



Nutrition Beverages and Plant Extracts.

BEVERAGES AND PLANT EXTRACTS

The beverages industry is a dynamic, global industry with an increasing demand for high quality products. Fruit juices are generally regarded as very healthy and they are gaining more and more importance in people's life. Golden, haze free apple juice, non-browning pear juice, less bitter and acidic turbid or clear orange and grapefruit juices are requested from the consumer today.

Besides stabilizing or decolourizing juices, natural colours, flavours and polyphenols can be recovered from all kind of fruits or plant extracts. Being of natural origin they can be found in more and more foodstuff.



CHEMRA is marketing a variety of adsorbents, ion exchange resins and chromatographic resins in these markets. Paired with a novel, high performing separation technology to meet the demand for safe and optimal food processing, CHEMRA is increasing the production yield by reducing the environmental impact of the process at the same time.

Typical applications

Major applications of these adsorbents, ion exchangers and chromatographic resins in clear and cloudy juices or plant extracts are:

- Stabilization of apple, pear and grape juice
- Partial or complete decolourization of apple, pear and grape juice
- Patulin and HMF removal
- Pesticides reduction
- Debittering and stabilization of lemon, orange and grapefruit juice by removing polyphenols, Naringin¹, Hesperidin and Limonin < 5 ppm (taste threshold)
- Enhancement of citrus peel extracts and core wash by removing bitterness and astringency
- Acidity reduction and ratio adjustment¹
- Reduction of browning in lemon juice¹
- Recovery of polyphenols and anthocyanins and other bio-active compounds from juice², waste streams and plant extracts
- Removal of off-flavours
- Improvement of sensory properties
- Sugar decolourization for the soft drink industry

¹ Pulp content 0,5-1% max. in single strength juice treatment. Can also be used in combination with membrane processes or in systems with external resin cleaning

² e.g. Pomegranate

PROCESSING

Juices can be either clear or turbid. CHEMRA is supporting both applications. We are trying to offer the most economi-

cal and easy to operate system for both applications.

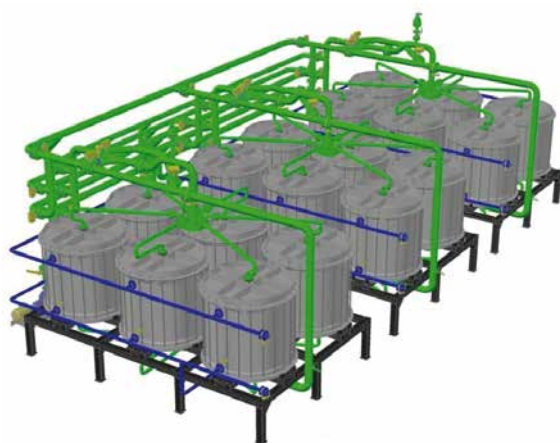
Clear juice and plant extracts

Clarified products are generally treated in fixed beds. In this process, the resins remain in the columns and are regenerated in situ. Traces of haze are removed during backwash or are passing the resin bed.

CHEMRA is introducing the fractal technology into the beverages market. Fractals, well known in the sweeteners industry for chromatographic separations, allow the usage of flat dished columns, giving a minimal mixing of the different solutions is the consequence. With this technology, an optimal distribution of the liquid (juice, water, eluent or regenerant) is ensured by providing multiple outlets over the distribution plate which all have the same liquid flow. For the first time ever, a real plug flow of the liquids can be achieved in juice processing. In extraction processes, the highest concentration of the valuable substances can be achieved with this novel fractal technology.

Cloudy juice

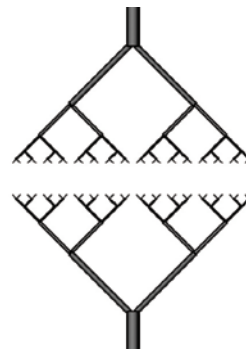
Cloudy juices can be produced in columns, which have enough free space for backwashing the resins after juice treatment (generally 50% free space). Typical cloudy juices are orange, grapefruit and lemon juices.



