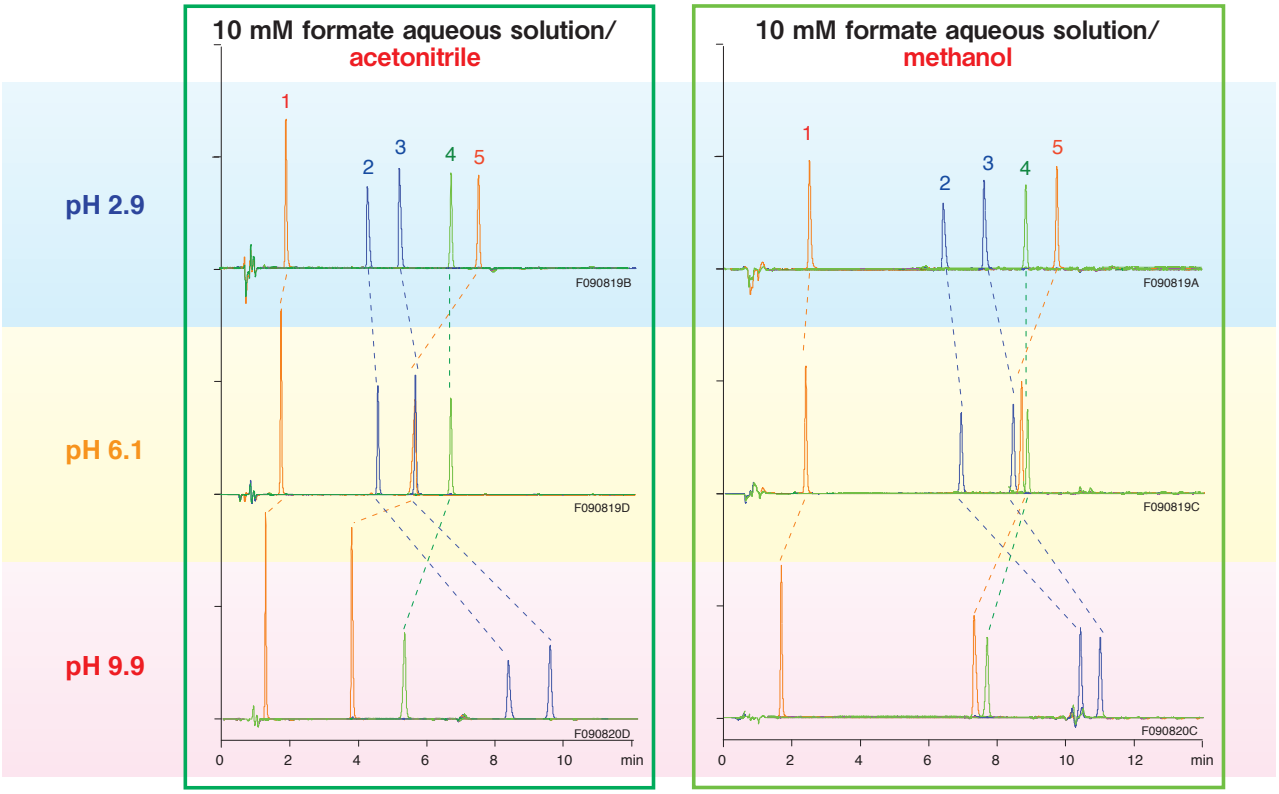
YMC-Triart C18

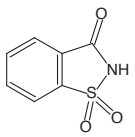
- Pore size : 12 nm
- Carbon content : 20%
- Usable pH range : 1.0~12.0
- USP L1

- Superior peak shape
- Usable over wide range of pH and temperature
- Usable with 100% aqueous mobile phase

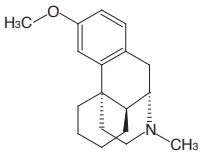
Flexibility in method development

[Efficient mobile phase screening for ionic compounds]

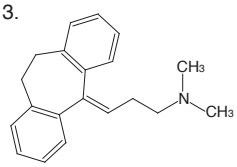


1.


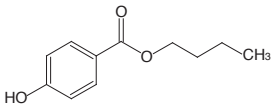
Saccharin
(Acidic compound)
pka=2.2

2.


