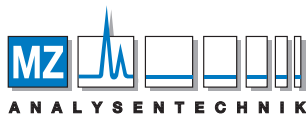




TOSOH

SkillPak™ Pre-Packed Columns



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TOSOH BIOSCIENCE



NOMENCLATURE

What's in our names?

Tosoh Bioscience has the most comprehensive selection of process media resins, with a variety of pore and particle size combinations for several modes of chromatography. When it comes to naming our resins, we've got it down to a science (literally). Here's how you can identify the right resin for your purification process:

1. Resin Type

Tosoh Bioscience offers three base beads for our resin products: TOYOPEARL®, TSKgel®, and Ca⁺⁺Pure-HA®. TOYOPEARL and TSKgel products are hydroxylated methacrylic polymer resins and are offered in many different pore sizes and particle diameters. The key differences between the two types are particle size availability, degree of crosslinking, dynamic binding capacity, and operating pressures. Since similarly functionalized TOYOPEARL and TSKgel resins have the same backbone polymer chemistry, the selectivity remains the same as you scale up or down.

5. Additional Abbreviations

Some of our products have additional features or need clarification about what type of product they are.

We use the following abbreviations to highlight these features:

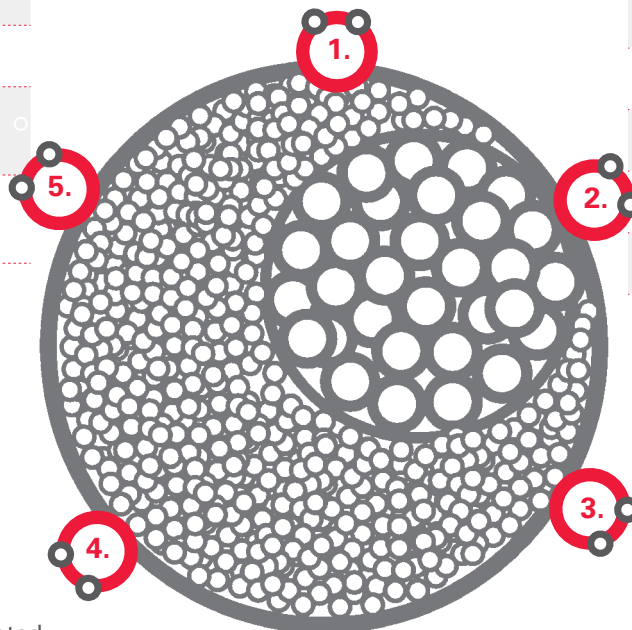
| | |
|---------|---|
| HC | High Capacity |
| MX | Mixed-Mode |
| AF | Affinity |
| Super | High Capacity Ion Exchanger |
| MegaCap | High Capacity Ion Exchanger for Capturing |
| GigaCap | Ultra High Capacity Ion Exchanger |

2. Ligand

TOYOPEARL or TSKgel resins are available in the following modes of chromatography functionalized with these ligands:

TOYOPEARL ligands

| Mode | Ligand |
|-------------------|--|
| HIC | Ether, PPG, Phenyl, Butyl, Hexyl |
| Anion Exchange | DEAE, QAE, Q, NH ₂ |
| Cation Exchange | CM, SP, Sulfate |
| Antibody Affinity | rProtein A, rProtein L |
| Affinity | Tresyl, Epoxy, Formyl, Amino, Chelate, Red, Heparin, Carboxy |
| Mixed-Mode | Tryptophan (Trp) |



4. Particle Size

Particle size is typically denoted in the product name as letters or numbers denoting the grade.

Particle size of TOYOPEARL and TSKgel resins (µm)

| Grade | TOYOPEARL | TOYOPEARL GigaCap | TSKgel |
|-------|-------------------------|-------------------|--------|
| EC | 200 | | |
| C | 100 (SEC resins are 75) | | |
| M | 65 (MX-Trp is 75) | 75 | |
| F | 45 | | |
| S | 35 (SEC resins are 30) | 35 | |
| (30) | | | 30 |
| (20) | | | 20 |

3. Pore Size

TOYOPEARL or TSKgel resins are available in the following pore sizes:

TOYOPEARL and TSKgel resin number key

| | | |
|----------------------|--------------------|--------------------|
| TOYOPEARL 550 resins | HW-55 base resin | 50 nm pore size |
| TOYOPEARL 600 resins | HW-60 base resin | 75 nm pore size |
| TOYOPEARL 650 resins | HW-65 base resin | 100 nm pore size |
| TOYOPEARL 750 resins | HW-75 base resin | > 100 nm pore size |
| TSKgel 3PW resin | PW-3000 base resin | 25 nm pore size |
| TSKgel 5PW resin | PW-5000 base resin | 100 nm pore size |

Fast Method Development and Scale-up

SkillPak are chromatography columns pre-packed with TOYOPEARL, TSKgel, or Ca⁺⁺Pure-HA process chromatography media. These columns have been designed to develop and scale-up purification processes for biomolecules, such as monoclonal antibodies, proteins and oligonucleotides.

SkillPak pre-packed columns are designed for your purification and separation tasks from platform design to pilot scale. These columns are ready to use upon receipt and show excellent physical strength and ideal flow characteristics for industrial downstream processing.

➤ **Table 1.** Specifications of SkillPak 1 columns

| | |
|----------------------------|---|
| Column dimension | 0.7 cm ID × 2.5 cm bed height |
| Volume | 1 mL |
| Maximum flow rate | 4 mL/min (600 cm/h) |
| Maximum operating pressure | 0.3 MPa |
| Connections | Standard fittings (10-32 for 1/16 inch capillary) |
| Shipping buffer | 20% ethanol for TOYOPEARL and TSKgel [with the exception of 0.5 mol/L sodium citrate with 20% ethanol for TSKgel SP-5PW (20) and SuperQ-5PW (20)], 20 mmol/L sodium phosphate with 20% ethanol for Ca ⁺⁺ Pure-HA |

➤ **Table 2.** Specifications of SkillPak 5 columns

| | |
|--------------------------------------|---|
| Column dimension | 0.8 cm ID × 10 cm bed height |
| Volume | 5 mL |
| Standard flow rate | 1.3 mL/min (150 cm/h) |
| Maximum flow rate | 5 mL/min (600 cm/h) for TOYOPEARL M and C grade resins; 2.5 mL/min (300 cm/h) for TSKgel, Ca ⁺⁺ Pure-HA and TOYOPEARL S- and F-grade resins, including TOYOPEARL AF-rProtein A HC-650F and TOYOPEARL AF-rProtein L-650F 1.6 mL/min (200 cm/h) for TOYOPEARL Phenyl-650S |
| Maximum operating pressure | 0.3 MPa for TOYOPEARL resins, ≤ 0.4 MPa for TSKgel resins and Ca ⁺⁺ Pure-HA |
| Connections | Standard fittings (10-32 for 1/16 inch capillary) |
| Shipping buffer | 20% ethanol for TOYOPEARL and TSKgel, 20 mmol/L sodium phosphate with 20% ethanol for Ca ⁺⁺ Pure-HA |
| Asymmetry factor (As) specifications | 0.8-1.4 for TOYOPEARL and TSKgel, 0.8-2.6 for Ca ⁺⁺ Pure-HA |

Tables 1 to 4 list the properties and operation specifications of the SkillPak 1, 5, 50, and 200 columns. These columns guarantee optimal performance and can be operated with commonly used low or medium pressure liquid chromatography systems. They are reproducibly packed and take into account the varying compressibility of each resin. This provides an accurate representation of conditions found in production scale columns.

