HPLC Column Selection

A Comparison of Reversed-Phase Columns

Based on the widely accepted work and data of Drs. Lloyd Snyder and John Dolan.[1,2] Grace has developed this column selection tool for choosing reversed phase HPLC columns based on peak capacities and column selectivity of polar and nonpolar compounds. Typically, chromatographers choose HPLC columns by comparing physical characteristics, such as surface area and carbon load. Often, this does not provide enough information about selectivity or capacity for adequate column selection. This chart provides a reliable means of choosing HPLC columns based on acidic, basic, and hydrophobic character.

The Snyder/Dolan column test procedure has been described in a series of publications. Based on retention data for a series of standard mixtures and the same separation conditions (50% acetonitrile/buffer; pH 2.8 and 7.0; 35°C), reversed-phase columns are characterized by five column-selectivity parameters: hydrophobicity (H), steric interaction (S*), hydrogen-bond acidity (A), basicity (B), and relative silanol ionization or cation-exchange capacity (C). Here we have chosen to graphically highlight data for H, (A), and (C), with (C) results at pH 7.0. Hydrophobicity (H) is often the primary analyte interaction with reversed phase columns and indicates overall capacity. Secondary interactions are often polar interactions with basic analytes. The degree of unprotonated base interaction (A) and protonated base interaction (C) with the packing material is measured and represented here.

Directions for Using the Column Chart

The chart lists the columns in descending order of hydrophobic capacity (H). To find similar HPLC columns to test as back-up columns, follow these steps.

1) Find the column you are currently using and note neighboring columns which have similar (H) capacity factors.

2) Compare the values for interaction of polar compounds ((A) and (C)).

If there is more than one choice for a back-up column, then compare your actual sample to the test probes. If your sample is nonpolar, then place more emphasis on hydrophobic values. If your sample is basic (polar), then pay special attention to (A) and (C) and determine if your sample will be protonated ((A)) or unprotonated ((C)) and place greater emphasis on one of these values.

Key to Chart

- Hydrophobic Indicator
- (A) Hydrogen bonding Indicator—pH 2.8 (Protonated under acidic conditions)
- (C) Cation Exchange Indicator—pH 7.0 (Unprotonated under neutral conditions)

Manufacturer	Column	Selectivity Parameters
ZirChrom	ZirChrom®-PBD C18	1.284
YMC	J'Sphere® H80 C18	1.132
Restek	Allure® C18	1.116
Phenomenex	Ultracarb® ODS (30)	1.114
YMC	YMC® Pack Pro C18 RS	1.114
Grace (Alltech)	**Adsorbosphere™ UHS C18**	1.103
Thermo/Hypersil	Hypersil® BetamaxNeutral C18	1.098
Agilent	Zorbax Extend C18	1.098
Agilent	Zorbax C18	1.089
Beckman	Ultrasphere® ODS	1.085
Grace (Alltech)	**Alltima™ HP C18 High Load**	1.080
Agilent	Zorbax Rx-18	1.077
Agilent	Zorbax Eclipse XDB-C18	1.077
Supelco	Ascentis® C18	1.077
Macherey Nagel	Nucleodur® C18 Gravity	1.056
Grace (Grom)	**Grom™ Sapphire 110 C18**	1.055
Restek	Restek® Ultra C18	1.055
Varian	OmniSpher™ 5 C18	1.055
Grace (Vydac)	**Denali® 120 C18**	1.052
Waters	Symmetry® C18	1.052
Akzo Nobel	Kromasil® 100-5C18	1.051
Waters	Nova-Pak® C18	1.049
Thermo/Hypersil	Hypersil® 100 C18	1.048
MacMod/ACT	ACE® 5 C18-HL	1.045
ZirChrom	ZirChrom®-EZ C18	1.040
Grace (Grom)	**Grom™ Sil 120 ODS-5 ST**	1.035
Dionex	Acclaim® 120 C18	1.032
Waters	Sunfire™ C18	1.031
Agilent	Zorbax Eclipse Plus C18	1.030
Merck	Superspher® 100 RP-18e	1.030
Shiseido	CAPCELL™ C18 AG120	1.030
Grace (Grom)	**Grom™ Sil 120 ODS-3 CP**	1.029
Waters	Delta-Pak™ C18 100A	1.028
Macherey Nagel	Nucleodur® Isis	1.023
Phenomenex	Prodigy™ ODS (3)	1.023
Phenomenex	Synergi™ Hydro-RP C18	1.022
Phenomenex	Luna™ C18	1.018
Supelco	Supelcosil™ LC-18	1.018
YMC	YMC® Pro C18	1.015
Phenomenex	Onyx™ Monolithic C18	1.012
Bischoff	ProntoSIL™ SpheriBOND 80-5-ODS2	1.010
Grace (Jones)	**Apex™ II C18**	1.008
Shiseido	CAPCELL™ C18 UG120	1.007
GL Sciences	Inertsil® ODS-2	1.007

