



CALGON CARBON CORPORATION

# Continuous Ion Exchange & Chromatography Technology for Pharmaceutical and Biotech Industries

CLEANER AIR

## APPLICATIONS

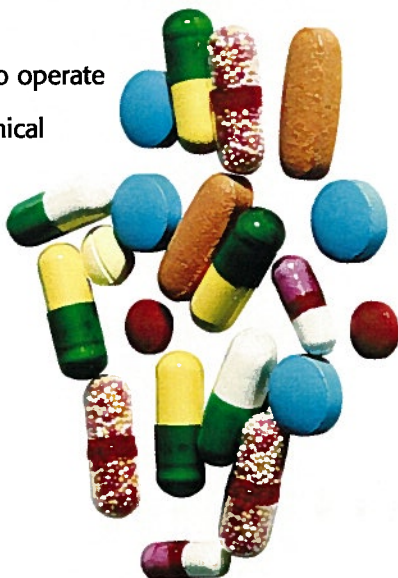
Pharmaceutical and biotech products derived from fluid process streams or fermentation processes, such as:

- Proteins
- Amino Acids
- Antibiotics
- Vitamins

## BENEFITS

Benefits realized when using CCC CSEP® Separator technology for processes requiring separation, purification, concentration and/or decolorization are:

- Highly reproducible results
- Easily scaled up
- Equipment is easy to operate
- Minimal water, chemical and waste streams
- Easily cleaned and sanitized
- Validatable
- Minimal number of valves and controls



## FLEXIBILITY

The CCC CSEP® system provides a high degree of versatility that is much appreciated in pharmaceutical applications. Systems go from pilot scale to full-volume production size with total conservation of all process parameters. Configuration changes are easily accomplished, allowing the user to utilize the same system for a number of different products. Ease of reconfiguration maximizes the return on equipment investment.

CSEP® / ISEP® systems can be assembled with 10, 20 or 30 sorbent cells. By optimizing the number of cells, high production rates can be achieved and the process can involve complex elutions that require multiple eluents and wash zones.

## SORBENT ASSET UTILIZATION

Fixed bed separation systems require vessels with enough sorbent volume to accommodate an acceptable adsorption cycle time, plus a second set of equal volume standing by. In such a system, much of the sorbent in the active bed is either loaded or unused as the mass transfer zone moves through the column. All of the sorbent in the standby bed, of course, is totally unused until that bed is switched in the process stream.

The CSEP® / ISEP® design utilizes several resin columns and maximizes the utilization of resin inventories. While sorbent feed enters the separator in one zone, elution, wash and regeneration occur simultaneously in other zones. With the CCC system, resin inventories can be reduced by 30% to 90%, depending on process and feed concentrations.

## DECREASED ELUENT USAGE

The CSEP® / ISEP® system can save a user as much as 2/3 of the chemicals used for elution. Counter-Current flow of regenerants and rinse water through low volume resin cells greatly reduces the amount of chemicals and diluents required to regenerate and clean the resin.

## INCREASED PRODUCT CONCENTRATION & RECOVERIES

Essentially complete recoveries without added dilution are possible with CSEP® / ISEP® systems. Counter-current flows and recycling of eluents combine to keep concentrations high without reduced recoveries.

## CONTINUOUS STEADY STATE

There is no interruption of feed or regenerant stream flows and effluent streams are consistent in composition. Instead of fluctuations that are tolerated in fixed bed systems, CCC's systems yield a constant output.

