

# beverage processing tool kit.....



By Stephen F. Pease & Jeanine Hurry

*B*everage in a modern sense now incorporates many new technologies that have advanced the art well beyond basic techniques of squeezing, crushing, evaporation and fermentation, for example. Today's technology tool kit includes techniques such as specialized filtration, pasteurization, resin technology and reverse osmosis.

## Spotlight on ion-exchange and adsorbent resin technologies

There is also a variety of readily available and inexpensive new beverage ingredients that have led to a rapid proliferation of advanced beverage types, such as sport drinks and vitamin water. Some recent consumer trends include new additives for health benefits, favorable fat profiles, carbohydrate replacement, new flavors, natural colors and more. Resin technology has played a role in the development of functional and natural beverages.

The ion-exchange and adsorbent resins are tiny porous spheres—approximately 0.5 mm in diameter. Resins are of three basic types:

1. Cationic, capable of adsorbing positively charged substances such as calcium and proteins;
2. Anionic, capable of adsorbing negatively charged substances such as chloride and some colors; and
3. Adsorbents, capable of adsorbing nonionically charged substances such as polyphenols, color, odor and obnoxious tastes. Adsorbent resins specifically are designed to adsorb target substances from particular liquid food streams.

All three types of resins are based on polymers of styrene, divinylbenzene and acrylic acid. The technology is subject to Food and Drug Administration CRF 173.25 and 173.65, and it has been in use for many decades.

Resin technology can be used in batch production, but it is most efficiently operated in pressurized columns, which are designed for industrial scale throughput. The economy of the process, unlike techniques such as activated carbon, derives from the unique ability of the resins to be regenerated for reuse. Resins can be reused hundreds of times. The lifetime of the resin, which is dependent on the application, can be from six months to 18 years. Resin regeneration is accomplished with typical factory cleaning chemicals.

In the 1960s, the beet sugar industry was an early adopter of resin technology. In this application, the resin was used to demineralize the sugar to increase sugar quality and yield. Years later, the technique was extended to demineralization of glucose and fructose. Some of the world's largest installations of

ion-exchange resins utilized water-driven (no chemicals) glucose and fructose separation as part of the process to make high-fructose corn syrup. From a strong sugar-based process application base, a multitude of smaller-scale niche beverage applications have been and continue to be developed.

### decolorization .....

Apple, grape, pear and pineapple juices are decolorized to improve quality. Lower-grade factory juices are decolorized for use as syrup and canning juices. A recent development is the decolorization of malt-based beers for use as flavored and colored malt beverages.

### deacidification .....

Orange juice is naturally high in citric acid, which is an irritant to some. Anionic resins are used to reduce the citric acid concentration to target levels, which creates a marketed low-acid orange juice. The technique is applicable to any acidic beverage.

### acidification .....

By contrast to the previous example, some grape juice and wine lacks sufficient acidity for optimal taste. Additionally, higher acid can enhance color intensity and, in some cases, stability versus tartrate deposits are achieved. The process uses cationic-type ion-exchange resins.

### demineralization .....

Gelatin processing by ion-exchange and adsorbent resins result in transparent, low-odor, shelf-stable products. This gelatin is commonly used in gummy products for children.

Whey waste from cheese processing used to be a troublesome waste problem. But today, due to membrane and ion-exchange techniques, these whey proteins are being used to create high-value products for use in many food products, including baby food.

Citric and lactic acid are large-volume fermentation products that also are demineralized by ion-exchange resins. Lactic acid processed in this way now is used for biodegradable polymer production.

## ARTICLE SUMMARY

**Challenge:** Industrial-scale ion-exchange and adsorbent technology is often ignored in favor of crystallization and distillation when considering food purification objectives.

**Solution:** Resins are regenerable and have a wide range of use—from demineralizing glucose and fructose, to deacidification, debittering and purification.

**Conclusion:** An experienced resin company can reduce development time and expense and speed a product to market. An accelerated optimization process allows the customer to achieve the objective at minimum operation and capital costs.



## PRODUCTS IN ACTION

### purification . . . . .

In most examples, the process objective is to remove objectionable substances. In some cases, however, the customer's objective is to adsorb valuable substances onto a resin and then recover the substance in purified form. These substances are considered high-value and are sold at a premium to food and nutraceutical formulators.

There are a variety of polyphenols substances on the market utilizing beverages, pills, capsules, tea, yogurts and other foods as delivery vehicles. Polyphenols include grape, pomegranate, cranberry and tea extracts. Fermented amino acids such as lysine, tryptophan

and methionine are adsorbed onto cationic resins and then recovered for animal feed use. Vitamins such as E and C are recovered by similar processes.

### debittering . . . . .

There are many applications in which adsorbent resins are used to remove bitterness. In citrus juices, a bitter substance called limonin is removed this way. Brewers yeast, a byproduct from beer making, can be utilized as a soup protein source when the bitter humulone hop is removed. Some of the super fruits may be bitter due to excessive pressing during juicing for the purpose of increased yield. In all cases, bitterness

may be removed by regenerable adsorbent resins, rendering the food palatable with improved flavor.

### nonaqueous . . . . .

In limited cases, ion-exchange and adsorbent resin are used to remove substances from oils. Removal of pesticides from citrus oils is an example that may be expected to proliferate. Trace metals removal from oils to reduce rancidity is under investigation.

### process development . . .

Industrial-scale ion-exchange and adsorbent technology is taught to a very limited extent in university courses; usually this is limited to water softening and demineralization. When an industry investigator is challenged with a real food purification objective, crystallization and distillation are usually considered first. When resins are considered, the skill set needed to perform lab-scale tests through pilot plant to full scale may be lacking. This skill set can be learned readily with inexpensive equipment. In the early stage of development, it is most expedient to work with an experienced resin manufacturer that can help with resin choice.

Beyond initial resin selection, an experienced resin company can help reduce process development time, expense and, perhaps most importantly, speed to market for the products. Ion-exchange and adsorbent resin technology scale up linearly from small-scale operations, resulting in a high degree of confidence for successful performance on capital installations. Good planning of lab test conditions and initial process design targets, including utility requirements and capital costs, usually leads to an accelerated optimization process.

This allows the customer to achieve the purification objective at minimum operating and capital costs.

### future developments . . .

Fruit juices are viewed favorably compared with carbonated sugar-containing beverages. Yet fruit juices have a high calorific content derived from sugars. Future research may include extraction of the "juice flavor and color profile" and then sweetening with low-calorie sweeteners. Activated carbon is widely used for decolorization, but it is becoming more expensive, availability can be variable and its leach metals are damaging to foods. Adsorbent resin as a replacement is increasing. Fruit, vegetable and botanical extracts are promoted today for health benefits, and it is expected that identification of active components will lead to a need for further separations. **WWD**

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