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# Fizzing at the point of dispense

It's perhaps not surprising that the world's beverage manufacturers are looking for new ways to satisfy their customers. One emerging trend is a focus on finding alternative points of consumption, close to the point of use, where personalised drinks are dispensed, mixed and served on demand. Not only does this approach open up the possibility of additional revenue streams but it also plays to the regulatory and consumer pressures forcing a shift to more sustainable supply chains using less plastic and glass.

Local delivery, mixing and dispensing of drinks close to the point of consumption reveals a series of logistical and technical challenges which are not present in more traditional mass volume manufacturing and distribution. One such technical challenge is how to carbonate drinks just before they are dispensed. In this article, two effervescent experts from technology consultancy, Sagentia, explore the technical challenges of in-line carbonation and the on-demand mixing and dispensing of fizzy drinks.

## The 'fizzics' of soda

Making a liquid fizzy is mainly a time challenge. Part fill a closed cylinder with water and the rest with carbon dioxide and the water will eventually carbonate. But it will take a weekend. In the new scenario of just-in-time manufacture, consumers are unlikely to tolerate a wait time of much more than a minute. The big challenge is therefore creating the optimum interface to allow carbonation to happen in a timely way. To do this we generally look at ways to increase the surface area of the liquid in question. There are lots of ways to do this, all of which are application dependent. The following methods can all be used to increase surface area and thus improve the rate of carbonation:

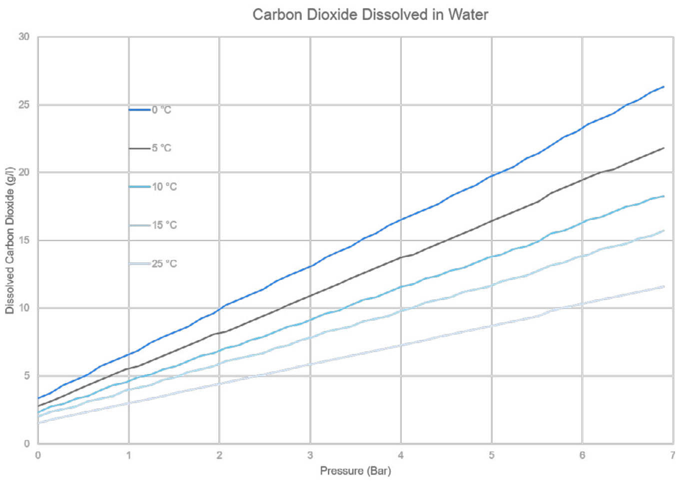
1. Stirred tank contactors
2. Hollow fibre membranes
3. Sparge
4. Spray carbonation
5. Entrainment

## Sparking innovations

Two other factors are key contributors to how quickly a liquid carbonates; temperature and pressure. Why is it that colder liquids absorb $CO_2$ more easily? When dissolving something in a solvent (in this case $CO_2$ into water), the maximum amount it's possible to dissolve will almost always vary with temperature. Most gases have reduced solubility in warm solvents because the kinetic energy of a warm solvent is higher, meaning it's much more likely that molecules of gas will get enough energy to escape.

In a sealed container it's possible to increase the pressure in the headspace. An increased headspace pressure means that there are more molecules of gas in a particular volume. Whereas, as the liquid is incompressible, there's the same amount of liquid. By increasing $CO_2$ pressure, it's possible to effectively 'stack the deck' in favour of the gas and shift the equilibrium in favour of dissolution. Simply speaking, more molecules are pushed in.

The diagram below shows the trade off and relative equilibrium points as temperature and pressure vary.




Real-life experience of the change in equilibrium $CO_2$ content can be seen every time you open a can of soda. Before opening the can, the $CO_2$ content in the liquid is set according to the particular temperature/pressure balance. At the point of opening, the pressure in the can drops significantly whilst its temperature stays the same. The diagram above shows that as the pressure drops the liquid will effectively be super-saturated for the pressure it is at and gas will be discharged until a new state of equilibrium is achieved. In other words, this gas is released as bubbles and we see and hear the fizz. A can of cola is carbonated to approximately 4 litres of gas per litre of liquid so there's a lot of gas to potentially let out. For those of us trying to carbonate, that means there's a lot of gas we have to get in! That 4 volumes equates to 8 grams per litre, so 330ml needs to have 2.64 grams of $CO_2$ dissolved inside.

Of the two methods of improving carbonation, (temperature and pressure) using temperature is the more problematic. For example, putting the liquid into a cold vessel may not allow the liquid to get cold enough, quickly enough. Using a cold element placed into the liquid is also problematic as typically the element will just cause water to freeze and form ice on the surface of the element. It's a tricky balance as the best carbonation rate is achieved at a point close to freezing but it's important not to get to freezing as, not only is it not possible to carbonate ice, but the ice also acts as an insulator which effectively lags the cold source.

## Flatly speaking

So there are a number of options for effectively carbonating drinks manufactured close to the point of consumption. Once carbonated though the beverage may need to be flavoured and dispensed. Either of these processes could impact the fizz quality and need both to be carefully managed. For anyone that has knocked a fizzy drink over the carpet, the huge surface area the drink is exposed to allows it to foam with the gas coming off all at once. Likewise dropping objects into a fizzy drink, particularly a porous object, will also make it foam. It is clear that gentle handling is needed to protect the quality of the product at this stage and to safeguard the customer experience.

Bearing this in mind the exit path out of the mini manufacturing system (or vending device) needs to be as simple, gentle and controlled as possible to protect the fizz. Sharp corners, foreign bodies, sudden changes in the diameter of the system and changes of temperature during the process will impact the drink. Once the dispensing path is known, the amount of de-carbonation likely should be measured and factored in.

## ¬ Memory-less foam

Adding flavour, in the form of syrups, to carbonated water is also potentially detrimental to a quality fizz. Due to hygiene and cleansing issues it is normally best to mix syrups into the drink as close to the exit as possible. However, to effectively mix the syrup through the drink it will be necessary to agitate the fluid with potentially negative consequences for its fizz. Adding to this is the fact that the syrup may be warm which, as we have seen, will also reduce the carbonation.

Likewise controlling bubbles in a mixed drink is difficult due to its tendency to foam. Release carbon dioxide into pure water and the bubbles just pop and disappear. In beer, for example, when bubbles arrive at the top of the drink they are likely to foam as the proteins and other ingredients help to reinforce the bubbles, causing them to stick around for much longer.

As such, controlling decarbonation in some flavoured drinks is critical, as rapid $CO_2$ release can create an awful lot of foam! This issue is an important consideration with the current trend towards naturally produced craft sodas.

On the plus side though is the fact that $CO_2$ foam has no memory. The propensity for a fizzy drink to go flat, once it's been served, is completely dependent on the environmental conditions in which it is drunk or stored. The manufacturing process for creating the required fizz in the first place has no bearing on its behaviour once it is in the glass.

## ¬ Bubbling with enthusiasm for the future

Local delivery, mix and dispense delivered direct to the glass is a mile away from mass volume beverage manufacture and bottling. The technologies and approaches used will need to be adapted and in many cases thought through from scratch. However single-serve production done locally promises to open up a raft of new revenue streams for beverage brand owners. New products and dispensing formats are emerging which meet consumer demand for added convenience and personalised experiences. The shift to just-in-time dispensing will enable the use of fresh, natural ingredients and perhaps a raft of new entrants into the market. With significantly fewer bottles and less packaging in the supply chain the sustainability credentials of a downstream approach are also clear.

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