➤ **Table 3.** Specifications of SkillPak 50 columns

| | |
|---|---|
| Column dimension | 2.5 cm ID × 10 cm bed height |
| Volume | approx. 50 mL (see labels and CoA) |
| Maximum recommended flow rate - in 2 mol/L NaCl for HIC media - in 1 mol/L NaCl for all other media | <ul style="list-style-type: none"> • ≤ 500 cm/h for most TOYOPEARL S, M, F, and C grade resins • ≤ 450 cm/h for TSKgel SP-5PW (20) • ≤ 400 cm/h for TOYOPEARL SuperQ-650S, NH₂-750F, Sulfate-650F, and AF-rProtein A HC-650F • ≤ 300 cm/h for TSKgel SuperQ-5PW (20) and TOYOPEARL Phenyl-600 and HW-40F |
| Connections | 1/4-28 Standard fittings with flat-bottom geometry for 1/8" OD or 1/16" OD capillary |
| Shipping buffer | 20% ethanol for TOYOPEARL and TSKgel resins |
| Asymmetry factor (As) | 0.8 - 1.4 for TOYOPEARL and TSKgel resins |
| Plate count | See resin-related specifications on the Certificate of Analysis |

➤ **Table 4.** Specifications of SkillPak 200 columns

| | |
|---|--|
| Column dimension | 5.0 cm ID × 10 cm bed height |
| Volume | approx. 200 mL (see labels and CoA) |
| Maximum recommended flow rate - in 2 mol/L NaCl for HIC media - in 1 mol/L NaCl for all other media | <ul style="list-style-type: none"> • ≤ 300 cm/h for most TOYOPEARL S, M, F, and C grade resins and TOYOPEARL GigaCap Q-650M • ≤ 250 cm/h for TOYOPEARL SuperQ-650S, NH₂-750F, GigaCap series, and Phenyl 600M, • ≤ 200 cm/h TSKgel SuperQ-5PW (20), TSKgel SP-5PW (20), and TOYOPEARL HW-40F |
| Connections | 1/4-28 Standard fittings with flat-bottom geometry for 1/8" OD or 1/16" OD capillary |
| Shipping buffer | 20% ethanol for TOYOPEARL and TSKgel resins |
| Asymmetry factor (As) | 0.8 - 1.4 for TOYOPEARL and TSKgel resins |
| Plate count | See resin-related specifications on the Certificate of Analysis |

Applications

The SkillPak 1 and SkillPak 5 (1 and 5 mL) columns are ideal to use for parameter and method optimization and for robustness testing for the development of a new or replacement purification process. The SkillPak 50 and SkillPak 200 (50 and 200 mL) columns are ideal for scaling-up the previously developed purification process in a controlled manner.

Method development for mAb purification: determine elution pH for a mAb using 1 mL and 5 mL SkillPak columns

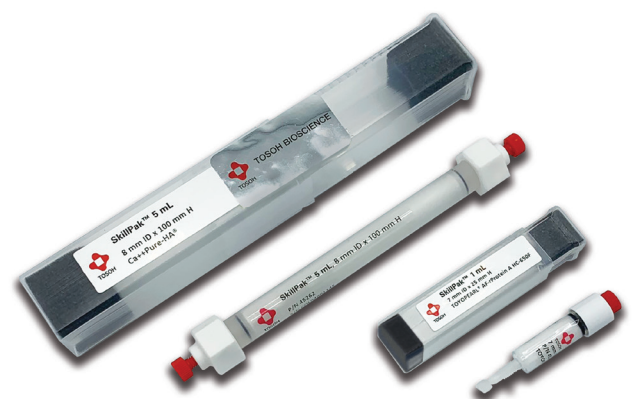
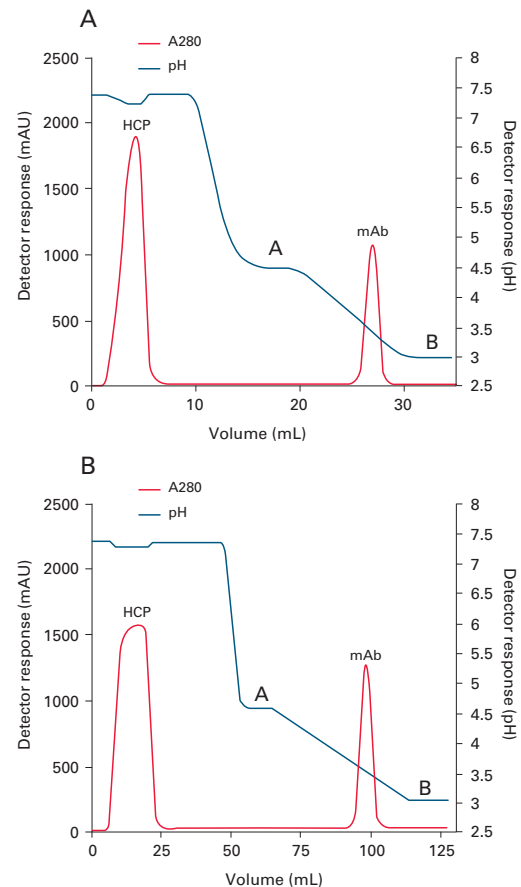
Finding the appropriate buffer and pH for mAb elution reduces the risk of increasing aggregation in the mAb sample. To identify optimized conditions for mAb binding and elution, a buffer-adjusted mAb containing Chinese Hamster Ovary (CHO) cell line supernatant was loaded onto a 5 mL SkillPak column pre-packed with TOYOPEARL AF-rProtein A HC-650F media.

