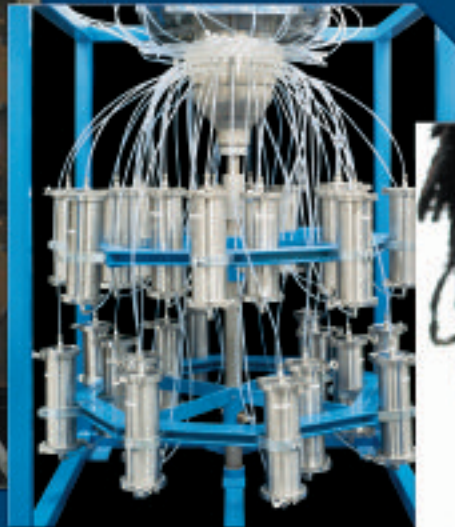


CalgonCarbon

Engineered Solutions

Making Water and Air Safer and Cleaner



ISEP[®]
Continuous Ionic Separation

CSEP[®]
Continuous Chromatographic Separation

RSEP[™]
Continuous Reaction Separation

For

PURIFICATION

SEPARATION

RECOVERY

SYNTHESIS

The Engineered Solutions group at Calgon Carbon offers multiple process technologies combined with separation equipment. Since 1990, many manufacturers and industries have discovered the exceptional value of Calgon Carbon's ISEP®/CSEP®/RSEP™ equipment technology for separating, recovering, purifying and synthesizing materials. With over 350 installations in more than 40 applications, ISEP®/CSEP®/RSEP™ continues to prove itself capable of economically solving complex processing problems. The Pharmaceutical industry has also discovered the added value of this equipment to process intermediates utilizing the valve in cGMP processes to produce drugs.

Technology Benefits

For any adsorption/desorption application, the Continuous Separator has the flexibility to achieve the following:

Substantial reduction in sorbent inventory – Reductions of 30% to 90% are possible as compared to conventional fixed bed or pulsed bed systems.

Reduced regenerant (eluent) and water usage – Eluent-to-resin volume ratios of less than one are achieved due to counter-current flow.

High product concentration – Low eluent and water usage translate into less dilution.

High recovery – Use of counter-current flows and recycling can provide essentially complete recovery.

Steady state/continuous operation – There is no interruption of feed or regenerant stream flows and effluent streams are consistent in composition.

Simple operation & control – No complex valve nest is used. Only two moving parts in entire system (distributor and turntable) with a rotation rate of .01 to 1 revolution per hour.

Flexibility – The system allows for a number of user functions to be simultaneously achieved within a dynamic process stream under continuous operating conditions.

Capital and operating cost reduction – Overall capital cost reduction of 30% to 50%, and operating cost reduction of 40% to 50% as compared to conventional fixed bed or pulsed bed systems.

Good tolerance for suspended solids – Processes with high suspended solids can be entertained with more frequent backwash intervals.

Capabilities

Pilot testing and custom chemical manufacturing at the customer site for performance evaluation. Systems with 1/8" and 1/4" valves are available including explosion proof system and portable systems.

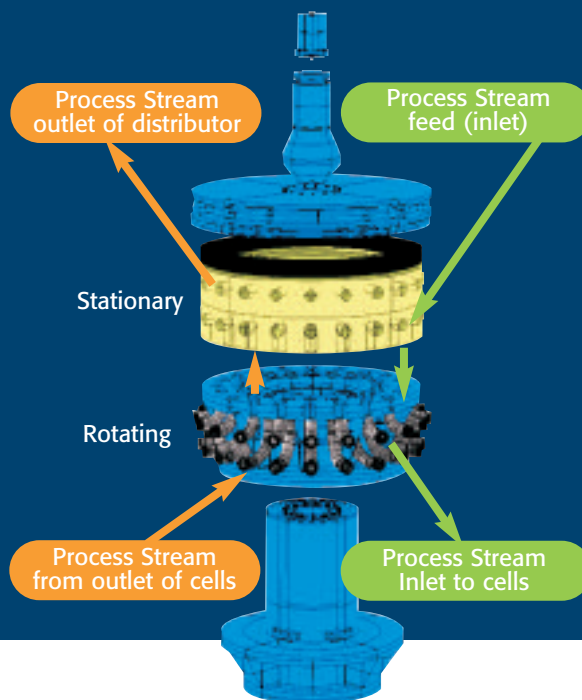
Full process engineering design support to match customer applications to the continuous separator.

Project management for full turnkey support that includes installation, startup, and operational assistance.

Complete service packages are available for on-site management of equipment.

Lease and rental packages are available for piloting work.

Analytical laboratory for bench, scale-up, and pilot support.



At the heart of the system is a single, multi-port, rotating distributor containing 10, 20 or 30 inlet and outlet ports. The distributor rotates at a specified rate using only one moving part. The stationary portion of the distributor manages and directs all incoming and out-going fluid streams into the appropriate zone and ports of the rotating portion of the distributor.

