PPM CARBONATED BEVERAGE FILLERS

The carbonated beverage filler is properly called a Counter Pressure Filler. It's called a counter pressure filler because in order to transfer a carbonated beverage from a holding tank (also called a surge tank) to a container, the container must first be pressurized. The basic process for transferring a carbonated beverage from a surge tank to a container is:
Seal on the container opening
Charge the bottle with carbon dioxide to the surge tank pressure.
Transfer the beverage from the surge tank to the container by gravity.
Relieve the pressure in the container to atmospheric pressure.
Unseal the container.

These are the basic steps required for filling a container with a carbonated beverage. However, most modern day counter pressure fillers have been enhanced to include double pre-evacuation and inert gas leveling. Most carbonated beverages are negatively affected by oxygen. If there is oxygen present in these beverages it will, in a very short time change the flavor profile of that beverage. Double pre-evacuation is a process whereby oxygen is removed from the container to prevent this from happening. This process removes 99.9% of the oxygen present in the container when it enters the filler. Inert gas leveling is the process whereby the container is overfilled with product after which the excess is pushed out utilizing a higher pressure inert gas (CO_2, Nitrogen) than the counter pressure. This provides for very precise fill heights as well as accurate fill amounts in the container.

There are basically two configurations of counter pressure filler. A rotary configuration and an in-line configuration and each has its benefits and its shortfalls. The rotary filler in general is faster primarily because of the large number of valves. However, there are costs associated with this speed. The first cost is the fact that when something goes wrong a large number of containers are lost because the machine cannot be stopped immediately. It must be brought to a stop through a number of revolutions resulting in the loss of those bottles filling at the time. Another cost associated with the rotary filler is the fact that its time functions (pre-evacuation, CO_2 charge, snift) are all based upon hard cams and an ideal speed. In other words, there is only one speed that a rotary travels that has the correct operating times. At every other speed, the times are different. Another cost is complexity. The rotary is by its very nature a much more complex (and expensive) machine. Another cost is associated with its higher speed. In order to operate a rotary at its optimum speed (obviously, there is no point in getting a rotary and then running it slowly, this would defeat the whole purpose of getting a rotary in the first place) a great deal of support must be provided. This support can be in the form of automated equipment such as un-casers, single filers, case packers and automatic palletizers (at great additional expense) or it can be in the form of labor (a great deal of it but only when operating the filler). There is another benefit to the rotary filler. The time between filling and capping or crowning is very short.

The in-line filler is limited in the number of valves it can accommodate. This limits its speed. There is also a time delay between filling and capping or crowning. This is only important for those fillers without double pre-evacuation and a fobber for those products sensitive to oxidation. A little explanation is in order here. Double pre-evacuation assures extremely low dissolved oxygen pickup in the product and a fobber assures that the headspace air is expelled prior to capping and assures “capping on foam”. The two together assure that each bottle of product will have maximum shelf life without oxidation affecting the flavor profile. The benefits of an in-line are its simplicity (low cost) and its flexibility. It can be made to accommodate a large range of container types and sizes. It can be made expandable by adding valves as the need arises. Another benefit is its adjustability of function times such as pre-evacuation, CO2 charge, snift. These times once set, repeat time after time after time. This means that the machine operates with all function times set at optimum, permanently. And if there is a reason to change one or more of the function times, this can be accomplished while the machine is operating. However, that’s not all. There are functions which can be added to an in-line which cannot be added to a rotary such as a pre-snift pause. Some times it is necessary to run product that is not at the optimum operating temperature. When this happens the product often wants to foam over causing “short fills”. A pause prior to snifting will often calm the product and prevent this foaming. And if something should go wrong, an in-line can be stopped at anytime during a cycle with very little lost product.

There are some subtleties involved in carbonated filling. The product temperature should be as close to freezing as possible but should not be freezing. The CO2 flow rate should be capable of very high volume or a buffer tank should be installed between the CO2 source and the filler surge tank.