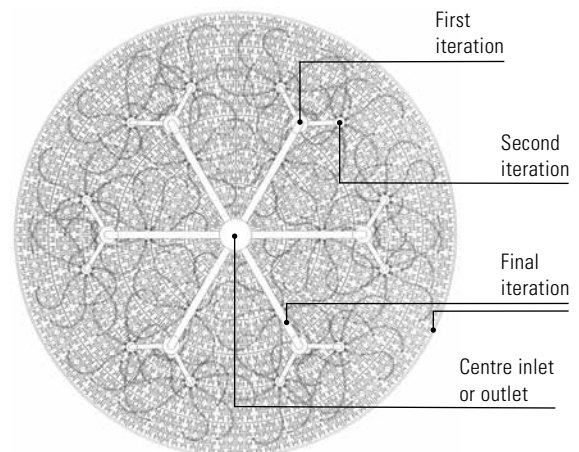
Example of a large 50 mto/h industrial fractal unit in cane sugar decolourization

Advantages of fractal systems:

- Perfect plug flow
- Best separation of liquids
- Lowest product loss
- Lowest regenerant usage
- Highest efficiency
- Lowest waste
- Lowest energy
- Smallest footprint



Fractal distribution principle³



Iterations in a distribution plate - Engineered fractal for fluid distribution and collection in a cylindrical column³

³ With the kind support of Amalgamated Research LLC, www.arifractal.com, and ESCON Engineering Services and Consulting GmbH, www.escon-gmbh.com.

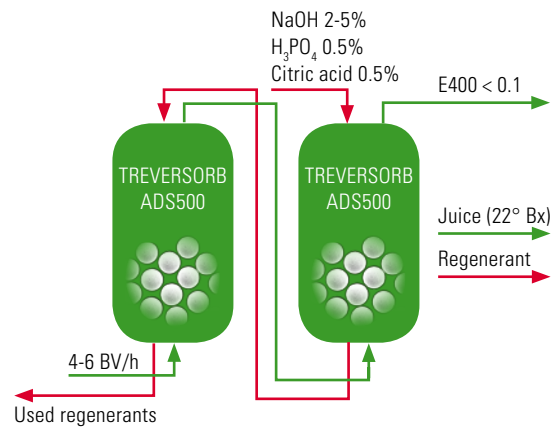
PROCESS LAYOUTS

Juice decolourization

When a juice is decolourized, a double-path through two columns gives a high decolourization performance where one column is acting as a working bed, the other one as a polisher. Generally a third column is in regeneration or in stand-by mode.

If required products as clear as water can be produced⁴.

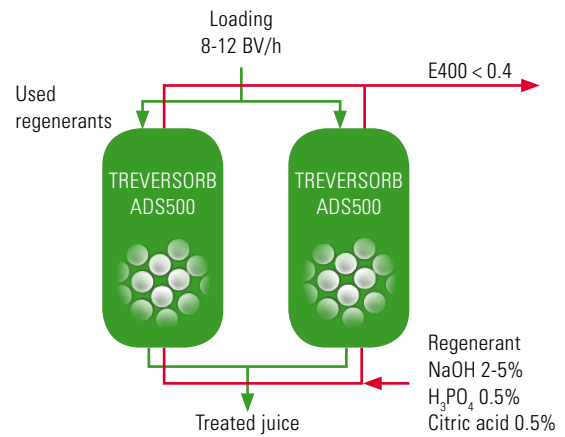
The same process is applied when debittering clear citrus juices or by-products.



Process details⁵: Inlet_{E400} 0.6 – Outlet < 0.1

Juice stabilization

In case a juice has to be stabilized, it is recommended to run the process at a higher flow rate and through two columns in parallel to achieve the highest throughput possible and to reduce the contact time. Depending on the adsorbent used in this process, substances being responsible for gushing can be partially removed as well. If proteins have to be removed please consult our technical expert.