The rotating portion of the distributor draws process fluid streams from the stationary component and feeds the cells containing sorbent media. The media can be ion exchange resins, silica gels, activated carbon, molecular sieves, etc. The cells are mounted on a turntable that rotates along with the distributor.

During a 360 degree rotation, each resin cell is subjected to an entire sorption cycle. This cycle usually consists of adsorption, regeneration or elution, and one or two rinse steps. Additional steps may be provided depending on the process complexity.

The use of short beds allows for maximum resin utilization. No resin sits idle in the cells regardless of resin state - exhausted or regenerated. This feature results in a much lower resin inventory than would be the case for a conventional ion exchange system. Counter-current regeneration and counter-current rinse water flow, along with low resin volume, combine to reduce the amount of chemicals and eluent required to regenerate and clean the resin.

Proven Applications

Biotech/Pharmaceutical Industry

Antibiotic Purification
Vitamin Recovery
Optical Isomer Fractionation
API Processing

Fermentation

Purification of Broth
Decolorizing Solutions
Cation Removal
Softening

Food Processing Industry

Fructose Enrichment
Impurities Removal
Decolorizing Processes
Deashing
Protein Fractionations

Hydrometallurgy Industry

Selective Metals Separation
Strategic Metals Recovery
Metals Concentration from Leach Liquors

Pulp and Paper Industry

Effluent Decolorizing

Inorganic Chemicals Industry

Potassium Salts
Advanced Fertilizer Production
Brine Purification
High-Purity Chemical Salts
Acid Decolorizing

Organic Chemicals Industry

Petrochemicals Production
Decolorizing Processes
Water Purification
P-Xylene Purification

Sugar Industry

Decolorizing
Deashing
Cation Removal
Purification of Syrups
Ion Exclusion

Wastewater Industry

Municipal
Industrial
Groundwater Remediation - Perchlorate

Water Treatment Industry

Desalination-Pretreatment
Demineralization-Ion Removal

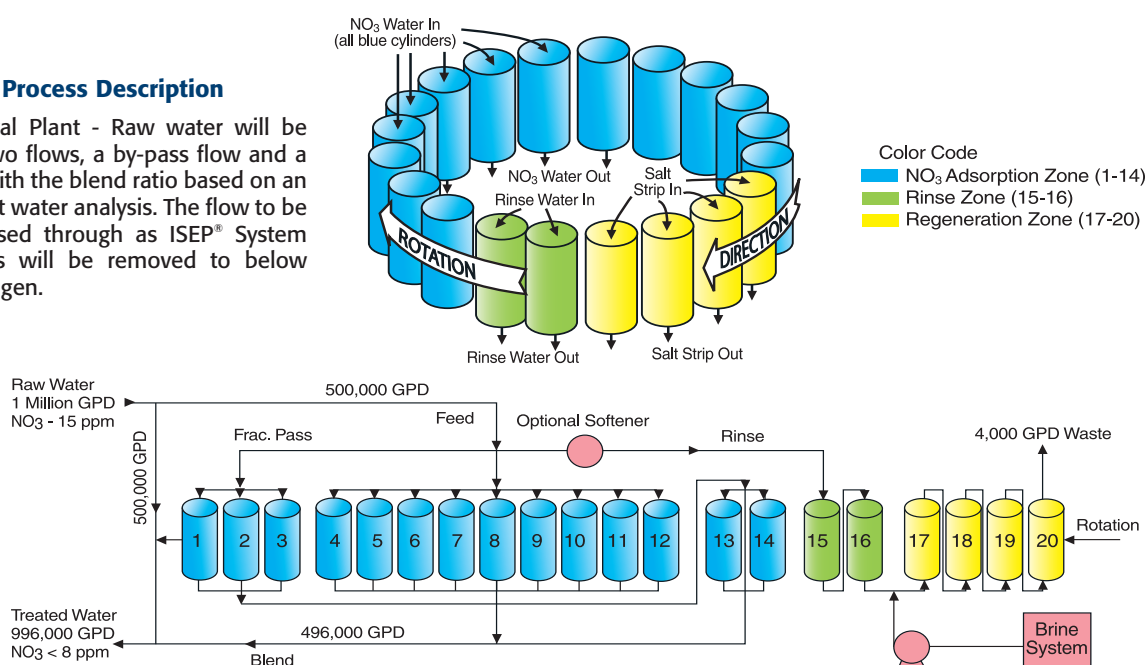
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Typical ISEP® Process Description

Nitrate Removal Plant - Raw water will be divided into two flows, a by-pass flow and a treated flow, with the blend ratio based on an individual plant water analysis. The flow to be treated is passed through as ISEP® System where Nitrates will be removed to below 1 ppm as nitrogen.