Conditions

| | |
|----------------------------|---|
| Columns: | SkillPak 1 TOYOPEARL AF-rProtein A HC-650F (1 mL) and SkillPak 5 TOYOPEARL AF-rProtein A HC-650F (5 mL) |
| Equilibration buffer: | 0.1 mol/L sodium phosphate, 0.15 mol/L NaCl, pH 7.3 |
| Mobile phase A (gradient): | 25 mmol/L citrate (NaOH), pH 4.5 |
| Mobile phase B (gradient): | 25 mmol/L citrate (NaOH), pH 3.0 |
| Elution gradient: | Linear from gradient buffer A to 100% B over 10 CV |
| Flow (load): | 0.25 mL/min (1 mL column); 1.5 mL/min (5 mL column) |
| Flow (wash, gradient): | 1.0 mL/min (1 mL column); 2.0 mL/min (5 mL column) using AKTA™ avant 25 |
| Samples: | 2 mL of buffer-adjusted CHO cell culture supernatant containing 4 mg mAb (1 mL column); 14 mL of buffer-adjusted CHO cell culture supernatant containing 20 mg mAb (5 mL column) |

Figure 1, Panels A & B, demonstrate that a sharp mAb peak with elution max at pH 3.5 was obtained using a linear pH gradient. To maximize recovery, pH 3.3-3.5 can be selected for step elution.

Figure 1. Determination of elution pH for mAb using SkillPak 1 TOYOPEARL AF-rProtein A HC-650F column (Panel A); SkillPak 5 TOYOPEARL AF-rProtein A HC-650F column (Panel B)



Method development for Fab purification: capture of Fab antibodies using a 1 mL SkillPak column

Humanized IgG₁ was digested using a papain enzyme to obtain Fab. See procedure below. 100 µL of the papain-digested IgG₁ which contains Fab material was loaded onto a 1 mL SkillPak column pre-packed with TOYOPEARL AF-rProtein L-650F resin.

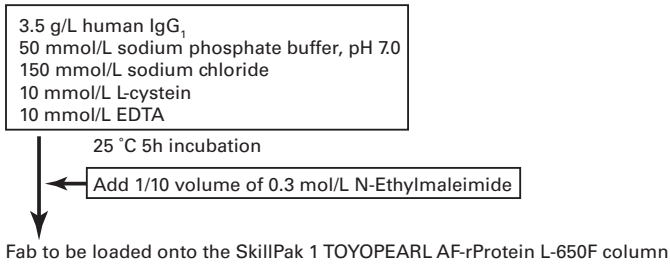
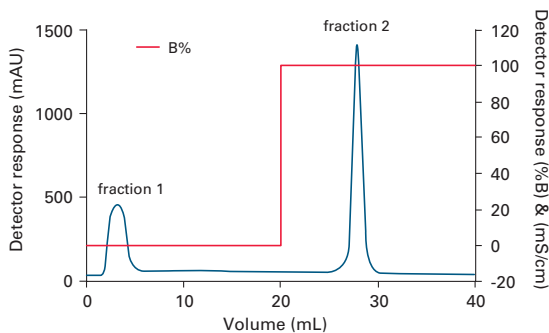


Figure 2 shows that Fab from the digested humanized IgG₁ was successfully captured by the SkillPak 1 TOYOPEARL AF-rProtein L-650F column. Fab was eluted at approximately 28 minutes.

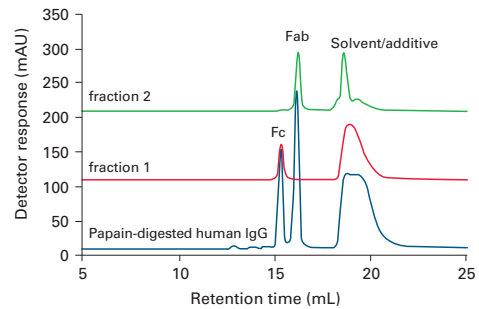
➤ Figure 2. Capture of Fab using the SkillPak 1 TOYOPEARL AF-rProtein L-650F column



Column: SkillPak 1 TOYOPEARL AF-rProtein L-650F
 Flow rate: 0.5 mL/min
 Mobile phase: A: 0.1 mol/L citrate buffer, pH 6.5
 B: 0.1 mol/L citrate buffer, pH 2.2
 Detection: UV @ 280 nm
 Sample: papain-digested human IgG₁

The unbound peak (fraction 1) and the Fab peak (fraction 2) were captured and then analyzed using a 2 µm size exclusion chromatography column, TSKgel UP-SW3000. Figure 3 shows that only fraction 2 contained Fab material, as compared to the papain-digested IgG (reference material).

➤ Figure 3. Analysis of captured Fab from the digested IgG₁ using TSKgel UP-SW3000



Column: TSKgel UP-SW3000, 2 µm, 4.6 mm ID x 30 cm
 Flow rate: 0.5 mL/min
 Mobile phase: 50 mmol/L phosphate buffer + 0.2 mol/L NaCl, pH 6.8
 Detection: UV @ 280 nm
 Samples: fractions of protein L chromatography
 papain-digest of human IgG



Method development for mAb purification: capture of intact antibodies using a 5 mL SkillPak column

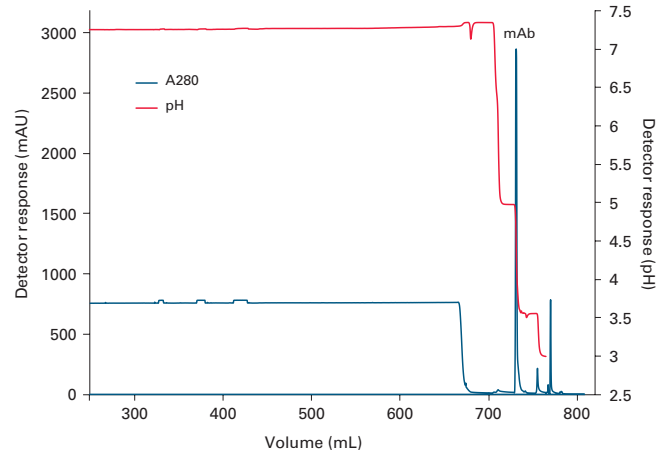
340 mL of hybridoma cell line supernatant (titer ~0.03 g/L) was loaded on a 5 mL SkillPak column packed with TOYOPEARL AF-rProtein A HC 650F resin.

