



OVERFLOW FILLERS



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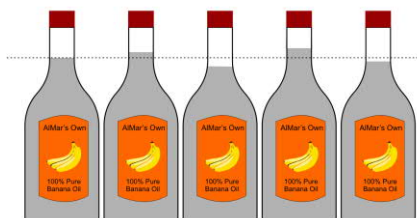
— **There** are several dozen styles of liquid filler available from over 100 US manufacturers. All have advantages and disadvantages and the range of choice may be overwhelming to the buyer who wants to know what kind of filler is "best". This whitepaper will discuss the class of filler commonly called "overflow" fillers. Subsequent whitepapers will discuss other filling architectures.

There are two broad classifications of liquid filler. Volumetric fillers measure and dispense an amount of liquid independent of the container size.

The second class, level fillers, rely on the internal volume of the container. Level fillers fill the product a certain distance from the top of the neck. This distance will remain constant regardless of the container's internal volume. This

internal volume can vary significantly especially for blown glass bottles. If filled volumetrically, the level of product will vary creating an appearance of over and under fill. This is especially true when products are displayed side by side on the store shelf. Level fillers are sometimes called "cosmetic" fillers because they give the cosmetic appearance of a constant fill volume.





Volumetrically identical fill volume



Cosmetically similar fill volume

Level fillers are available in **inline** or **rotary** configurations for fill volumes from an ounce or less to multiple gallons and speeds from 5-10cpm (containers per minute) to 1,200ppm and more. They are available for **still liquids**, as will be discussed here. They are also available for carbonated beverages such as soft drinks and beer. This requires specialized configuration beyond the scope of this paper.

Level fillers are generally simpler than volumetric fillers of similar capacities. This simplicity makes them easier to run, clean, set up and maintain. Simplicity also makes them less expensive to buy and operate.

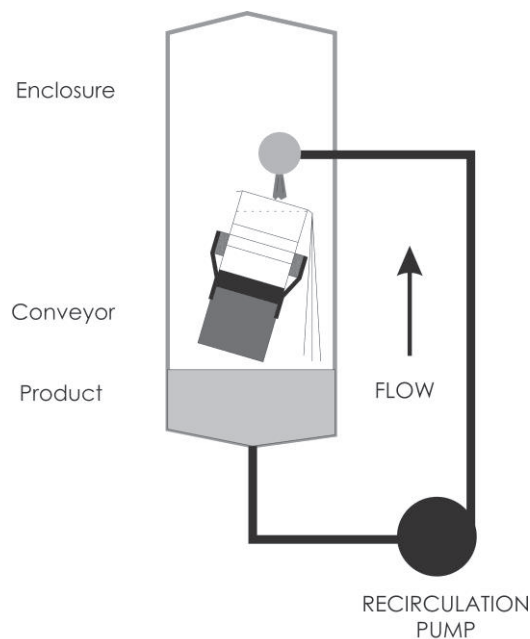
There are two main disadvantages to level filling. One is that the fill quantity is dependent upon the container volume. If the container's internal volume varies, as with glass bottles, the amount of product in the container will vary. If the container volume can be well controlled, there will be little variation in actual fill volumes and product giveaway is minimized.

Level fillers are also not generally suitable for viscous, non-free-flowing products that will not settle quickly to a level surface. Filling in a hot, nonviscous, state may allow a work-around with some products.



This paper will confine itself to **overflow style fillers** as they are the most common and versatile. As the name implies, they fill the container until it overflows. Some can fillers, called

cascade fillers, do this by passing the can under a continuous stream of product, tilting the can to control overflow volume. Excess product runs into a trough below for recirculation.



Cascade Filler
From Packaging Machinery Handbook

These work well and can run at very high (2,000+cpm) speeds. One advantage is that they can be used to top off containers, such as adding brine

to a can of Vienna sausages. A disadvantage is that the container must be washed after closing.



Overflow Fillers

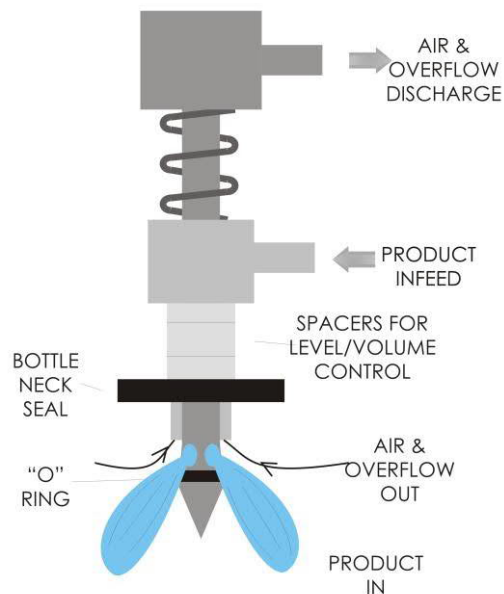
A much more common application uses a **controlled overflow** and **recirculation**. The basic principle of operation is that a filling nozzle is inserted into the container and makes a seal with the container neck. As the nozzle continues into the container neck, the nozzle tip is forced open allowing product to flow into the container via one of two channels. Air is vented through the other. Once the product level reaches the vent, it escapes through the vent and is captured in a tank for recirculation. After

sufficient time for a complete fill has been allowed, the nozzle is withdrawn. As it is withdrawn, the spring closes the nozzle stopping product flow. Foamy products may be a problem in other types of filler but not in these generally as the foam is driven out the overflow and back to the recirculation tank.

