Counter Pressure (Isobaric) Filling

A Counter Pressure Filler (also known as an Isobaric Filler) is a device used to fill bottles or aluminum cans from a pressurized or non-pressurized bulk storage tank without losing carbonation. Brewers, sparkling wine makers, and soft drinks manufacturers use these devices to bottle carbonated drinks for retail sale. A primary pressurized (or not pressurized) storage tank suitable for carbonated drinks, a chiller and carbon dioxide (CO2) supply storage bottles are all basic tools needed to operate a counter pressure (isobaric) filler. Other required tools are a carbonating unit, this can be combined with the primary storage product tank, or it can be a separate independent carbonating unit.

Description

A counter pressure filler will fill by means of a filling tube from the top of the bottle with a diffuser that distributes the liquid around the walls of the container while filling, to avoid foaming. The center of the filling tube has a smaller return tube fitted inside that allows the CO2 contained in the pressurized bottle to escape to the top of the filling tank and therefore allowing more product to fill the bottle while the CO2 escapes upwards.

An alternative method (not much used in automatic filling equipment due to its complexity and cost) is to fill from the bottom up, a bit like when a glass is filled in a bar from a beer pump) by means of a long tube that fills from the bottom of the bottle and a crown hermetic seal that seals the bottle once it is filled. All fillers have two inputs - one for CO2 gas and the other being the actual drink supply line. Designs also include a vent to allow venting of gas from the top of the bottle during the filling operation. A valve on each input and the vent let you control the pressure and speed of filling and venting.

How it works

A counter pressure (isobaric) bottle filler works by maintaining constant carbon dioxide (CO2) gas pressure on the beer, wine or soft drink as the bottle is filled. Bottles and drinks are typically chilled to reduce foaming due to temperature differences. The bottle is first pressurized with CO2, the fill valve is opened, and the CO2 is then vented to allow the bottle to fill from the bottom.

The process of counter pressure filling consists of the following steps:

- When on the counter-pressure filler the bottle is first sealed by the filling valve gasket.
- Depending on the product to be filled, (for example this is a must for beer, cider and some delicate wines, where oxidation is a critical enemy of long shelf life), a vacuum is first created inside the bottle by sucking out the air contained in it. This air in in great part made up of Oxygen and Nitrogen. The oxygen must be removed first to allow significantly longer shelf life (TOP is the measure of
Oxygen in a beer bottle and stands for **Total Oxygen Pick-up rate** and is measured normally in ppb (Parts Per Billion, a good range is between 40-100 ppb). **This operation is called Pre-Evacuation of air.** Typically, this operation of pre-evacuation is repeated twice to bring down next to zero the percentage of Oxygen left inside the bottle before the filling operation takes place.

![Diagram of filling system](image)

**The filling moment**

- At this time the bottle is filled by practically only pressurized CO2 at, let’s say, 2.2 to 3.0 bars of pressure.
- Gas has been pumped into the bottle to fill it with CO2 and we have removed harmful oxygen.
- The valve at the top of the filling tank is vented to allow oxygen to escape.
- This also pressurizes the bottle to the filling pressure. The CO2 input is then closed.
- The filling valve is opened, allowing beer to flow into the bottle. Pressure is slowly released by the vent allowing CO2 to escape and beer to flow in and replace CO2 into the bottle. Because the bottle remains pressurized during the fill, foaming is kept to a minimum. When the bottle is filled, the infeed liquid drink valve is closed.
- Remaining pressure is released from the vent and a cap is put on the bottle. For some products a small foaming before capping (for example when bottling beer) is induced by way of a fine warm water spray. This little head of foam displaces any Oxygen that may have settled in the neck of the bottle between filling and capping.
• Once capped, bottles are generally washed externally with a fine water spray when exiting the filler to remove any sugary or sticky residue that may have settled on the outside surface of the bottle. If not removed these sediments would soon become dry and sticky and discolor the bottle and the label.

• Because the bottle is filled at this point, only a small amount of foaming occurs as the cap is put on and sealed.