Conditions

| | |
|------------------------|--|
| Column: | SkillPak 5 TOYOPEARL AF-rProtein A HC-650F (5 mL) |
| Equilibration buffer: | 0.1 mol/L Na ₂ HPO ₄ /NaH ₂ PO ₄ , 0.15 mol/L NaCl, pH 7.3 |
| Post-loading 1st wash: | equilibration buffer (5 CV) |
| Post-loading 2nd wash: | 0.1 mol/L acetate (NaOH), pH 5.0 (5 CV) |
| Elution: | 0.1 mol/L acetate (NaOH), pH 3.5 (5 CV) |
| Column strip: | 0.1 mol/L acetic acid, pH 2.9 (3 CV) |
| Column cleaning: | 0.2 mol/L NaOH (3 CV), 15 min hold |
| Flow (load): | 150 cm/h (1.25 mL/min), 4 min residence time |
| Flow (wash/elution): | 240 cm/h (2.0 mL/min) (AKTA avant 25) |
| Temperature: | ambient (room temperature) |
| Sample: | 340 mL hybridoma cell culture supernatant (buffer-adjusted) |

After a short wash at pH 5.0, a sharp and efficient elution peak was obtained at the start of the pH 3.5 elution (Figure 4). Total mAb recovery was 9.8 mg in the elution peak (4.8 mL).

➔ **Figure 4.** Capture of intact mAb using SkillPak 5 TOYOPEARL AF-rProtein A HC-650F column



Column reproducibility: capture of intact mAb using a 5 mL SkillPak column

A 5 mL SkillPak column pre-packed with TOYOPEARL AF-rProtein A HC-650F resin was loaded with 23.5 mg of mAb feedstock. After 10 cycles the average recovery was 91% (average yield was 21.3 mg) as shown in the table below. Both pH max for elution and yield were highly consistent throughout the 10 cycles.

| Reproducibility of a 5 mL SkillPak column for capture of intact mAb | | | | | | | |
|---|---------------------------|--------------------|-------------------|---------------|-------------------------|-------------|------------|
| Run # | Retention @ peak max (mL) | Peak area (mL*mAU) | Peak height (mAU) | pH @ peak max | Eluate A280 (1:10 dil.) | Eluate (mL) | Yield (mg) |
| 1 | 102.1 | 6327 | 1599 | 3.57 | 0.309 | 9.62 | 21.9 |
| 2 | 102.1 | 6335 | 1587 | 3.57 | 0.299 | 9.79 | 21.5 |
| 3 | 102.2 | 6351 | 1577 | 3.56 | 0.312 | 9.34 | 21.4 |
| 4 | 102.1 | 6358 | 1620 | 3.57 | 0.296 | 9.60 | 20.9 |
| 5 | 102.3 | 6308 | 1572 | 3.56 | 0.290 | 9.86 | 21.0 |
| 6 | 102.0 | 6310 | 1619 | 3.57 | 0.298 | 9.56 | 20.9 |
| 7 | 102.0 | 6300 | 1630 | 3.55 | 0.300 | 9.45 | 20.8 |
| 8 | 102.0 | 6294 | 1622 | 3.54 | 0.298 | 9.51 | 20.8 |
| 9 | 102.1 | 6309 | 1605 | 3.53 | 0.312 | 9.65 | 22.1 |
| 10 | 102.2 | 6291 | 1596 | 3.57 | 0.307 | 9.71 | 21.9 |
| Ave. | 102.1 | 6318 | 1603 | 3.56 | | | 21.3 |
| St.Dev. | 0.1 | 23 | 20 | 0.01 | | | 0.5 |

ext. coefficient=1.36



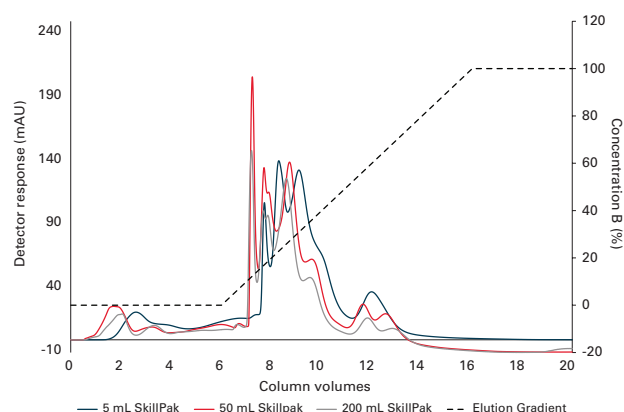
Seamless scale-up of downstream processes

To demonstrate the excellent scale-up capabilities of SkillPak pre-packed columns, we separated two different protein standards on different column dimensions packed with the anion exchange (AEX) resin TOYOPEARL NH₂-750F and cation exchange (CEX) resin TOYOPEARL Sulfate-650F.

➤ **Table 5.** Composition of AEX protein standard

| Protein | C (g/L) | pI |
|------------------------------|---------|------------|
| Papain | 0.5 | ~8.8 |
| Trypsin inhibitor (soy bean) | 0.5 | ~4.1 - 4.5 |
| BSA | 1 | ~4.7 |
| Pepsin | 1 | ~2.7 |

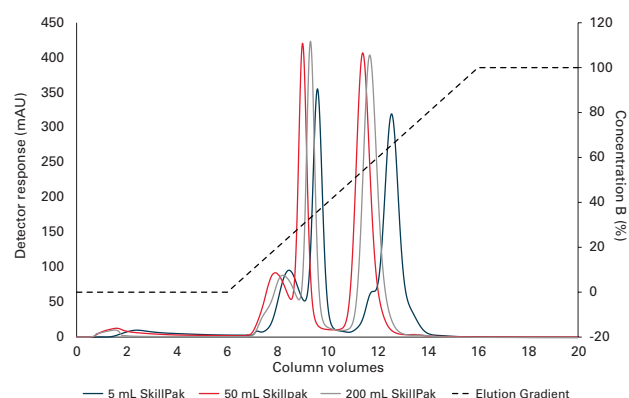
➤ **Figure 5.** Separation of a protein standard on TOYOPEARL NH₂-750F in different scales



➤ **Table 6.** Composition of CEX protein standard

| Protein | C (g/L) | pI |
|--------------------------------|---------|------|
| γ-Globulins (from human blood) | 0.5 | ~7.2 |
| Ribonuclease A | 0.5 | ~8.5 |
| α-Chymotrypsinogen | 0.5 | ~9.6 |
| Lysozyme | 0.5 | ~11 |

➤ **Figure 6.** Separation of a protein standard on TOYOPEARL Sulfate-650F in different scales



The separation of the protein standards on AEX and CEX leads to similar elution profiles on the different column scales. The proteins eluted with increasing net surface charge during the linear salt gradient. In both cases, a shift to the right in retention volume can be observed with decreasing column volume. This can be attributed to the different influences of the system dead volume.

