Continuous Processing of RTD Tea & Coffee Beverages

The convenience and availability of Ready To Drink (RTD) tea and coffee is consistent with the changing lifestyle of consumers worldwide. These days, most people have less free time, and consumers are trending towards eating lighter meals on the go. RTD tea and coffee is a primary beneficiary of this trend as consumers are also more health conscious and look for healthier alternatives to traditional soft drinks. RTD beverages have therefore become an increasingly dynamic category. This article discusses some of the key technology innovations driving category growth across the major regional markets for these products.

Tea is currently the second most consumed beverage in the world, next to water. What has helped it achieve this status is ongoing research into its health benefits and continuous work in packaging products to make them more convenient for consumers.

Convenience packaging in the tea and coffee markets began with the invention of the teabag in the early 1900’s. This was followed by instant tea and coffee, iced-tea mixes and eventually, ready-to-drink (RTD) tea and coffee in the 1980s. RTD beverages bring the ultimate convenience to consumers. They need no preparation and can be consumed immediately, anywhere. RTD bottles and cans allow easy distribution and products are available to consumers at various points of consumption, such as fuel stops, fast food outlets, restaurants and vending machines.

In the last five years fast-food chains are also beginning to cash in on the RTD trend. Fast-food giant McDonald’s added sweet tea and a line of iced coffee drinks to its menu in mid-2008. In mid-2009 fast-food chain Subway also added iced tea options to their beverage menu.

Tea is one of the most underdeveloped beverages in the United States (US) and barely compares in market size to other beverage categories, such as carbonated soft drinks, coffee and water. There are also numerous variables available to help drive market growth in the RTD tea market. For example, RTD tea manufacturers are adding fruit flavors, active botanical extracts and varying sweetness levels to their products to differentiate them from the competition. The possibilities are endless for RTD tea manufacturers as they can develop virtually unlimited combinations in the preparation of new products.

The RTD tea market in the US is currently estimated to be worth $1.2 billion and is expected to enjoy double-digit growth over the next five years. RTD tea and coffee represent only a small percentage of overall beverage consumption in the US, especially compared to soft drinks, and is expected to continue growing faster than other beverage categories. In the US, Lipton® and AriZona® dominate the RTD tea category, with sales in 2010 of $423 million for Lipton (a 36-percent market share) and $332 million and 30 percent market share for AriZona.

Assisting RTD beverage companies in making premium quality tea and coffee and revolutionary way to produce premium liquid extracts from coffee and tea slurries. The IES may also be used with a variety of botanicals.

Two key characteristics of the IES are:

1. Ability to capture and preserve key flavor notes for inclusion in the final extract. Aromatic compounds of fresh-brewed roast and ground coffee, or distinctive varietal characteristics of tea blends, are captured at their peak quality by processing slurries at low temperatures and short residence times.

2. Flexibility of a continuous modular system. The unmatched flexibility of this modular approach means that some of the individual modules can be combined with existing processes or installed in stages.

The IES is the first system in the world to couple state-of-the-art flavor-recovery technology, as used by many international flavor houses, with the extraction of soluble solids. Several of the IES modules are unique in themselves. A combination of all of them into an integrated system has no equal in the world for the processing of coffee or tea for the RTD market.

At the core of the system is the patented Spinning Cone Column (SCC), now widely acknowledged as the world’s premier flavor-recovery technology. The SCC is the fastest, most efficient method for the capture and preservation of volatile flavor components, from all kinds of liquid and slurry substances. When a slurry of coffee beans or tea leaves and water is introduced into the SCC, the beverage is literally brewed within the closed system. The SCC effectively performs the dual roles of flavor and soluble-solids extraction simultaneously, thus avoiding intermediate flavor loss or degradation.

The Integrated Extraction System (IES)

The Integrated Extraction System (IES) was specifically designed as a unique and revolutionary way to produce

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**IES System installed for the production of premium tea and coffee concentrates**
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Also unique in the IES system is the Centritherm™ Evaporator, which uses spinning cone technology for evaporation with only one second heat contact time at low temperatures.