Adsorption Zone

The adsorption zone has 14 ports in parallel for single pass flow where the nitrate will be removed. Since the rotation of the ISEP® valve is from the right to the left on the diagram, cells 1-3 will become increasingly loaded with nitrate. To prevent any possibility of leakage of NO₃, the treated water from cells 1-3 is passed through two freshly regenerated cells 13 and 14. This is a safeguard against nitrate dumping as can occur in conventional fixed bed units.

Strip Wash Zone

A small amount of pre-softened feed water is used to strip wash cells 15 and 16 after which it will be used to dilute the 24% brine solution used for regeneration. This two-pass countercurrent configuration is most effective in preventing salt from regeneration being transferred into the product water. The softening process prevents the possibility of calcium sulfate precipitating in the resin bed.

Regeneration Zone

The combination brine and strip wash (8% NaCl) is directed through cells 17-20 for true counter-current regeneration for maximum regeneration efficiency and solids removal from the resin bed.

Equipment Specifications and Capacities

Port Sizes	1/8 inches to 3 inches 3mm to 76mm	Materials of Construction – Wetted parts of the distributor generally consist of two materials - an alloy head and a polymer head. Options include, but are not limited to: Stationary Head – Polypropylene, Polyethylene, PVDF and PTFE Rotating Head – 316SS, Alloy 20, PEEK and C22 (ASTM D575) Cells – Resin chambers can be constructed from a variety of materials to suit the application. The chambers contain top and bottom retention screens to allow upflow or downflow in any of the zones.
Number of Ports	10, 20, 30 standard (other configurations available)	
Flow Rates	5 ml/min to 1, 200 m3/hr	
Operating Pressure	100 psi/6.9 bar max. Mini-CSEP® to 500 psi/34.5 bar	
Operating	Temperature 35°F to 230°F 2°C to 110°C	
Resin Volume	1 liter to 300m3	

Modes of Operation

The Continuous Separator offers a variety of operating techniques. These techniques are defined as modes of operation within each functional zone.

Parallel Flow – Ports are manifolded together for single contact. Useful for high flow rates, high mass transfer rates and lower recovery requirements.

Parallel Flow w/Upflow – Important in applications with high suspended solids.

Series Flow – Employs multiple lengths of cells when mass transfer zone is longer than a single cell height. Also used in stripping or regeneration to maximize effluent concentrations.

2-Pass Series Flow – Combination of parallel and series flow. Used for large volumes requiring complete removal.

Recirculating Flow – Used in stripping when fast fluid velocity is needed.

Other Calgon Carbon Engineered Solutions Products

UV - Disinfection - For the inactivation of Cryptosporidium and Giardia in Municipal Water Systems.

UV Oxidation - Oxidizes small amounts of toxic organic compounds, including NDMA in ground and wastewaters. The Rayox® System and Perox-Pure™ for proven results.

Odor Control - For Removal of Hydrogen Sulfide and VOCs from the air.

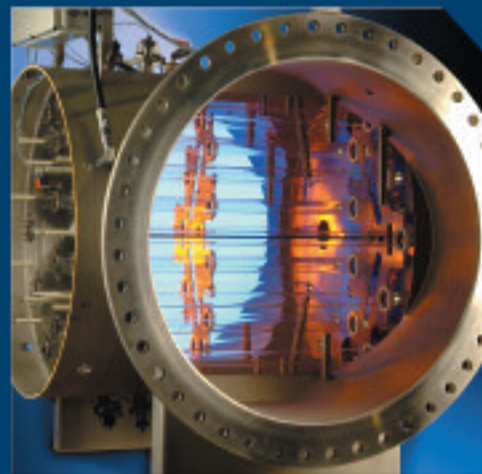
Systems include:

- Phoenix™
- Centaur™
- VentSorb™
- SweetStreet™
- SweetVent™
- Titan™
- High-Flow
- Deep Bed OCU

Calgon Carbon Corporation Company Overview

Calgon Carbon Corporation (NYSE:CCC), and its European operation Chemviron Carbon, is a global manufacturer and supplier of granular, powdered and pelletized activated carbons, UV disinfection and UV oxidation systems, continuous ion exchange and chromatography, innovative treatment equipment systems plus value-added services for the purification of drinking water, treatment of municipal and industrial wastewater, control of odors, pollution abatement, plus industrial and commercial manufacturing processes. The world's largest manufacturer of granular activated carbon, Calgon Carbon has production and operations in North America, Europe, and Asia.

Calgon Carbon has originated cutting-edge purification systems. From purifying water, foods and pharmaceuticals, to separating gas and providing removal solutions for mercury emissions from coal-fired power plants, Calgon Carbon technologies are designed to enhance production efficiencies, minimize waste and remove pollutants – in short, making water and air safer and cleaner.



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