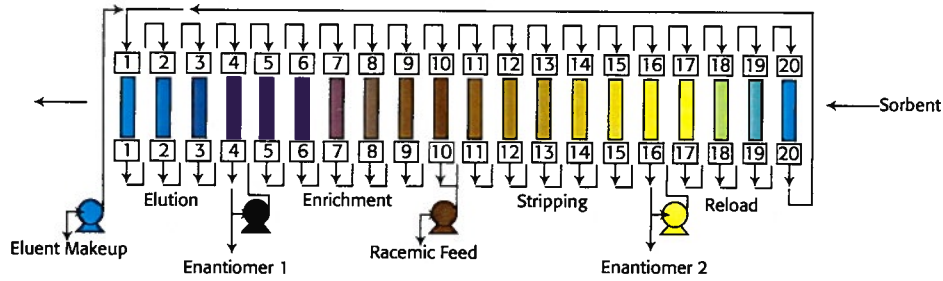
## SUSPENDED SOLIDS TOLERANCE

Any port in the separator system can operate in the upflow direction to remove suspended solids. This feature also allows resin beds to be lifted and resettled on every rotation.

CLEANER WATER AND PURER PRODUCTS



# CSEP® Chiral Separation Process Flow



## 1. Enrichment Zone

The feed is entrained in the voids of the sorbent. The feed column steps into the Enrichment Zone. One (slow) enantiomer adsorbs preferentially. The other (fast) enantiomer is washed forward by the eluent. The slow enantiomer increases in purity as the column steps across the Enrichment Zone. The fast enantiomer is removed from the columns and returns to the Stripping Zone.

## 2. Stripping Zone

Racemic feed enters along with eluent moving forward from the Enrichment Zone. The slow enantiomer is removed by the sorbent as the eluent moves across the zone. The fast enantiomer increases in purity.

## 3. Reload Zone

The fast enantiomer is taken off at Port 16. A relatively small portion of that flow is sent forward to the Reload Zone. All of the fast enantiomer carried back to the stripping zone by the sorbent. This increases the

concentration of the fast enantiomer. This zone also cleans up the eluent for re-use in the Elution Zone, reducing the amount of makeup eluent needed.

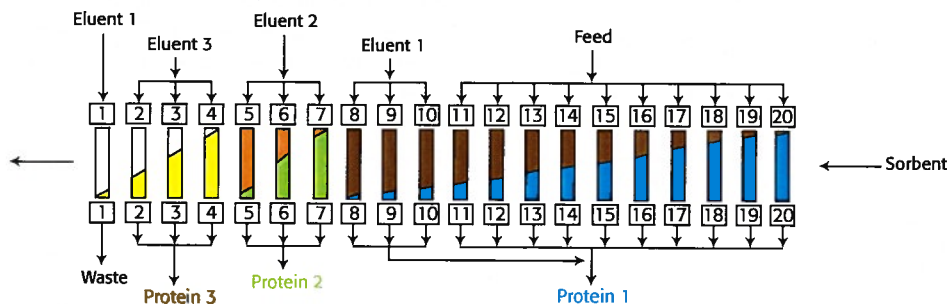
## 4. Elution Zone

The sorbent carries the slow enantiomer to the Elution Zone. A high flow of eluent in that zone removes the enantiomer from the sorbent as the cell steps across the zone. A portion of the flow is sent forward to the Enrichment Zone to effect the separation. The sorbent leaves the Elution Zone clean and ready to perform separation in the other Zones.

## 5. Counter-Current Flows

The efficiency of separation in each zone is enhanced by the counter-current nature of the flows. The components encounter the sorbent multiple times because the sorbent moves counter to the eluent.

# CSEP® Protein Separation Process Flow



## 1. Feed Zone

A feed containing a mixture of proteins is fed to several columns in parallel to limit velocity. This improves loading kinetics. In some instances, one protein (family) does not adsorb at all and elutes immediately.

## 2. Eluent 1 Zone

The first protein (family) is eluted most easily.

## 3. Eluent 2 Zone

The second protein (family) adsorbs more strongly and is desorbed by a buffer solution.

## 4. Eluent 3 Zone

A third protein (family) adsorbs most strongly and is desorbed by another buffer solution.

## 5. Reconditioning Zone

The sorbent is reconditioned with the first eluent before being returned to loading.