Chilling product to avoid foaming while filling in counter pressure (isobaric)

Any variation of pressure in any carbonated product, while it is being filled in a bottle or other container, will inevitably cause an expansion of any gas contained in it and the creation of foam (bubbles of gas in the product). The warmer the product the more severe the effect of foaming will be.

Some products are more sensitive than others to the creation of foam, in general the higher the level of proteins in a drink, the higher the sensitivity to the creation of foam. Beer is more sensitive than carbonated water, some beers are more sensitive than others, again depending on the level of proteins contained in the beer. This is one of the main reasons why micro brewers have initial difficulties in stabilising the filling conditions of their products when they begin to bottle their products, as artisanal batches of beer often vary in level of proteins from one formulation to the next and from one batch to the next.

Also, high sugar content non-alcoholic drinks suffer from the same condition, for example Cola products are notoriously sensitive to the creation of foam due to their high sugar content, and Kvass in Eastern Europe is also a malted rye drink that is high in proteins and subject to foaming easily during filling.

The answer to foaming while filling is two fold:

1) Chill the product more if you get foam. Most beers are best filled at 2 C from the storage tanks and reaching 3-4 C in the bottle.

2) Stabilize the oscillations of pressure variations between storage tank, carbonator unit (if used to carbonate the product) and the filling machine.

3) In order to do that we use two classes of tools either fitting a modulating valve inside the infeed connection of the filler to adjust constantly the pressurized flow of product to the filler (this method is however reserved for the higher end of high speed filling machines as it is expensive) or a pneumatic product feeding pump which ensure a smooth and pressure constant feeding of beer or other foaming product to the filler. This is also a rather expensive solution (typically a pneumatic pump costs up to 7 times a centrifugal screw pump of equivalent capacity) but solves a lot of headaches and allows ease of production to inexperienced operators or beginners of the filling process.

4) Adding a non-return valve at the infeed of the filling machine to avoid “waves” of product oscillating back and forward from the carbonator to the filler.

De-aeration of water prior to producing carbonated soft drinks or water

Not to be confused with the pre-evacuation of air from bottles prior to filling, the de-aeration of water is an essential part of the carbonation process of most water-based drinks.
While beer, wine and cider are all saturated to a lesser or greater degree with CO2 as part of their production process (wine, beer and cider produce alcohol from sugar fermentation and release CO2 carbon dioxide in the air) soft drinks or carbonated water are not saturated with CO2.

Water is normally saturated with air. If you don’t believe me boil some water for cooking rice or pasta. The bubbles you see coming out is not steam but bubbles of air that expand and escape the water. Try boiling again the same water the next day and there will be no bubbles coming out, you will see just the normal thermals of the hot water. The air is gone forever.

Therefore, if you tried to carbonate water straight away as it comes out of a tap or a spring, you would have a very poor result.

The water in this case is already saturated with air (which is dissolved in it, the colder the liquid the more gas it will accept before becoming saturated) and as you know when a liquid is saturated with a gas, if you put extra gas in it, the gas does not dissolve - it is rejected, and literally, goes up in the air.

So, what happens when you open a bottle of water that has been poorly carbonated without prior de-aeration? You will have a flash of CO2 and then the water will go rapidly flat. Not a great result for your marketing efforts and for your customers!

To remedy this situation any water that is to be carbonated, either on its own or in preparation to mixing it with fruit and other ingredients to produce a soft drink, needs to be treated to first extract the air dissolved in the water before you can carbonate it.

This is done by adding a second column before the carbonating column unit.

This preparation unit is called a DE-AERATOR UNIT and it consists of a column that will extract the air in the water by means of a vacuum pump

The water is showered down from the top inside a perforated stainless-steel tube, housed inside the main column, in a doughnut (tube in tube) configuration and the vacuum pump, positioned at the top of the de-aerator column takes out the air from the water, which is then sucked out of the column by a secondary pump, and sent to the carbonating unit.

Your water is now ready to be mixed with other ingredients and carbonated and chilled to make your favorite soft drink.

Cheers!

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