We also determined the dynamic binding capacity (DBC) of Bovine Serum Albumin (BSA) on the AEX resin on SkillPak 5, SkillPak 50, and SkillPak 200 columns to demonstrate scale equivalence. The values for Dynamic Binding Capacity (DBC) of BSA on the different scales of TOYOPEARL NH₂-750F are very close, with a maximum deviation of 4% (see Table 7). This shows the independence of binding capacity from column scale, which can be very important with regard to loading mass in scaled-up processes. With the given independence, binding capacity can be determined on a small scale to conserve both product and buffers. Later the determined capacity and thus maximum loading masses can be confidently assumed for larger-scale columns.

➤ **Table 7.** DBC of BSA on different scales of TOYOPEARL NH₂-750F

| Column Volume | DBC 10% |
|---------------|---------|
| 5 | 67.10 |
| 50 | 64.89 |
| 200 | 64.58 |

(Full application note available)

Development and scale-up of an antibody platform

We developed and scaled up a 2-step platform to purify a specific mAb, Pertuzumab, using SkillPak pre-packed columns up to 200 mL. The 2-step platform consists of a Protein A capture and a single polishing step on a salt-tolerant anion exchange resin (AEX).

➤ **Table 8.** Summary of 2-step scale-up from 5 mL to 50 mL to 200 mL using TOYOPEARL AF-rProtein A HC-650F and TOYOPEARL NH₂-750F in SkillPak pre-packed columns

| CV (mL) | Loaded mAb (mg) | Recovery Pro A (%) | Recovery NH ₂ (FT) (%) | Overall recovery (%) | Monomer purity (%) |
|---------|-----------------|--------------------|-----------------------------------|----------------------|--------------------|
| 5 | 176 | 98.14 | 87.76 | 86.13 | 99.92 |
| 50 | 1932 | 98.58 | 94.97 | 93.62 | 99.69 |
| 200 | 7728 | 97.58 | 92.63 | 90.38 | 99.75 |

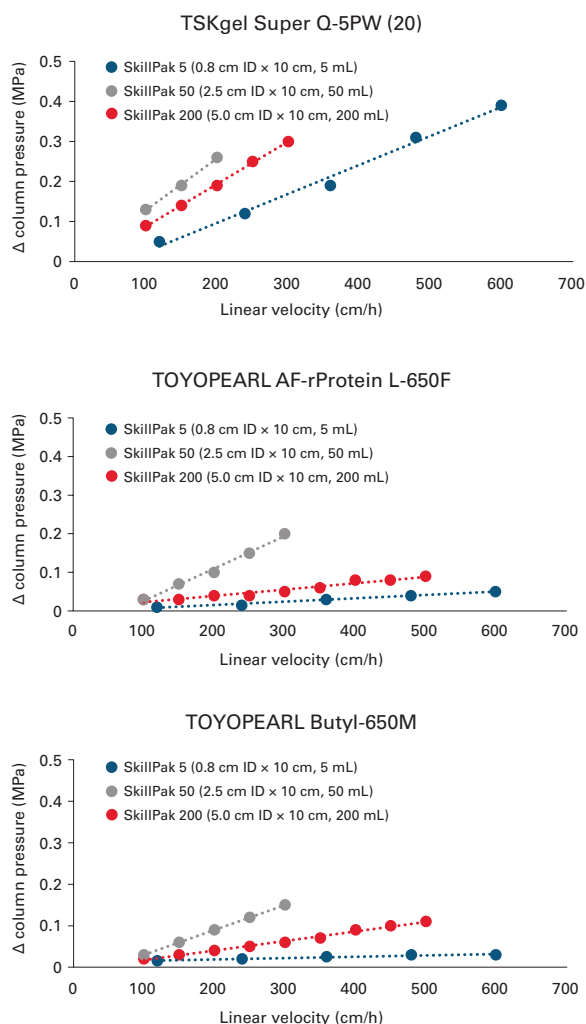
Overall recoveries of around 90 % and a high monomer purity of over 99.9 % were achieved. Using the SkillPak column platform, we could effortlessly develop and the scale-up the process without adjusting the process parameters between the different scales. This seamless scale-up using SkillPak pre-packed columns allows scientists to move from process development to pilot scale quickly, safely, and efficiently.

(Full application note available)

Packing Performance

SkillPak columns exhibit excellent flow characteristics packed with specified process resins and are compatible with low to medium pressure chromatography systems. The figures below demonstrate the superior packing performance for SkillPak columns pre-packed with several TOYOPEARL and TSKgel resins. Representative results are shown here with different bead diameters (20 µm for TSKgel Super Q-5PW (20), 45 µm for TOYOPEARL AF-rProtein L-650F, and 65 µm for TOYOPEARL Butyl-650M). During development of the SkillPak columns, the pressure/flow characteristics have been evaluated for all resin grades to ensure the best performances during the use of the columns.

➤ **Figure 7.** Packing performance data for SkillPak columns



Ordering Information: SkillPak 1 columns

| Part # | Description | Resin volume | Column dimensions |
|---|---|--------------|--------------------|
| Affinity Chromatography | | | |
| 0045200 | SkillPak 1 TOYOPEARL AF-rProtein L-650F | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045221 | SkillPak 1 TOYOPEARL AF-rProtein L-650F (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045201 | SkillPak 1 TOYOPEARL AF-rProtein A HC-650F | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045222 | SkillPak 1 TOYOPEARL AF-rProtein A HC-650F (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045202 | SkillPak 1 TOYOPEARL AF-Chelate-650M | 1 mL | 0.7 cm ID × 2.5 cm |
| Ion Exchange Chromatography | | | |
| 0045203 | SkillPak 1 TOYOPEARL GigaCap Q-650M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045204 | SkillPak 1 TOYOPEARL GigaCap S-650S (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045205 | SkillPak 1 TOYOPEARL Sulfate-650F (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045206 | SkillPak 1 TOYOPEARL SuperQ-650S (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045207 | SkillPak 1 TSKgel SP-5PW (20) (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045208 | SkillPak 1 TSKgel SuperQ-5PW (20) (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045209 | SkillPak 1 TOYOPEARL NH ₂ -750F (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045210 | SkillPak 1 TOYOPEARL GigaCap DEAE-650M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045211 | SkillPak 1 TOYOPEARL GigaCap CM-650M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045212 | SkillPak 1 TOYOPEARL QAE-550C (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045213 | SkillPak 1 TOYOPEARL SP-550C (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| Hydrophobic Interaction Chromatography | | | |
| 0045214 | SkillPak 1 TOYOPEARL Butyl-600M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045215 | SkillPak 1 TOYOPEARL Butyl-650M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045216 | SkillPak 1 TOYOPEARL Phenyl-600M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045217 | SkillPak 1 TOYOPEARL Phenyl-650M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045218 | SkillPak 1 TOYOPEARL PPG-600M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045219 | SkillPak 1 TOYOPEARL Hexyl-650C (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| 0045220 | SkillPak 1 TOYOPEARL Ether-650M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| Mixed-Mode Chromatography | | | |
| 0045224 | SkillPak 1 TOYOPEARL MX-Trp-650M (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| Size Exclusion Chromatography | | | |
| 0045223 | SkillPak 1 TOYOPEARL HW-40F (qty. 5) | 1 mL | 0.7 cm ID × 2.5 cm |
| HA Chromatography | | | |
| 0045225 | SkillPak 1 Ca ⁺⁺ Pure-HA | 1 mL | 0.7 cm ID × 2.5 cm |
| Column Libraries | | | |
| 0045226 | SkillPak 1 Anion Exchange column library, (TOYOPEARL GigaCap Q-650M, GigaCap DEAE-650M, NH ₂ -750F) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045227 | SkillPak 1 Cation Exchange column library, (TOYOPEARL GigaCap S-650S, GigaCap CM-650M, Sulfate-650F) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045228 | SkillPak 1 Antibody column library, (TOYOPEARL AF-rProtein A HC-650F, AF-rProtein L-650F, NH ₂ -750F, Sulfate-650F, GigaCapQ-650M, GigaCapS-650S) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045229 | SkillPak 1 mAb Platform column library, (TOYOPEARL AF-rProtein A HC-650F, Sulfate-650F, NH ₂ -750F) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |

Ordering Information: SkillPak 1 columns, continued

| Part # | Description | Resin volume | Column dimensions |
|-------------------------|--|--------------|--------------------|
| Column Libraries | | | |
| 0045230 | SkillPak 1 Salt Tolerant column library, (TOYOPEARL Sulfate-650F, NH ₂ -750F) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045231 | SkillPak 1 Mixed Mode column library, (Ca ⁺⁺ Pure-HA, TOYOPEARL MX-Trp-650M) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045232 | SkillPak 1 Best-in-Class column library, (Ca ⁺⁺ Pure-HA, TOYOPEARL AF-rProtein A HC-650F, AF-rProtein L-650F, NH ₂ -750F, Sulfate-650F) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045233 | SkillPak 1 HIC column library, (TOYOPEARL Butyl-650M, Phenyl-650M, PPG-600M, Hexyl-650C, Ether-650M) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045234 | SkillPak 1 HIC column library, (TOYOPEARL Butyl-600M, Phenyl-600M, PPG-600M, Hexyl-650C, Ether-650M) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045235 | SkillPak 1 HIC column library, (TOYOPEARL Butyl-650M, Phenyl-650M, PPG-600M) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045236 | SkillPak 1 HIC column library, (TOYOPEARL Butyl-600M, Phenyl-600M, PPG-600M) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045237 | SkillPak 1 HIC column library, (TOYOPEARL Phenyl-650M, PPG-600M, Hexyl-650C) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |
| 0045238 | SkillPak 1 HIC column library, (TOYOPEARL Phenyl-600M, PPG-600M, Hexyl-650C) | 1 mL × 2 ea | 0.7 cm ID × 2.5 cm |

Ordering Information: SkillPak 5 columns

| Part # | Description | Resin volume | Column dimensions |
|---|--|--------------|-------------------|
| Affinity Chromatography | | | |
| 0045257 | SkillPak 5 TOYOPEARL AF-rProtein L-650F | 5 mL | 0.8 cm ID × 10 cm |
| 0045258 | SkillPak 5 TOYOPEARL AF-rProtein A HC-650F | 5 mL | 0.8 cm ID × 10 cm |
| 0045259 | SkillPak 5 TOYOPEARL AF-Chelate-650M | 5 mL | 0.8 cm ID × 10 cm |
| Ion Exchange Chromatography | | | |
| 0045239 | SkillPak 5 TOYOPEARL GigaCap Q-650M | 5 mL | 0.8 cm ID × 10 cm |
| 0045240 | SkillPak 5 TOYOPEARL GigaCap S-650S | 5 mL | 0.8 cm ID × 10 cm |
| 0045241 | SkillPak 5 TOYOPEARL Sulfate-650F | 5 mL | 0.8 cm ID × 10 cm |
| 0045242 | SkillPak 5 TOYOPEARL SuperQ-650S | 5 mL | 0.8 cm ID × 10 cm |
| 0045243 | SkillPak 5 TSKgel SP-5PW (20) | 5 mL | 0.8 cm ID × 10 cm |
| 0045244 | SkillPak 5 TSKgel SuperQ-5PW (20) | 5 mL | 0.8 cm ID × 10 cm |
| 0045245 | SkillPak 5 TOYOPEARL NH ₂ -750F | 5 mL | 0.8 cm ID × 10 cm |
| 0045246 | SkillPak 5 TOYOPEARL GigaCap DEAE-650M | 5 mL | 0.8 cm ID × 10 cm |
| 0045247 | SkillPak 5 TOYOPEARL GigaCap CM-650M | 5 mL | 0.8 cm ID × 10 cm |
| 0045248 | SkillPak 5 TOYOPEARL QAE-550C | 5 mL | 0.8 cm ID × 10 cm |
| 0045249 | SkillPak 5 TOYOPEARL SP-550C | 5 mL | 0.8 cm ID × 10 cm |
| Hydrophobic Interaction Chromatography | | | |
| 0045250 | SkillPak 5 TOYOPEARL Butyl-600M | 5 mL | 0.8 cm ID × 10 cm |
| 0045251 | SkillPak 5 TOYOPEARL Butyl-650M | 5 mL | 0.8 cm ID × 10 cm |
| 0045252 | SkillPak 5 TOYOPEARL Phenyl-600M | 5 mL | 0.8 cm ID × 10 cm |
| 0045253 | SkillPak 5 TOYOPEARL Phenyl-650M | 5 mL | 0.8 cm ID × 10 cm |
| 0045254 | SkillPak 5 TOYOPEARL PPG-600M | 5 mL | 0.8 cm ID × 10 cm |
| 0045255 | SkillPak 5 TOYOPEARL Hexyl-650C | 5 mL | 0.8 cm ID × 10 cm |
| 0045256 | SkillPak 5 TOYOPEARL Ether-650M | 5 mL | 0.8 cm ID × 10 cm |
| Mixed-Mode Chromatography | | | |
| 0045261 | SkillPak 5 TOYOPEARL MX-Trp-650M | 5 mL | 0.8 cm ID × 10 cm |
| Size Exclusion Chromatography | | | |
| 0045260 | SkillPak 5 TOYOPEARL HW-40F | 5 mL | 0.8 cm ID × 10 cm |
| HA Chromatography | | | |
| 0045262 | SkillPak 5 Ca ⁺⁺ Pure-HA | 5 mL | 0.8 cm ID × 10 cm |
| Column Libraries | | | |
| 0045263 | SkillPak 5 mAb Platform column library, (TOYOPEARL AF-rProtein A HC-650F, Sulfate-650F, NH ₂ -750F) | 5 mL × 1 ea | 0.8 cm ID × 10 cm |
| 0045264 | SkillPak 5 Salt Tolerant column library, (TOYOPEARL Sulfate-650F, NH ₂ -750F) | 5 mL × 1 ea | 0.8 cm ID × 10 cm |
| 0045265 | SkillPak 5 Mixed Mode column library, (Ca ⁺⁺ Pure-HA, TOYOPEARL MX-Trp-650M) | 5 mL × 1 ea | 0.8 cm ID × 10 cm |
| 0045266 | SkillPak 5 Best-in-Class column library, (Ca ⁺⁺ Pure-HA, TOYOPEARL AF-rProtein A HC-650F, AF-rProtein L-650F, NH ₂ -750F, Sulfate-650F) | 5 mL × 1 ea | 0.8 cm ID × 10 cm |