In Coffee Slurry processing the IES produces a final coffee extract which is as good as, and in many cases better, than freshly brewed coffee. The GC analysis below shows a comparison between a commercially available coffee extract and one produced by the IES. The high concentration of volatile compounds and dominance of “front-end” characters in the IES sample is attributable to the fact that it was collected from a slurry of fresh roasted coffee, not a liquid extract. In Tea Slurry processing the IES can collect the delicate, floral character of freshly brewed tea by literally brewing the tea within the SCC. A slurry of cold water and milled tea leaves is passed through the SCC. The presence of tea solids greatly enhances the recovery, in terms of both quality and quantity, of volatile compound.

The IES can also be used to manufacture Soluble (Instant) Tea Powder. In traditional soluble tea manufacturing processes much of the typical tea flavor is lost. Major flavor losses traditionally occur during the extraction, concentration and drying steps. Often soluble teas do not contain any of the floral character distinctive of a fresh brew. The IES process first removes the flavor from the tea as it is being brewed therefore protecting color, while achieving concentrations possible in traditional evaporators.

How does the IES work?
The IES couples innovative flavor extraction techniques with soluble solids extraction and comprises the following modules:

**Slurry Preparation module**
This module accepts tea leaves, roasted coffee beans, or other plant material and employs specialized wet milling techniques to minimise flavor loss. Water is mixed with the milled material to form a slurry mixture which is then fed into the Flavor Extraction module.

**Flavor Extraction module**
Integrals to the system is the Flavor Extraction module, or Spinning Cone Column. The SCC collects volatile flavor compounds as soon as they are produced by the brewing process. The extracted flavor is heavily weighted in light, “front-end” compounds generally lost in other extraction techniques and does not require further rectification. It is then stored, avoiding potential damage from subsequent processing, to be added to the concentrated extract at a later stage.

**Clarification module**
The flavor-stripped slurry exiting the Flavor Extraction module (SCC) is a mixture of extract and insoluble solids. The Clarification module is a three-stage process to separate insoluble solids from liquid extract. The first stage removes bulk solids while the second stage removes fine particulates. A third, optional stage polishes the extract to a clarity often described as “bright”. Depending on final product requirements and packaging, the operator can decide how many of these stages are implemented.

**Washing module (optional)**
This optional module is a way of washing spent tea leaves or coffee grounds to increase the yield of soluble solids recovered from the leaf or bean.

**Concentration module**
This consists of the Centritherm evaporator: a spinning cone evaporator with extremely short residence time (around 1 second). High concentration ratios can be achieved in a single pass without thermal degradation, thereby protecting color, while achieving concentrations not possible in traditional evaporators.

**Concentration of Tea & Coffee Extracts**

Today tea and coffee extracts are usually concentrated to higher soluble solids levels for convenience, to reduce transportation and packaging costs and reduce energy consumption in subsequent drying processes. This concentration is normally performed by traditional evaporators, like rising film plate systems, or membrane systems, such as Reverse Osmosis. The Centritherm evaporator, however, offers a number of unique benefits when processing tea and coffee extracts.

These benefits include:
- High concentrations are readily achievable (without product recycle).
- Viscous tea and coffee concentrates are easily handled.
- Exceptionally short residence times (~1 sec on the heating surface). Low operating temperatures (around 50°C). Negligible thermal impact resulting in high quality concentrates.

**High Quality Tea Concentrates**

Both green and black tea extracts are extremely sensitive to heat. Exposure to elevated temperatures for prolonged periods initiates changes to the color and flavor of the extract as well as degrading health promoting “active ingredients”. In extreme cases, this “thermal impact” can also cause caramelization of naturally occurring sugars within the tea extract. In the Centritherm evaporator, the action of the spinning cones reduces the contact time between the heating surface and the tea extract to approximately one second. Temperatures from 35°C can be utilized to protect the healthy properties of the tea extracts, while also ensuring there are no burnt or stewed properties coming through in the flavor of the concentrate.

Extracts from traditional tea extraction systems are generally within the range of 2.5 to 6.2° Brix (2 to 5 % Soluble Solids), although this can vary with tea variety and type of extractor. The Centritherm Evaporator is capable of concentrating such extracts up to 60° Brix (52 % Soluble Solids) on a continual basis with minimal to no damage to the product quality.