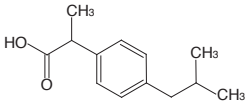
Dextromethorphan
(Basic compound)
pka=8.3

3.


Amitriptyline
(Basic compound)
pka=9.4

4.


n-Butylparaben
(Weakly acidic compound)
pka=8.3

5.


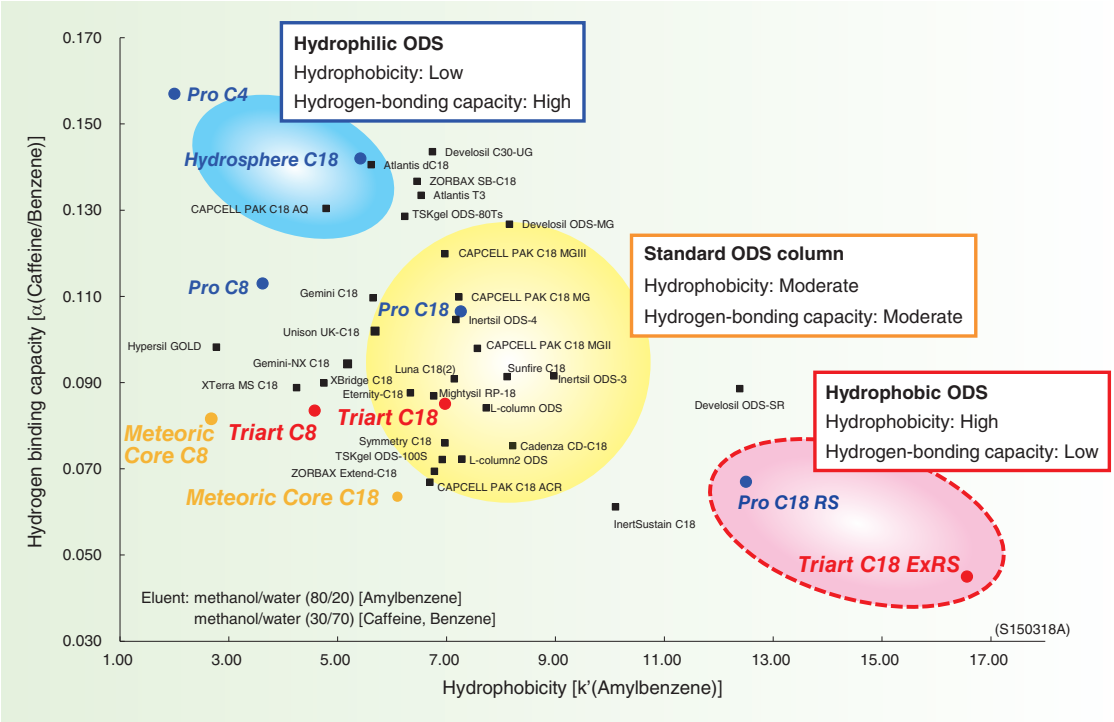
Ibuprofen
(Acidic compound)
pka=4.4

Column	: YMC-Triart C18 5 µm 50 X 2.0 mmI.D.
Eluent	: A) 10 mM HCOOH for pH 2.9 10 mM $HCOONH_4$ for pH 6.1 10 mM $HCOONH_4$-NH_3 for pH 9.9 B) organic solvent 5-90%B (0-10 min), 90%B (10-15 min)
Flow rate	: 0.2 mL/min
Temperature	: 25℃
Detection	: UV at 230 nm

On reversed-phase HPLC, pH and organic solvent are the most important factors to control retention and selectivity. Triart C18 with wide usable pH range offers significant advantage in selection of mobile phase condition. Triart C18 delivers symmetrical peak shapes for all types of compounds. Moreover, this feature is independent from mobile phase pH and mobile phase condition. Chromatographers can choose the most optimal condition by combining various mobile phase conditions such as mobile phase pH, and types of organic solvent/buffer system.

