What makes DBC so important? And why is it so useful to know how to determine it?

Abstract

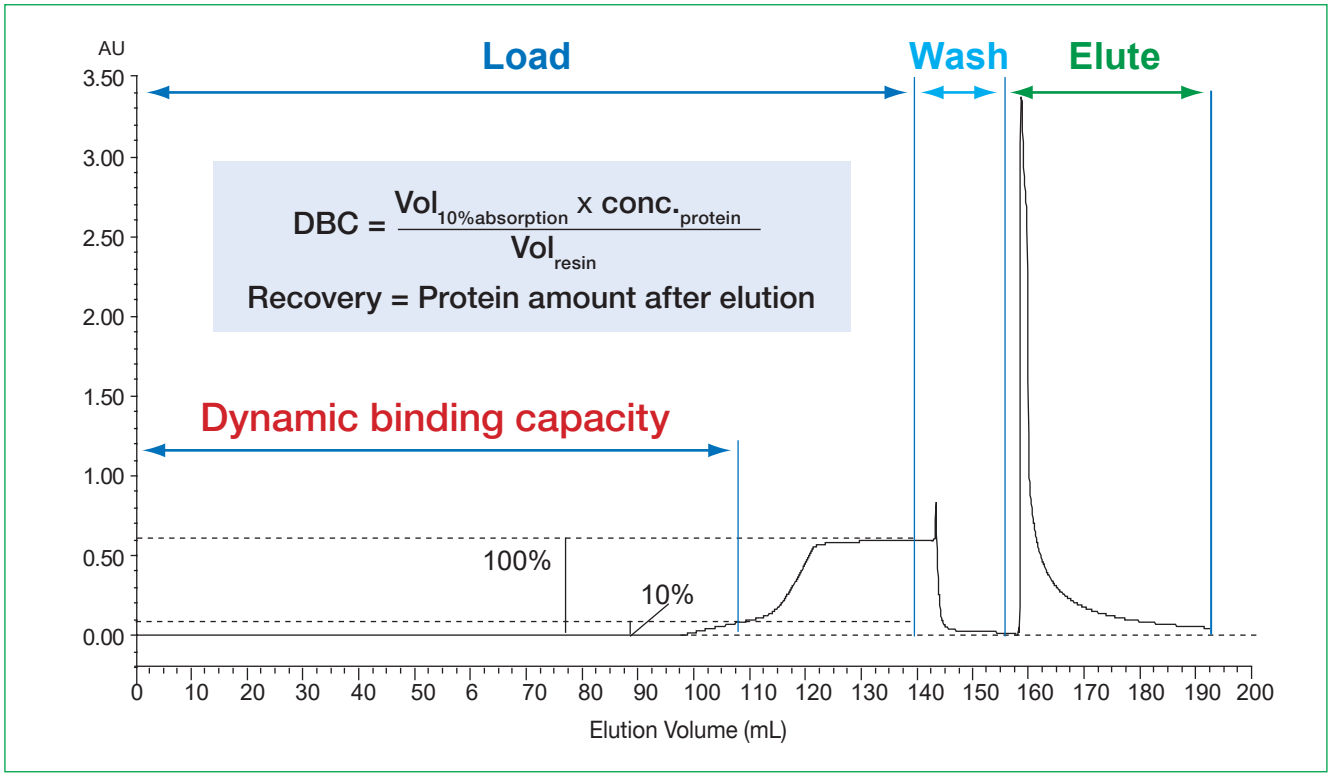
High productivity is the main focus when a chromatography resin is selected in downstream processing (DSP). The higher the dynamic binding capacity (DBC) of a resin, the more substance can be loaded onto the column and consequently the higher is the throughput of the process.

High DBC → **High Loadability** → **High Productivity**

In contrast to the static binding capacity (SBC), where the maximum target binding of the bulk resin is measured, the DBC is a real process parameter as it is determined using the chromatographic setup. Therefore, modern process resins with maximum DBC are needed for increased productivity.