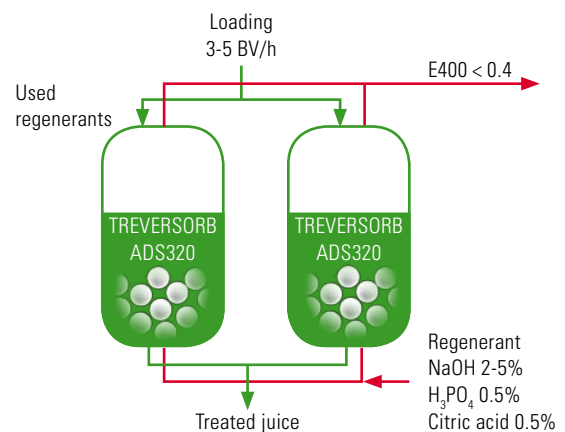


Process details⁵: Inlet_{E400} 0.6 – Outlet < 0.4

Juice debittering

Bitterness in citrus juice is primarily due to the presence of polyphenols, furanolactones and flavonoids such as Limonin, Naringin and Hesperidin. These bitter components can be effectively removed by using a selective adsorption process.

Cloudy juices contain generally a certain amount of fibres which might block the resin bed, which can act like a filter. Therefore the turbidity shall be limited to 0.5-1% maximum, too high solids are clogging the resin beds too fast and lead to a high pressure drop over the resin bed. The length of the fibres shall not exceed 0.5-0.7mm to prevent the build-up of a filter cake on top of the resin bed. These columns have a simple inlet and outlet system to allow the solids to pass through but keeping the resins in the column. Generally these columns have a dished end. During backwash, air or nitrogen is blown into the resin bed to allow the solids to desorb from the adsorbents and leave the resin bed on top of the column⁶.

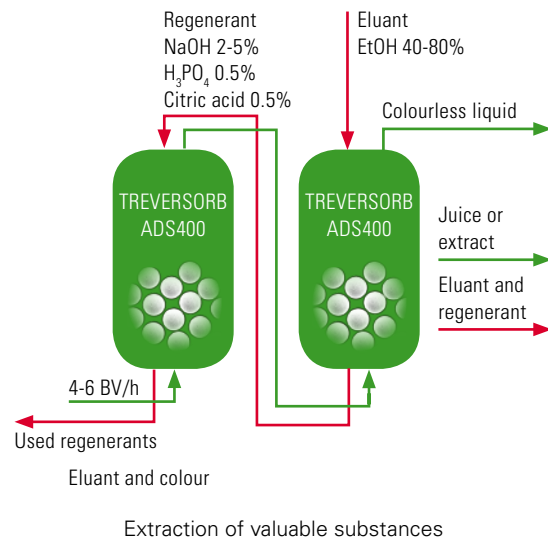


Process details⁵ Limonin: in 15 ppm /out < 5 ppm

Colour and flavour extraction

In case an extraction of valuable substances is required, it is recommended to work with clear starting material. A fractal column design is recommended. One column acts as a working column which should get loaded to a maximum, the second column works as a polisher to reduce product losses and increase the yield. Once loaded, the working column will be generally washed with demineralized or softened water to replace non-valuable substances and sugars, then eluted with Ethanol (generally 40-80% w/w), and subsequently regenerated. The regeneration can be done with NaOH and phosphoric acid at elevated temperatures. In some cases alkaline ethanol is used.