Suitable as a first choice column

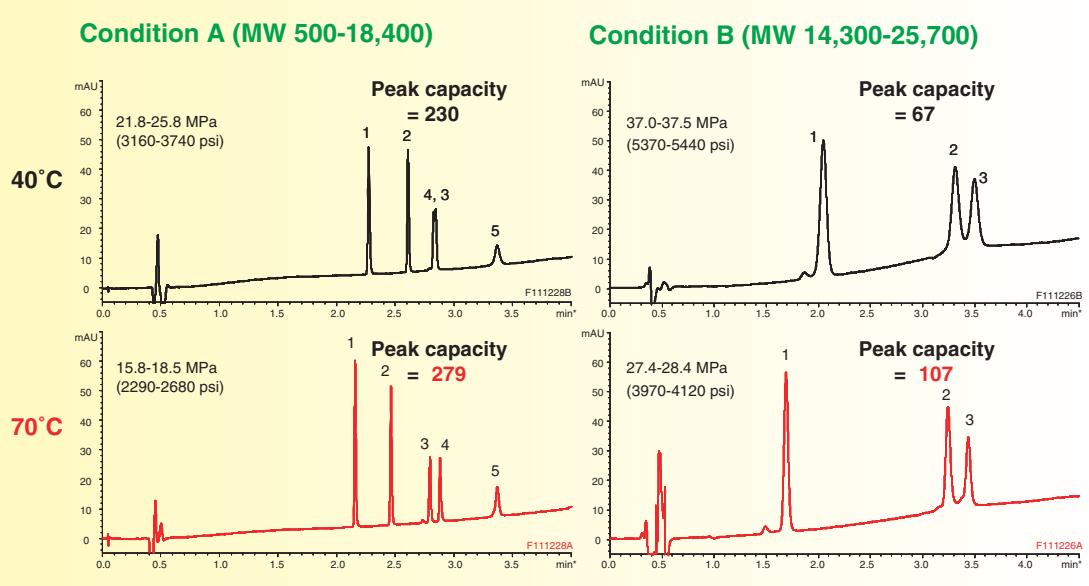
[Comparison of hydrophobicity and hydrogen-bonding capacity of various columns]



Triart C18 has a favorable balance of hydrophobicity and hydrogen bonding capacity, and is used as a versatile first-choice column for method development. In contrast, conventional hybrid silica based ODS columns tend to have low hydrophobicity than conventional silica based columns.

Highly efficient RP-HPLC separation of proteins and peptides using high temperature

[Comparison of separation of peptides and proteins at between 40℃ and 70℃]



Analytes	MW	Peak width ½ (min)	
		40°C	70°C
Condition A			
1. Oxytocin	1,007	0.017	0.014
2. Leu-Enkephalin	556	0.015	0.015
3. β-Endorphin	3,465	–	0.016
4. Insulin	5,733	–	0.015
5. β-Lactoglobulin A	18,400	0.043	0.030
Condition B			
1. Lysozyme	14,300	0.069	0.044
2. α-Chymotrypsinogen	25,700	0.080	0.049
3. β-Lactoglobulin A	18,400	0.080	0.048

Column	: YMC-Triart C18 (1.9 µm, 12 nm) , 50 X 2.0 mmI.D.
Eluent	: A) water/TFA (100/0.1) B) acetonitrile/TFA (100/0.1) - condition A B) acetonitrile/2-propanol/TFA (50/50/0.1) - condition B
Gradient	: 10-80%B (0-5 min) - condition A 30-60%B (0-5 min) - condition B
Flow rate	: 0.4 mL/min
Detection	: UV at 220 nm
Injection	: 1 µL (50 µg/mL) - condition A 1 µL (250 µg/mL) - condition B
System	: Agilent 1200SL

PC (peak capacity) = 1 + (gradient time/peak width*)
*peak width = $2W_{0.5h}$ average

The effect of temperature on separation of peptides and proteins with a variety of molecular weight (MW) is estimated. The separations at 40°C and 70°C are compared. By increasing column temperature to 70°C, selectivity change is observed, and peaks become sharper. Thus, improved resolution especially for larger molecules is obtained. Generally, larger molecules diffuse very slowly compared to small molecules. An elevated temperature can improve efficiency and peak shape by lowering mobile phase viscosity and improving mass transfer.
Temperature is a simple and effective tool to increase resolution in separation of proteins and peptides.