**High Quality Coffee Concentrates**

Coffee extracts, like tea, are heat-sensitive. Exposure to high temperatures results in damage to the extract’s color, flavor and active ingredients. The Centritherm evaporator has been shown to have minimal impact on such factors due to the low operating temperatures and short residence times.

Once again, at high concentrations, coffee extracts become extremely viscous. The Centritherm evaporator ensures the...
extract is evenly distributed across the heating surface, via centrifugal force, thus avoiding development of “cooked” or burnt characters in the resulting concentrates.

In the soluble coffee process extracts from traditional soluble coffee multi-cell extraction systems are generally within the range of 7.5 to 25 ° Brix (6.1 % to 20.7 % Soluble Solids). High concentrations are then required prior to spray or freeze drying. These concentrations are achieved using either:

- Two passes through a Centritherm evaporator;
- The Centritherm as a finisher after a traditional evaporator;
- Or a pre-evaporator coupled to a Centritherm evaporator.

When using such methods, the Centritherm evaporator is capable of concentrating coffee extracts up to 70 ° Brix (62.0 % Soluble Solids). A range of Centritherm evaporator models are installed around the world for production of both liquid and soluble coffees and are available for batch or continuous processing.

The IES is a flexible, automated and easy to use readymade solution for the manufacture of RTD beverages. It offers manufacturers the ability to produce a range of products in terms of flavor profiles, clarity and concentration to meet the requirements of customers in any market. Producing high quality aroma and concentrates easily and reproducibly benefits the manufacturer by allowing them to lower their inventory and production costs. The IES can be manufactured in a variety of sizes to meet varying capacity requirements.

The Author
Leon Skaliotis is the Sales & Marketing Director for FT Technologies and is based at the Australian Head Office in Griffith NSW, Australia.

### Table 1: GC comparison results of Tea extract Vs. Tea Slurry

<table>
<thead>
<tr>
<th></th>
<th>Black Tea Aroma from extract mg/liter</th>
<th>Black Tea Aroma from Slurry mg/liter</th>
<th>Factor Difference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hexanal</td>
<td>17</td>
<td>193</td>
<td>11.4</td>
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<tr>
<td>2-Pentenal</td>
<td>14</td>
<td>71</td>
<td>5.1</td>
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<tr>
<td>cis-Hex-2-enal</td>
<td>4</td>
<td>53</td>
<td>13.3</td>
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<tr>
<td>trans-Hex-3-enol</td>
<td>44</td>
<td>85</td>
<td>1.9</td>
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<tr>
<td>trans-Hex-2,4-dienal</td>
<td>27</td>
<td>58</td>
<td>2.1</td>
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<tr>
<td>cis-Linalool Oxide</td>
<td>34</td>
<td>53</td>
<td>1.6</td>
</tr>
<tr>
<td>cis-Hept-2,4-dienal</td>
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<td>237</td>
<td>15.8</td>
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<tr>
<td>trans-Linalool Oxide</td>
<td>128</td>
<td>168</td>
<td>1.3</td>
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<tr>
<td>Benzaldehyde</td>
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<td>Linalool</td>
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<tr>
<td>Pheny lacetaldehyde</td>
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<td>2.1</td>
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<tr>
<td>Methyl Salycilate</td>
<td>63</td>
<td>175</td>
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<tr>
<td>Geraniol</td>
<td>77</td>
<td>180</td>
<td>2.3</td>
</tr>
</tbody>
</table>

**Flavor Extraction from Tea & Coffee**

The Spinning Cone Column is unique among distillation systems in that it is able to process feed streams with high proportions of suspended solids. If a slurry of roast and ground coffee beans (or tea leaf) and cold water is fed into the SCC, it is possible to capture all the aroma, including top-notes, reminiscent of a fresh brew.

Several SCC parameters can be adjusted to control the profile of the essence recovered. This allows flavor houses and beverage manufacturers to produce different flavor profiles from the same source material enabling them to cater to different consumer tastes.