How to Determine the DBC of a Resin

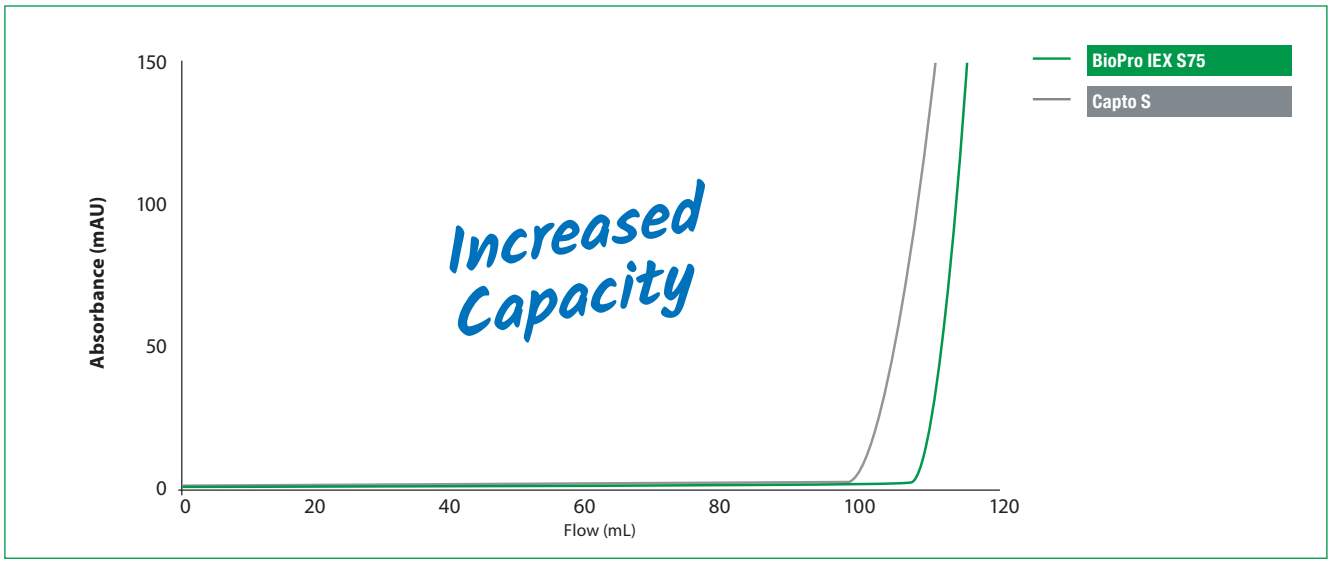
The DBC of a resin as most important factor for the productivity is determined by pumping a defined amount of substance through the column and measuring the breakthrough point of the target. The DBC per mL resin can then be calculated. The scheme and the corresponding formula for the DBC determination is shown below:



To determine the DBC, a protein solution with a defined concentration is pumped through the column and the proteins bind to the column. The solution is pumped until a flow through of the protein is detected and saturation is reached. Afterwards, the amount of protein that was pumped through the column until a protein breakthrough at 10% of the saturation is calculated. This value for the binding capacity can be normalised on the resin volume:
DBC = mg bound protein / mL resin