Manufacturer	Column	Selectivity Parameters
Merck	LiChrospher® 100 RP-18	1.006
Bischoff	ProntoSIL™ 120-5-C18 H	1.005
Shiseido	CAPCELL™ C18 M G	1.005
Grace (Jones)	**Genesis® 120 C18**	1.005
Bischoff	EU Reference Column C18	1.004
Grace (Alltech)	**Allsphere™ ODS2**	1.004
Merck	Purospher® STAR RP18e	1.003
Merck	Chromolith® RP18e	1.003
Phenomenex	Luna® C18(2)	1.002
Varian	Pursuit® C18	1.001
MacMod/ACT	ACE® 5 C18	1.000
Tosoh	TSKgel® Super-ODS	0.998
Agilent	Zorbax StableBond 80A C18	0.996
Phenomenex	Prodigy™ ODS(2)	0.995
Thermo/Hypersil	Hypersil® BDS C18	0.993
Grace (Alltech)	**Alltima™ C18**	0.993
Grace (Vydac)	**Vydac® Everest® C18**	0.993
Thermo/Hypersil	Hypersil® Beta Basic-18	0.993
GL Sciences	Inertsil® ODS-3	0.990
Grace (Alltech)	**Adsorbosphere™ C18**	0.989
Phenomenex	Synergi™ Max-RP C18	0.989
Shiseido	CAPCELL™ C18 SG120	0.987
Grace (Jones)	**Apex™ I C18**	0.985
Thermo/Hypersil	Hypersil® ODS-2	0.985
Grace (Alltech)	**Alltima™ HP C18**	0.985
Waters	Xterra® MS C18	0.984
Waters	Symmetry® 300 C18	0.984
Supelco	Discovery C18	0.984
Supelco	Supelcosil™ LC-18-DB	0.979
Waters	Spherisorb® S5 ODSB	0.975
Thermo/Hypersil	Hypersil® Bio Basic-18	0.974
Thermo/Hypersil	Hypersil® ODS	0.974
Bischoff	ProntoSIL™ 120-5-C18-AQ	0.974
Grace (Jones)	**Genesis® 300 C18 C18**	0.974
Bischoff	Prontosil™ 200-5-C18 AQ	0.974
Agilent	Zorbax C8	0.974
Tosoh	TSK gel® ODS-80Ts	0.971
Waters	Resolve C18	0.968
Phenomenex	Gemini® C18 110A	0.967
Grace (Alltech)	**Econosil™ C18**	0.966
Phenomenex	Aqua® C18	0.966
YMC	YMC® ODS-AQ C18	0.965
Waters	Spherisorb® ODS-2	0.962
Macherey Nagel	Nucleosil® 100-5-C18 HD C18	0.961