Ordering Information: SkillPak 50 columns

| Part # | Description | Resin volume | Column dimensions |
|---|---|--------------|-------------------|
| Size Exclusion Chromatography | | | |
| 0045300 | SkillPak 50 TOYOPEARL HW-40F | 50 mL | 2.5 cm ID × 10 cm |
| Ion Exchange Chromatography | | | |
| 0045302 | SkillPak 50 TSKgel SuperQ-5PW (20) | 50 mL | 2.5 cm ID × 10 cm |
| 0045304 | SkillPak 50 TOYOPEARL SuperQ-650S | 50 mL | 2.5 cm ID × 10 cm |
| 0045306 | SkillPak 50 TOYOPEARL GigaCap Q-650M | 50 mL | 2.5 cm ID × 10 cm |
| 0045308 | SkillPak 50 TOYOPEARL GigaCap DEAE-650M | 50 mL | 2.5 cm ID × 10 cm |
| 0045310 | SkillPak 50 TOYOPEARL NH ₂ -750F | 50 mL | 2.5 cm ID × 10 cm |
| 0045312 | SkillPak 50 TOYOPEARL QAE-550C | 50 mL | 2.5 cm ID × 10 cm |
| 0045314 | SkillPak 50 TOYOPEARL GigaCap S-650S | 50 mL | 2.5 cm ID × 10 cm |
| 0045316 | SkillPak 50 TSKgel SP-5PW (20) | 50 mL | 2.5 cm ID × 10 cm |
| 0045318 | SkillPak 50 TOYOPEARL Sulfate-650F | 50 mL | 2.5 cm ID × 10 cm |
| 0045320 | SkillPak 50 TOYOPEARL GigaCap CM-650M | 50 mL | 2.5 cm ID × 10 cm |
| 0045322 | SkillPak 50 TOYOPEARL SP-550C | 50 mL | 2.5 cm ID × 10 cm |
| Hydrophobic Interaction Chromatography | | | |
| 0045324 | SkillPak 50 TOYOPEARL PPG-600M | 50 mL | 2.5 cm ID × 10 cm |
| 0045326 | SkillPak 50 TOYOPEARL Butyl-600M | 50 mL | 2.5 cm ID × 10 cm |
| 0045328 | SkillPak 50 TOYOPEARL Butyl-650M | 50 mL | 2.5 cm ID × 10 cm |
| 0045330 | SkillPak 50 TOYOPEARL Hexyl-650C | 50 mL | 2.5 cm ID × 10 cm |
| 0045332 | SkillPak 50 TOYOPEARL Phenyl-600M | 50 mL | 2.5 cm ID × 10 cm |
| 0045334 | SkillPak 50 TOYOPEARL Phenyl-650M | 50 mL | 2.5 cm ID × 10 cm |
| 0045336 | SkillPak 50 TOYOPEARL Ether-650M | 50 mL | 2.5 cm ID × 10 cm |
| Affinity Chromatography | | | |
| 0045338 | SkillPak 50 TOYOPEARL AF-rProtein A HC-650F | 50 mL | 2.5 cm ID × 10 cm |
| 0045340 | SkillPak 50 TOYOPEARL AF-rProtein L-650F | 50 mL | 2.5 cm ID × 10 cm |
| 0045342 | SkillPak 50 TOYOPEARL AF-Chelate-650M | 50 mL | 2.5 cm ID × 10 cm |
| Mixed-Mode Chromatography | | | |
| 0045344 | SkillPak 50 TOYOPEARL MX-Trp-650M | 50 mL | 2.5 cm ID × 10 cm |

Ordering Information: SkillPak 200 columns

| Part # | Description | Resin volume | Column dimensions |
|---|--|--------------|-------------------|
| Size Exclusion Chromatography | | | |
| 0045301 | SkillPak 200 TOYOPEARL HW-40F | 200 mL | 5.0 cm ID × 10 cm |
| Ion Exchange Chromatography | | | |
| 0045303 | SkillPak 200 TSKgel SuperQ-5PW (20) | 200 mL | 5.0 cm ID × 10 cm |
| 0045305 | SkillPak 200 TOYOPEARL SuperQ-650S | 200 mL | 5.0 cm ID × 10 cm |
| 0045307 | SkillPak 200 TOYOPEARL GigaCap Q-650M | 200 mL | 5.0 cm ID × 10 cm |
| 0045309 | SkillPak 200 TOYOPEARL GigaCap DEAE-650M | 200 mL | 5.0 cm ID × 10 cm |
| 0045311 | SkillPak 200 TOYOPEARL NH ₂ -750F | 200 mL | 5.0 cm ID × 10 cm |
| 0045313 | SkillPak 200 TOYOPEARL QAE-550C | 200 mL | 5.0 cm ID × 10 cm |
| 0045315 | SkillPak 200 TOYOPEARL GigaCap S-650S | 200 mL | 5.0 cm ID × 10 cm |
| 0045317 | SkillPak 200 TSKgel SP-5PW (20) | 200 mL | 5.0 cm ID × 10 cm |
| 0045319 | SkillPak 200 TOYOPEARL Sulfate-650F | 200 mL | 5.0 cm ID × 10 cm |
| 0045321 | SkillPak 200 TOYOPEARL GigaCap CM-650M | 200 mL | 5.0 cm ID × 10 cm |
| 0045323 | SkillPak 200 TOYOPEARL SP-550C | 200 mL | 5.0 cm ID × 10 cm |
| Hydrophobic Interaction Chromatography | | | |
| 0045325 | SkillPak 200 TOYOPEARL PPG-600M | 200 mL | 5.0 cm ID × 10 cm |
| 0045327 | SkillPak 200 TOYOPEARL Butyl-600M | 200 mL | 5.0 cm ID × 10 cm |
| 0045329 | SkillPak 200 TOYOPEARL Butyl-650M | 200 mL | 5.0 cm ID × 10 cm |
| 0045331 | SkillPak 200 TOYOPEARL Hexyl-650C | 200 mL | 5.0 cm ID × 10 cm |
| 0045333 | SkillPak 200 TOYOPEARL Phenyl-600M | 200 mL | 5.0 cm ID × 10 cm |
| 0045335 | SkillPak 200 TOYOPEARL Phenyl-650M | 200 mL | 5.0 cm ID × 10 cm |
| 0045337 | SkillPak 200 TOYOPEARL Ether-650M | 200 mL | 5.0 cm ID × 10 cm |
| Affinity Chromatography | | | |
| 0045339 | SkillPak 200 TOYOPEARL AF-rProtein A HC-650F | 200 mL | 5.0 cm ID × 10 cm |
| 0045341 | SkillPak 200 TOYOPEARL AF-rProtein L-650F | 200 mL | 5.0 cm ID × 10 cm |
| 0045343 | SkillPak 200 TOYOPEARL AF-Chelate-650M | 200 mL | 5.0 cm ID × 10 cm |
| Mixed-Mode Chromatography | | | |
| 0045345 | SkillPak 200 TOYOPEARL MX-Trp-650M | 200 mL | 5.0 cm ID × 10 cm |