THE MANUFACTURE & BOTTLING OF CARBONATED SOFT DRINKS

The manufacture of a carbonated soft drink includes a source of clean water, whatever flavor elements are used to establish the flavor profile, sugar or other sweeteners and any coloring agents and preservatives that are intended to be added. All of these elements are added together in a stainless steel vessel fitted with a mixer and mixed. This stainless steel vessel must also be capable of being pressurized to at least 15 pounds per square inch (psi) and of being cooled via a cold room or a jacket which wraps around the periphery of the vessel starting from the bottom and going partway up the tank walls and a glycol chiller. A carbonating stone assembled within the bottom of the stainless steel vessel and a source of carbon dioxide will also be required. After mixing the recipe, the mixture is cooled to about 34 degrees and the vessel pressurized to 15 psi after which carbon dioxide is bubbled in via the carbonating stone connection. Depending upon the volume of liquid in the tank carbonating to 3 to 3.5 volumes will take anywhere from two hours to overnight.

There is a second method whereby the product is pre-mixed in a non-pressure vessel then pumped through a heat exchanger where it is cooled to 34 deg F by a glycol chiller, then passed through a point carbonator (or two point carbonators depending upon the number of volumes of CO2 necessary) then into a surge tank. A point carbonator is a device which inserts CO2 into the product as it flows through it.

Both of the above scenarios are termed “Batch” processes. In the world of Coke and Pepsi the mixing and carbonating steps are carried out automatically in a “continuous flow” process utilizing very sophisticated (and expensive) equipment.

The next step for the first two scenarios above is packaging the product into either glass or pet containers. This process requires another specialized piece of equipment called a counter pressure filler. In order to transfer a carbonated beverage from a vessel where it is stored, into a container, the container must first be pressurized. In its simplest configuration a counter pressure filler charges the container with CO_2 (counter pressure), then fills it with product, then the counter pressure is relieved (allowed to escape to the atmosphere in a controlled manner) then the container is closed (capped or crowned).

DOUBLE PRE-EVACUATION AND ITS APPLICATION TO CARBONATED AND NON-CARBONATED PRODUCTS

Double pre-evacuation is the process of evacuating the air from the container to be filled with a product, prior to filling the container. There are two components to this. The first is air pickup during the fill process. The second is headspace air. Both of these must be dealt with. The first is addressed with double pre-evacuation. Basically, the container is sealed, evacuated, charged with an inert gas, evacuated a second time then charged with an inert gas a second time then filled. The result of all this is to remove 99.99% of the air in the container at the start of the cycle. This process protects the product placed into the container from the effects of oxidation. The second is addressed in one of two ways. For a carbonated beverage, the product should be foaming when the package is crowned (or capped)., For a non-carbonated beverage the headspace air should be evacuated just prior to corking or capping. Oxidation can harm the product at a minimum by severely impacting its flavor profile and at a maximum by destroying it entirely, making it unfit for human consumption. The effects of oxidation can occur quickly, in as little as a week or two. Oxidation affects carbonated and still products equally and the results are generally bad. The oxidation of tea beverages such as tea and green tea and alcoholic beverages such as beer, wine and sparkling liquor progresses with the passage of time after their production, so that their flavor gradually deteriorates. This is mainly due to oxygen entering these beverages in the process of their production. In the case of beer, for instance, if only an extremely small amount of oxygen enters the beer during its production process, the oxygen molecules are partially reduced by electrons transferred from metal (Fe, Cu) ions existing in the beer in its preserved state so that active oxygen is produced. The active oxygen oxidizes a variety of ingredients in the beer, such as isohumulone and alcohols, and generates aldehydes, which is the cause of aging odour, thereby deteriorating the flavor.

There are other methods of removing air from a container. There is nitrogen sparging and there is the liquid nitrogen drop. Both of these methods remove some of the air from the container but since it does this in the atmosphere, air is free to return and it does. The only way to remove 99.99% of the air from a container and be sure it remains removed is double pre-evacuation. If you want great shelf life for your product, double pre-evacuation is the only way to get it.