Practical Example: Higher Capacity Determined for BioPro IEX

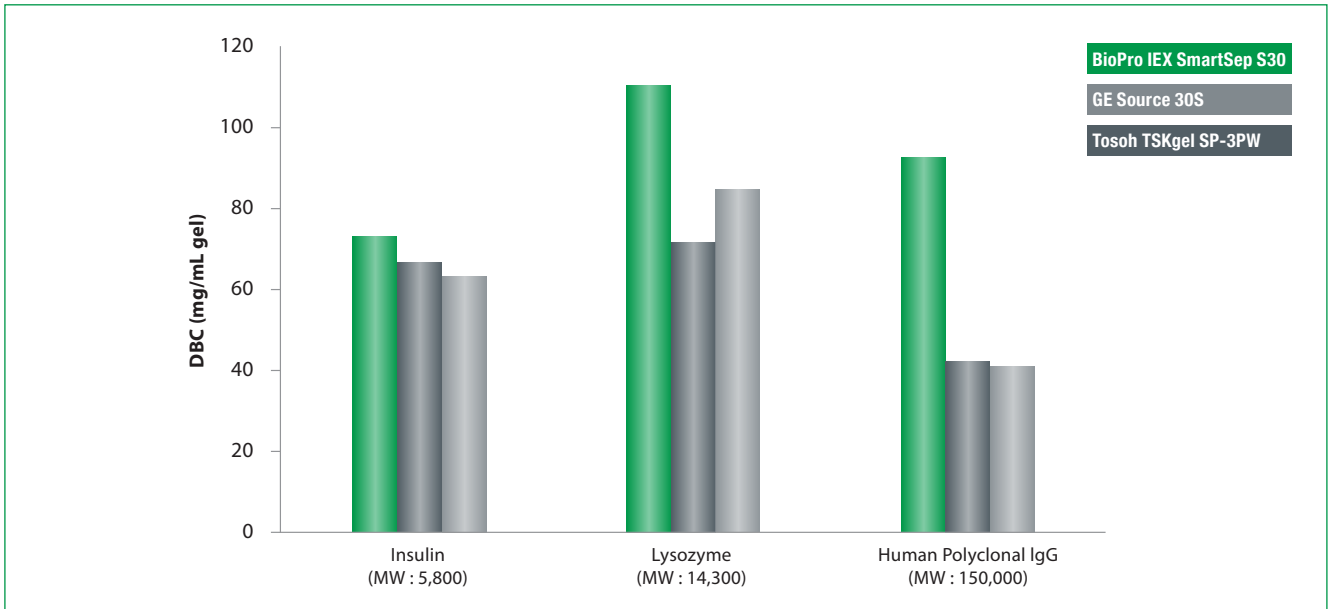
In this study, the dynamic binding capacity of BioPro IEX S75 and Capto S for a monoclonal antibody was determined based on the above-described procedure. The results are shown in the following chromatogram:



BioPro IEX shows a later breakthrough of the IgG compared to the alternative material, so more of the antibody could be bound to the resin before the breakthrough was reached. Therefore, BioPro IEX has a higher DBC for the monoclonal antibody.