Grace (Jones)	**Genesis® 120 AQ C18**	0.960
Macherey Nagel	Nucleodur® Pyramid	0.958
Thermo/Hypersil	Hypersil® Elite C18	0.958
Dionex	Acclaim® 300 C18	0.957
Bischoff	ProntoSIL™ 300-5-C18 H	0.956
Waters	Delta-Pak™ C18 300A	0.955
Bischoff	ProntoSIL™ HyperSORB 120 ODS	0.951
Thermo/Hypersil	Hypersil® PAH C18	0.949
Bischoff	ProntoSIL™ 120-5-C18 Aqplus	0.947
Phenomenex	Jupiter® 300 C18	0.945
Varian	Polaris® C18-Ether	0.943
Waters	Atlantis® T3 C18	0.941
Tosoh	TSKgel® 80Ts QA	0.940
Grace (Alltech)	**Alltima™ C18-WP**	0.938
Waters	YMC® Hydrosphere C18	0.937
Grace (Alltech)	**Brava™ BDS C18**	0.938
Bischoff	ProntoSIL™ 60-5 C8 SH	0.929
Varian	Polaris® C18-A	0.928
YMC	J'Sphere® M80 C18	0.926
Agilent	Zorbax Eclipse XDB-C8	0.919
Waters	Atlantis® dC18 b	0.917
Supelco	Ascentis® Express C8	0.915
Thermo	Hypersil® GOLD aQ	0.915
Phenomenex	Selectosil™ C18	0.911
Merck	LiChrosorb® RP-18	0.909
Grace (Vydac)	**Vydac® 218TP C18**	0.909
Waters	Acquity UPLC® BEH Shield RP18 EP	0.907
Macherey Nagel	Nucleosil® C18	0.906
Agilent	Zorbax StableBond 300A C18	0.905
Grace (Alltech)	**Prosphere™ C18 300**	0.903
Grace (Vydac)	**Vydac® 201TP C18**	0.901
Supelco	Ascentis® C-8	0.899
Waters	Nova-Pak® C8	0.899
Waters	Symmetry® C8	0.893
YMC	YMC® Pro C8	0.890
Agilent	Zorbax Eclipse Plus C8	0.889
Phenomenex	Luna™ C8(2)	0.889
Grace (Alltech)	**Prevail™ C18**	0.888
Grace (Alltech)	**Prosphere™ 100 C18**	0.883
Grace (Alltech)	**Alltima™ AQ EP**	0.882
Thermo/Hypersil	Hypersil® GOLD C18	0.881
Phenomenex	Synergi™ Fusion-RP EP	0.879
Phenomenex	Luna™ C8	0.875
Grace (Grom)	**Grom™ Sil 120 Octyl-6 MB C8**	0.872
Grace (Jones)	**Apex™ I C8**	0.869
Shiseido	CAPCELL™ C18 A Q	0.867
Macherey Nagel	Nucelosil® 100-5-C8 HD	0.865
Akzo Nobel	Kromasil® 100-5C8	0.864
Grace (Jones)	**Genesis® 120 EC C8**	0.863
Grace (Alltech)	**Prevail™ Amide EP**	0.862
Macherey Nagel	Nucleosil® ODS	0.860
Restek	Ultra AQ C18	0.857
Waters	Sunfire™ C8	0.856
Waters	Acquity UPLC® BEH C8	0.855
Shiseido	CAPCELL™ PAK C8 UG120	0.854
Waters	Symmetry® Shield C18	0.850
Grace (Alltech)	**Alphabond™ C18**	0.845
Supelco	Ascentis® RP-Amide	0.843
Merck	Purospher® RP-18	0.841
Supelco	Discovery BIO Wide pore C8	0.839
Grace (Grom)	**Grom™ Sapphire 110 C8**	0.835
Thermo/Hypersil	Hypersil® Beta Basic-8	0.834
Grace (Alltech)	**Alltima™ HP C8**	0.834
Thermo/Hypersil	Hypurity® C8	0.833
Supelco	Discovery C8	0.832
GL Sciences	Inertsil® C8-3 C8	0.830
MacMod/ACT	ACE® 5 C8	0.830
Grace (Jones)	**Genesis® 120 C8**	0.829
Thermo	Hypersil® GOLD C8	0.825
Phenomenex	Onyx™ Monolithic C8	0.824
Tosoh	TSKgel® Super-Octyl	0.824
Grace (Alltech)	**Prevail™ Select C18**	0.822
Thermo/Hypersil	Hypersil® Bio Basic-8	0.821
YMC	YMC® Basic C18	0.821
Grace (Alltech)	**Econosphere™ C18**	0.818
Tosoh	TSKgel® Octyl-80Ts	0.814
Whatman	Partisil™ ODS(3)	0.810
Macherey Nagel	Nucleodur® Sphinx RP	0.805
Thermo/Hypersil	Aquasil™ C18	0.805
MacMod/ACT	ACE® AQ EP	0.804
Waters	Xterra® MS C8	0.803
Phenomenex	Luna™ C5	0.800
Waters	MicroBondapak C18	0.798