PASTEURIZATION (BATCH & TUNNEL)

Pasteurization is a process that destroys microorganisms in a liquid medium by application of heat. Louis Pasteur first applied this process to wine making to prevent microbial spoilage, and pasteurization is currently used for the preservation of milk and many other food products. Pasteurizing temperatures in the range of 55–75°C will destroy all vegetative bacteria of significance in human disease, as well as many fungi and viruses.

The PPM Batch Pasteurizer is capable of a programmed thermal ramp where the temperature change per unit time is programmed and also a dwell time at a specific pasteurization temperature is programmed. This flexibility in conjunction with a dense spray assembly assures complete pasteurization of each and every batch. The bottles or jars are fed in on the powered conveyor filling the unit to capacity. Thereupon, the doors are closed and the process begins. Heated water is sprayed over the containers heating them evenly and thoroughly. The containers temperature is ramped up at a rate which is safe for the glass containers. When the pasteurization temperature is reached, this temperature is maintained for the duration of the dwell time after which the containers are cooled at a rate which is also safe for glass. When the final chilled temperature is reached the machine shuts down and is ready for unloading. The same powered conveyor feeds the bottles or jars out. After unloading is complete the unit is ready for another batch.

The PPM Tunnel Pasteurizer is made up of a number of modules (zones) each with its own pump, spray assembly, heat exchanger and temperature controller. The speed of the conveyor belt in conjunction with the heated spray assemblies determines the rate of heating of the containers. The temperature ramps up within each zone and also from zone to zone until the pasteurization temperature is reached. It then maintains this temperature for the proper dwell time after which the cooling cycle begins. All of this happens on a continuous basis as the containers are moving through the pasteurizer on the conveyor belt. The tunnel pasteurizer has the greater potential for speed between the batch pasteurizer and the tunnel pasteurizer.

VACUUM CALCULATIONS FOR EVACUATION AND THE DIFFERENCE BETWEEN A LIQUID RING VACUUM PUMP AND A VENTURI VACUUM PUMP

Q=V x Ln (P1/P2)
Where:
Q = Total amount of air to be removed
V = Volume of reservoir plus connecting pipe in cu. Ft.
P1 = Initial absolute pressure in Torr (mmHg A)
P2 = Required absolute pressure in Torr
Ln = Natural logarithm

Let’s use six 12oz bottles as our volume which in this case would equal 6×13oz=78oz = .081 cuft
Atmospheric pressure in Torr is 760
25” of Vacuum = 120 Torr
760/120=6.333
Ln 6.333=1.846
1.846 x .081 = .149 cuft/min
We want to evacuate the bottles in 1 sec therefore we multiply by 60
.149 x 60 = 8.97 cu. Ft. / min

Basically we need a vacuum pump capable of approximately 10 ACFM

Most single stage, liquid ring vacuum pumps with a 1-1/2 HP motor are capable of 10 ACFM.

As the following specifications plainly show a venturi vacuum pump is totally unsuitable for this application. At 24” of vacuum the maximum flow that can be achieved is 4.5 SCFM. And this flow requires 28 SCFM of air at 80 PSI. That is essentially a 10 HP Compressor.

That means it would take a 20 HP compressor and two venturi vacuum pumps to almost achieve what a liquid ring vacuum pump with a 1-1/2 HP motor achieves. And obviously, anything less will certainly not do the job.

Model #	**Air Consumption (SCFM) @ 80 PSI**	**Vacuum Flow (SCFM) VS. Vacumm Level (”Hg) @ 80 PSI**										
		0″	3″	6″	9″	12″	15″	18″	21″	24″	27″	28″
VP80-200H	7.80	5.40	4.70	3.85	3.30	3.00	2.60	2.10	1.60	1.20	0.60	0.00
VP80-250H	12.50	9.00	8.50	7.85	7.00	6.50	5.30	3.90	2.50	1.80	0.90	0.00
VP90-300H	22.00	20.00	17.00	14.00	12.70	12.00	10.00	7.40	4.90	2.70	1.30	0.00
VP90-350H	28.00	28.00	22.00	18.70	15.90	14.50	11.80	8.10	5.70	4.50	2.25	0.00