High DBC for High Loadability

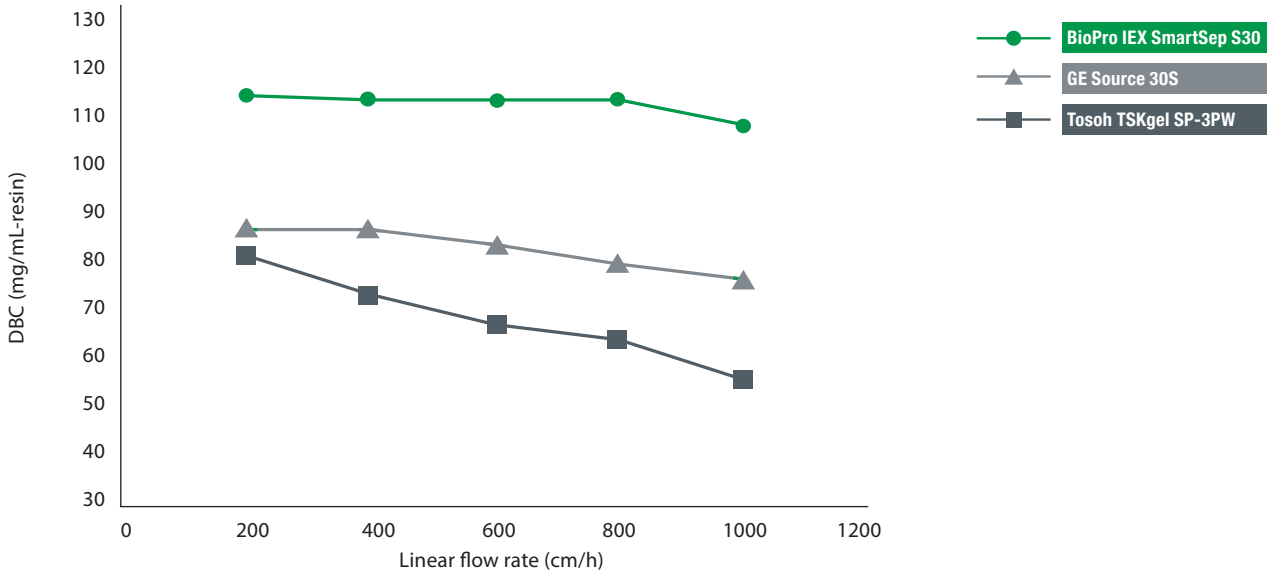
The higher the DBC of a resin for a dedicated protein or antibody, the higher is the throughput. This of course depends on the target molecule and the mobile phase composition. Therefore, resins that exhibit high DBC values for various targets are needed for efficient DSP. In a comparison study, the DBC values of proteins with different sizes and characteristics were determined with three IEX materials. The results are plotted below: BioPro IEX SmartSep shows higher dynamic binding capacity for both, small peptides and large proteins.



Column:	50 x 5.0 mm ID
Flow rate:	400 cm/h (1.32 mL/min)
Temperature:	25 °C

High DBC at High Flow Rates

The DBC depends on the chromatographic parameters such as pH, buffer conditions, conductivity and also on the flow rate. In this example, the DBC values of three resins were determined at different linear velocities. The result: BioPro IEX SmartSep shows high loadability even at high flow rates.

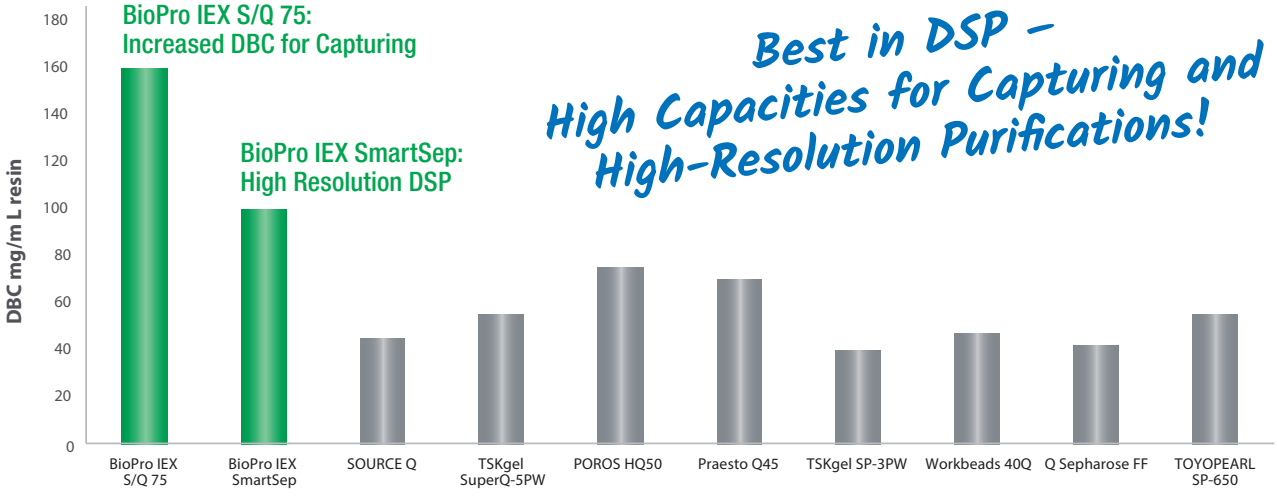


Column:	50 x 5.0 mm ID
Equilibration buffer:	20 mM Glycine-NaOH (pH 9.0)
Linear velocitiy:	200-1,000 cm/h (0.66 mL/min–3.27 mL/min)

High flow rates further improve the productivity of the purification because they additionally increase the throughput. Therefore, a combination of high loadings and high velocities are ideal for efficient processing. BioPro IEX combines both – high loadability and high flow rates.