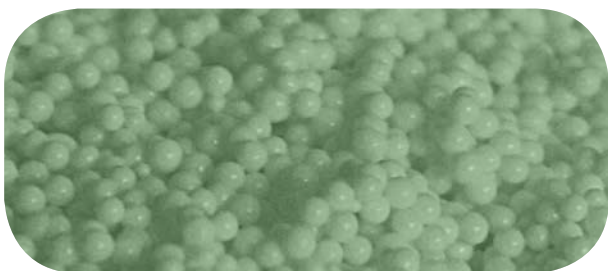
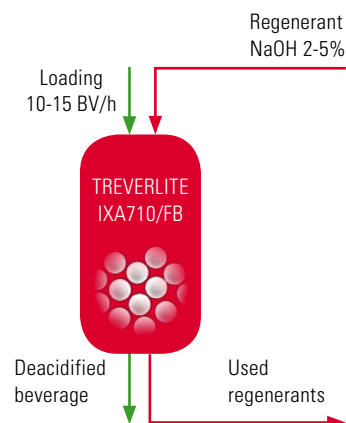
Flavours can be extracted by either eluting them from the adsorbent or strip them with steam if they are volatile enough. The fractal design allows an optimal concentration of the valuable substance in the eluant.



Acidity adjustment

In some cases, the acid content of a beverage is too high. In this case specific weak base anionic resins can be used to reduce the acid content of this beverage. The process is rather simple by passing the liquid through a resin bed, removing almost all free acidity and blending back the beverage to the level of acidity desired. In case the liquid is turbid, the column should have 50% free space for efficient backwash or an external backwash tower to remove the solids from the resin.

These organic acids can be recovered eventually by selective elution of the resin bed with another acid.



⁴ Some colour develops again over time due to the oxidation and condensation of the remaining phenolic compounds in the juice.

⁵ Typical values

⁶ ADS320 can also be used in common cloudy juice systems with external resin cleaning

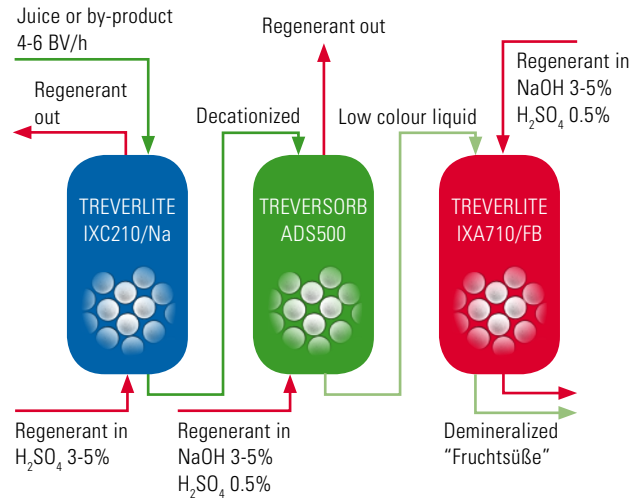
Demineralization of juice and by-products

Demineralized fruit juices or side products are ideal sweet blends for many beverages. In this case both cations and anions have to be removed. In most cases polymeric adsorbents are used as well to remove colour bodies at the same time.

In this process, the first step is removing cations and most proteins through cation exchange on a specific macro-reticular strongly acidic cation exchange resin. The cation exchange resin is followed by a high performing adsorbent. Most colour bodies can be more easily removed from the beverage at low pH.

After the adsorbent bed, a weak base anionic resin is taking out the free organic and inorganic acids.

In case the organic acid content of the beverage is very high, it can be advisable to install a second weak base resin before the cationic resin to remove free acids first.