Fill level (and volume) is determined by how far the nozzle is inserted into the container as the product level can rise no higher than the overflow vent. Spacers or washers added to the nozzle control the entry depth.

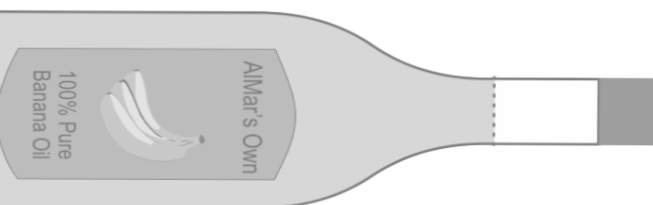


This picture shows the typical nozzle
with inflow and vent:



Nozzles are commonly fabricated from stainless steel but may be made from plastic and other materials as needed.

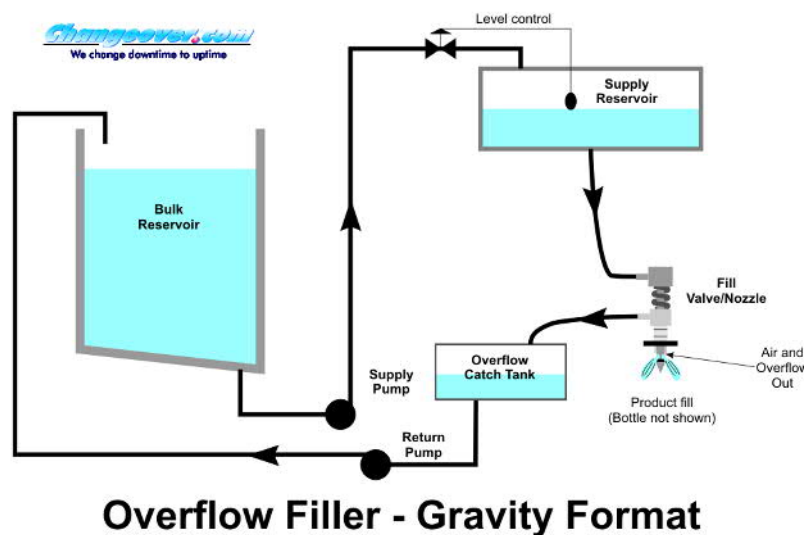
The "O" ring, which seals the nozzle when closed, and the neck seal must be chosen for product compatibility.



Gravity Configuration

Overflow fillers may be **gravity**, **pressure** or **vacuum**.

A gravity configuration is shown below:



This configuration uses a **gravity tank** above the filling nozzles. As the nozzles are forced into the bottles and opened, product flows into the bottle by gravity. The height of the product above the bottle determines the pressure and flow rate. Normally a bulk reservoir with

pump maintains a constant level in the gravity tank. A constant level is important as changes in the head pressure can result in changes in fill volume. This occurs because during filling some bottles, especially lightweight non-round bottles can

expand slightly. When the nozzles are removed, the bottle relaxes and the fill level increases, sometimes to the point of overflowing the neck.

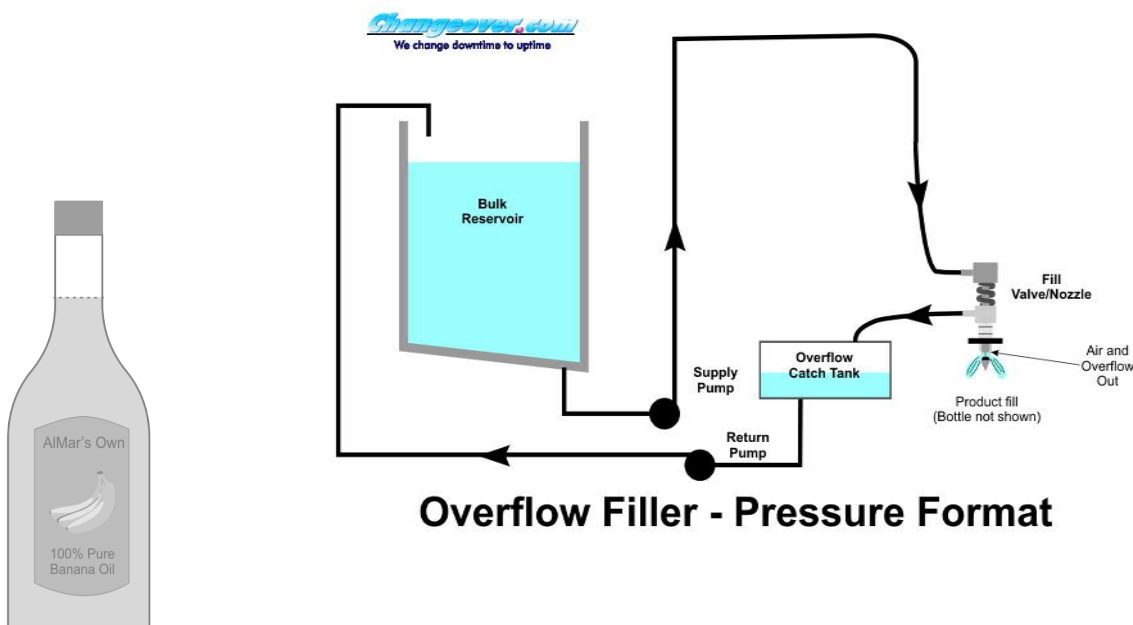
Gravity fillers are generally suitable only for low viscosity, water-like, products. Viscous, products, heavier than a light oil, will not flow quickly enough by gravity.