Agilent	Zorbax StableBond 80A C8	0.795
Agilent	Zorbax Rx-C8	0.792
Grace (Alltech)	**Platinum™ C18**	0.786
Grace	**VisionHT™ C18**	0.786
Phenomenex	Luna™ Phenyl-Hexyl	0.782
Grace (Alltech)	**Alltima™ C18-LL**	0.780
Bischoff	ProntoSIL™ 120-5-C18 ace-EPS	0.772
Grace (Vydac)	**Vydac® 218MS C18**	0.770
Waters	Acquity UPLC® BEH phenyl	0.764
Waters	Spherisorb® C8	0.763
YMC	J'Sphere® L80 C18	0.762
Bischoff	ProntoSIL™ 300-55-C18 ace-EPS	0.762
Dionex	Acclaim® Organic Acid C18	0.761
Waters	Xterra® C18 RP	0.757
Grace (Alltech)	**Alltima™ C8**	0.756
Whatman	Partisil™ C8	0.749
Merck	LiChrospher® 60 RP-Select B C18	0.747
Bischoff	ProntoSIL™ 120-5 C8 SH	0.739
Grace (Alltech)	**Allsphere™ ODS1**	0.733
Waters	Symmetry® Shield C8	0.730
Thermo/Hypersil	Hypurity® C4	0.713
MacMod/ACT	ACE® 5 C4-300	0.710
Varian	Polaris® C8-Ether	0.705
Bischoff	ProntoSIL™ 60-5-Phenyl	0.705
Waters	Nova-Pak® Phenyl	0.704
Macherey Nagel	Nucleosil® 100-5-C18 Nautilus	0.702
Agilent	Zorbax StableBond 300A C8	0.701
Bischoff	ProntoSIL™ SpheriBOND 80-5-ODS1	0.700
Thermo/Hypersil	Fluophase® RP F	0.698
Phenomenex	Jupiter® 300 C4	0.698
Grace (Alltech)	**Prosphere™ 300 C4**	0.689
Bischoff	Prontosil™ 60-5-C4	0.686
Waters	Xterra® Phenyl	0.683
Waters	Spherisorb® ODS-1	0.682
Thermo/Hypersil	Hypersil® Prism C18 RPN	0.678
Thermo/Hypersil	Fluophase® PFP F	0.675
Agilent	Zorbax XDB-Phenyl	0.665
Waters	Symmetry® 300 C4	0.659
Waters	Xterra® C8 RP	0.657
Grace (Alltech)	**Alltima™ HP C18 EPS**	0.655
Supelco	Discovery BIO Wide pore C5	0.654
Agilent	Zorbax Bonus RP EP	0.654
Phenomenex	Synergi™ Polar-RP C18	0.654
MacMod/ACT	ACE® Phenyl	0.647
Grace (Jones)	**Genesis® 120 C4 EC**	0.646
Thermo/Hypersil	Hypersil® Prism C18 RP	0.645
Thermo/Hypersil	BetaMax® Acid EP	0.635
Supelco	Discovery HS F5 F	0.631
Agilent	Zorbax SB-Phenyl	0.623
Grace (Alltech)	**Platinum™ EPS C18**	0.619
Grace	**VisionHT™ C18-P**	0.619
Grace (Alltech)	**Prevail™ C8**	0.617
Grace (Jones)	**Genesis® 300 C4 C4**	0.615
Grace (Jones)	**Genesis® Phenyl**	0.609
Agilent	Zorbax StableBond 80A C3	0.601
MacMod/ACT	ACE® Phenyl-300	0.599
Agilent	Zorbax SB-AQ EP	0.593
ZirChrom	ZirChrom®-PS EP	0.589
Waters	MicroBondapak Phenyl	0.585
Grace (Alltech)	**Platinum™ C8**	0.584
Grace (Alltech)	**Platinum™ EPS C8 300**	0.584
Thermo/Hypersil	BetaBasic® Phenyl	0.582
Macherey Nagel	Nucleosil® C8	0.575
Macherey Nagel	EC Nucleosil® 100-5 Protect 1 EP	0.544
Bischoff	Prontosil™ 120-5-C8 ace-EPS	0.532
Phenomenex	Prodigy™ Phenyl-3	0.529
Agilent	Zorbax StableBond 300A C3	0.526
Grace (Alltech)	**Alltima™ HP C18 Amide**	0.497
Thermo/Hypersil	BetaMax® Base EP	0.470
Grace (Alltech)	**Platinum™ EPS C8**	0.420
Thermo/Hypersil	Hypurity® Advance	0.412

References:

1. "The "Hydrophobic-subtraction" Model of Reversed-phase Column Selectivity", L.R. Snyder, J.W. Dolan and P.W. Carr, *J. Chromatogr. A*, 1060 (2004) 77-116.
2. "A New Look at the Selectivity of Reversed-phase HPLC Columns", L.R. Snyder, J.W. Dolan and P.W. Carr, *Anal. Chem.*, 79 (2007) 3255-3262.