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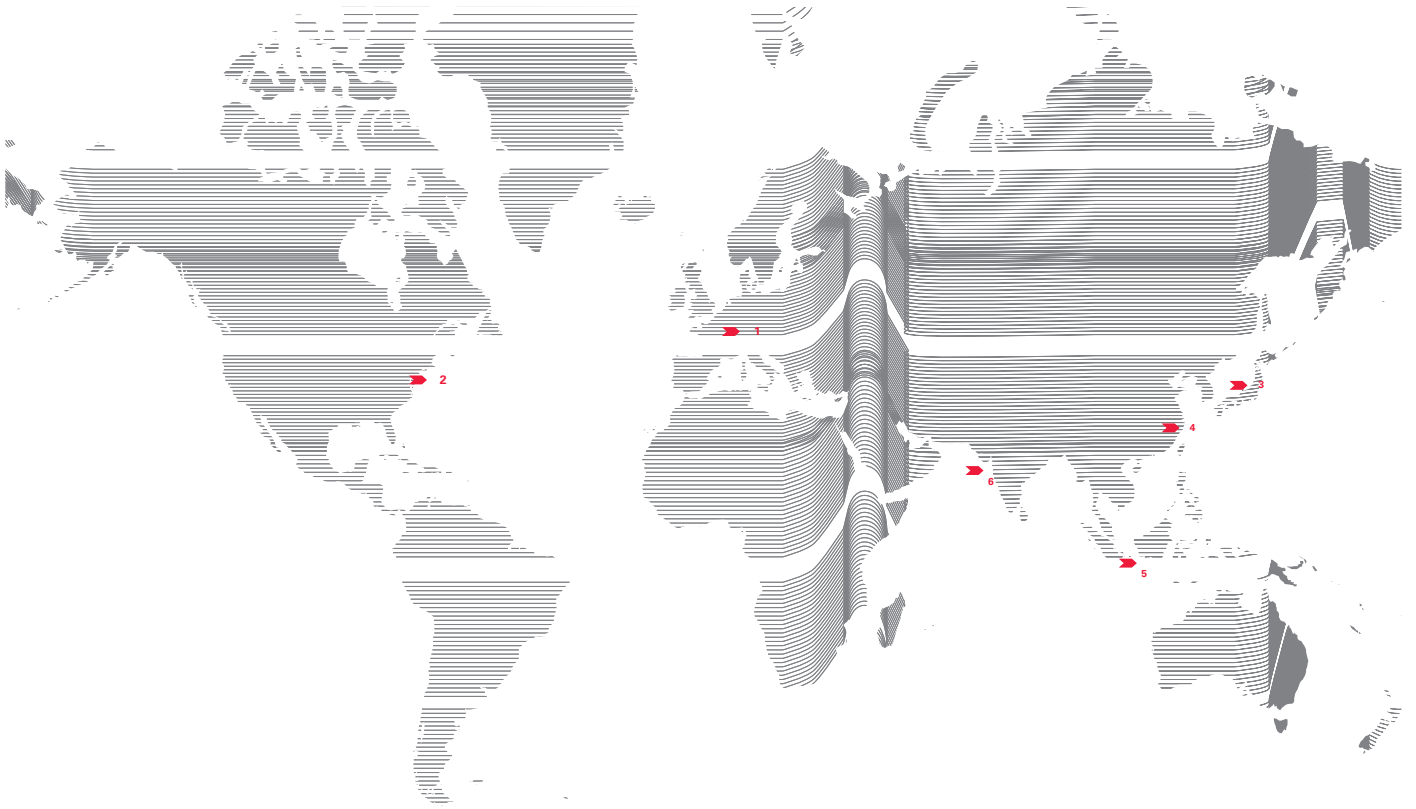
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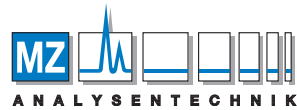
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TOSOH HISTORY

| | |
|------|--|
| 1935 | Founding of Toyo Soda Manufacturing Co., Ltd. |
| 1936 | Operation of Nanyo Manufacturing Complex begins |
| 1979 | Tosoh develops TOYOPEARL media |
| 1983 | First TOYOPEARL hydrophobic interaction (HIC) resin |
| 1995 | Tosoh Nanyo gel factory receives ISO9001 |
| 2007 | TOYOPEARL GigaCap high capacity ion exchange series starts |
| 2012 | A second TOYOPEARL production site doubles manufacturing capacity |
| 2012 | First TOYOPEARL multimodal resin |
| 2013 | High capacity TOYOPEARL Protein A resin for antibody purification introduced |
| 2014 | TOSOH Bioscience GmbH celebrates its 25th anniversary |
| 2016 | First salt-tolerant TOYOPEARL ion exchanger |
| 2016 | TOYOPEARL® Sulfate-650F receives the TMM Innovation Award 2016 |
| 2017 | High capacity TOYOPEARL Protein L resin for antibody purification introduced |
| 2019 | Completion of the third TOYOPEARL factory |
| 2020 | SkillIPack pre-packed columns launched globally |



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