Sugar decolourization

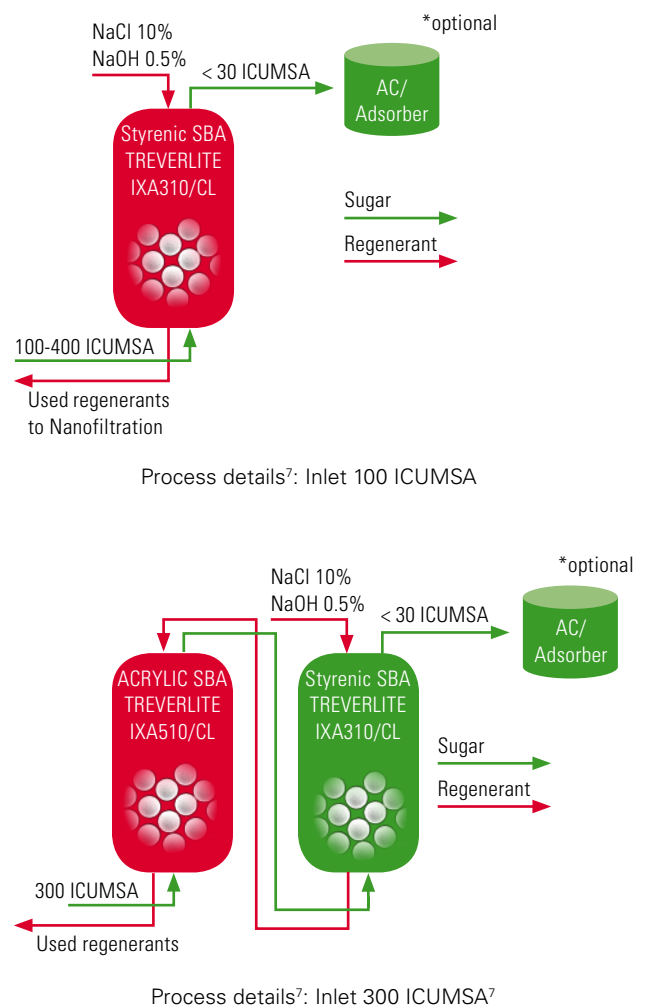
In many countries white sugar for the production of soft drinks is expensive and/or difficult to purchase.

On the other hand slightly coloured sugar generally produced from cane is much less expensive and easier to find. In this case the colour has to be removed to meet the required specification of the soft drink industry. The most economical process is to use specific ion exchange resins to remove these colour bodies.

The figures show two processes to decolourize slightly coloured to medium coloured cane sugar syrups.

In the case of sugar decolourization, the regeneration of the strong anion exchange resins is performed with alkaline brine which can subsequently be recovered by nanofiltration.

For sugar syrups with less than 100 ICUMSA, styrenic anion exchange resins can be used such as TREVERLITE IXA310/CL. In case higher colour loads have to be removed, a combination of styrenic and acrylic anion exchange resins, such as TREVERLITE IXA310/CL and TREVERLITE IXA510/CL, is advisable.



TYPICAL PRODUCTS

| Products | Applications |
|-------------------------------------|---|
| TREVER® SORB ADS100, ADS150, ADS400 | Flavour recovery |
| TREVER® SORB ADS300 | Stabilization and debittering of clear juice |
| TREVER® SORB ADS320 | Debittering of turbid juice ⁸ |
| TREVER® SORB ADS340 | HMF and pesticides removal |
| TREVER® SORB ADS400, ADS700 | Colour recovery |
| TREVER® SORB ADS400, ADS500, ADS510 | Decolourization and stabilization of apple, pear and grape juice, colour recovery |
| TREVER® SORB ADS620 | Colour recovery |
| TREVER® SORB ADS800, ADS810 | Regenerable, virtually dust free synthetic carbon |
| TREVER® SORB XS... ⁹ | Novel adsorbents for off flavour removal and other applications |
| TREVER® LITE IXA310/CL | Cane sugar decolourization |
| TREVER® LITE IXA510/CL | Cane sugar decolourization |
| TREVER® LITE IXA710/FB | Removal of acids |
| TREVER® LITE IXC210/Na | Removal of cations |

The list of adsorbents and ion exchange resins represents only a selection of CHEMRA products. According to particular applications these products might get modified to fit your needs.



Safety

Please note, that polymeric resins can swell significantly between the aqueous and pure solvent phases or when rewetted. Care should be taken. Glass columns and even steel columns can break. Wear glasses when using resin systems. To avoid high pressure build up, an operation in counter current or up-flow through the polymer bed shall be considered.

⁶ Typical values

⁷ For sugars with higher colour loads please consult our technical experts

⁸ Solids 0.5-1% can be also used in common cloudy juice systems with external resin cleaning

⁹ Experimental samples



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