Comparison of the Specified DBC Values of Various Process Resins

Because the maximum DBC is such an important factor, it is included in the standard specifications of process resins. This overview shows a comparison of DBC values of various available process resins. Based on these specifications, the BioPro IEX resins have the highest dynamic binding capacities for BSA (anion exchange mode) and Lysozyme (cation exchange mode). Therefore, the resins are ideal resins for high productivity processes.



Conclusion

The dynamic binding capacity is an essential factor to increase the productivity of downstream processes. The higher the binding capacity, the higher is the maximum loadability of the target feed which consequently increases the throughput. The DBC can be determined by loading the target onto the column and measuring its breakthrough.

The IEX resins from YMC BioPro IEX exhibit high DBC values for various types of biomolecules – from small peptides to large proteins and antibodies – even at elevated flow rates. In a direct comparison of the specified DBC values, the resins from YMC clearly outperform alternative resins used for process scale.

Specifications

BioPro IEX Series	BioPro IEX SmartSep Q10	BioPro IEX SmartSep Q20	BioPro IEX SmartSep Q30	BioPro IEX SmartSep S10	BioPro IEX SmartSep S20	BioPro IEX SmartSep S30
Ion Exchange Type	strong anion exchanger			strong cation exchanger		
Charged Group	-R-$N^+(CH_3)_3$			-R-SO_3^-		
Matrix	hydrophilic polymer beads					
Pore Size	porous					
pH Range	2–12					
Compression Factor	1.05–1.15					
Particle Size	10 µm	20 µm	30 µm	10 µm	20 µm	30 µm
Pressure Resistance	regular use: 3 MPa max.: 4 MPa	regular use: 2 MPa max.: 3 MPa		regular use: 3 MPa max.: 4 MPa	regular use: 2 MPa max.: 3 MPa	
Typical Flow Rate	200–1000 cm/h max. 2000 cm/h					
Ion-Exchange Capacity	min. 0.08 meq/mL-resin					
Dynamic Binding Capacity	min. 100 mg/mL-resin (BSA)			min. 100 mg/mL-resin (lysozyme)		

Ordering Information and Screening Opportunities

Strong anion exchanger: BioPro IEX Q

Product	Particle Size	Code	Pack Sizes*					
			50 mL	250 mL	1 L	5 L	10 L	20 L
BioPro IEX SmartSep Q10	10 µm	QSA0S10	✔	✔	✔	✔	✔	✔
BioPro IEX SmartSep Q20	20 µm	QSA0S20	✔	✔	✔	✔	✔	✔
BioPro IEX SmartSep Q30	30 µm	QSA0S30	✔	✔	✔	✔	✔	✔
BioPro IEX Q75	75 µm	QAA0S75	✔	✔	✔	✔	✔	✔

* Larger or customised pack sizes are available on request.

Strong cation exchanger: BioPro IEX S

Product	Particle Size	Code	Pack Sizes*					
			50 mL	250 mL	1 L	5 L	10 L	20 L
BioPro IEX SmartSep S10	10 µm	SSA0S10	✔	✔	✔	✔	✔	✔
BioPro IEX SmartSep S20	20 µm	SSA0S20	✔	✔	✔	✔	✔	✔
BioPro IEX SmartSep S30	30 µm	SSA0S30	✔	✔	✔	✔	✔	✔
BioPro IEX S75	75 µm	SPA0S75	✔	✔	✔	✔	✔	✔

* Larger or customised pack sizes are available on request.