Pressure Format

The pressure format **replaces** the gravity tank with a pump. This is often a centrifugal, non-positive displacement pump. Diaphragm and other positive displacement pumps can also be used. Pumps should generally be started when the fill nozzle opens and stopped as it closes. This is especially important if a positive displacement pump is used to avoid damage to the system from

excessive pressure.

If the product being filled is a suspension, it may be desirable to keep it moving at all times to prevent the particles settling. This may be done by keeping the pump running at all times with a bypass allowing circulation directly to the overflow tank when not actually filling.



Overflow Filler - Pressure Format

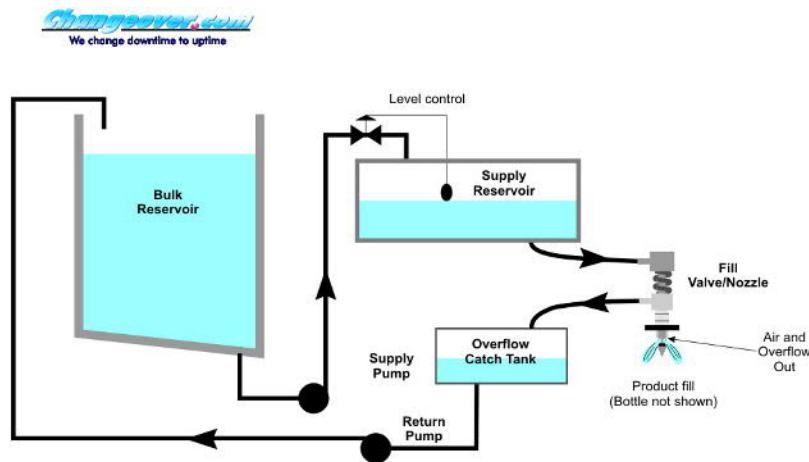


Vacuum Format

The third arrangement is for vacuum filling. This is similar to the gravity arrangement but the overflow catch tank is sealed and maintained **under** vacuum. The vacuum in the overflow tank creates a vacuum in the container when the valve opens "pulling" the product into the container. This can be useful with messy or flammable products such as nail polish. In the event of a damaged neck or other defect preventing a good seal between nozzle

and bottle there will be leakage out in the gravity and pressure configuration. In the vacuum configuration, a damaged neck will allow air to leak in rather than product leaking out.

One drawback to the vacuum configuration is that the container must be rigid. Glass is fine, a heavy plastic bottle may also work well. If a light weight, non-rigid, container is used, the vacuum will collapse the container and little or no filling will take place.




Overflow Filler - Vacuum Format

Gravity Configuration Variation

A variation on the gravity configuration is **continuous motion rotary machines** commonly used for milk and water filling. The product reservoir is mounted above and rotates with the main turret. The filler nozzles are permanently mounted to the reservoir.

The nozzles are similar to the others in that they allow product to enter on one side and air to escape on the other. Instead of overflowing to a catch tank, the air escapes through a standpipe in the bowl above the product level. There is no actual product overflow or recirculation.



If the product is filled cold (<100 degrees F or so) rubber or silicone diaphragms may be used instead of springs. Hot-filled products will require all metal construction with springs and high temperature "O" rings.

Overflow fillers use the bottle neck to push them open either by lowering the nozzle into the bottle or pushing the bottle up to open the nozzle. Some bottles may be too lightweight to resist this downforce and will **collapse**.



In these cases, it will be necessary to use a neck support to prevent collapse. For an inline filler, this may be a "V" block that moves in to capture and support the neck during filling. A rotary filler may use a starwheel to support the neck as the bottle rotates around on the turret. Not all bottles have suitable neck rings so these must be specified when required.

Dripping is another issue that must be addressed. The nozzles themselves have a simple "O" ring seal and should not drip if the "O" ring is in good condition. During filling, they are submerged and the outside will be wet with product when removed. There is not much that can be done other than to catch the drips before they fall on the bottle.

Inline fillers generally use a drip tray that moves under the nozzles as they are withdrawn from the bottles. Rotary machines usually use a semi-circular tray that extends about 45 degrees of the turret. This keeps the tray under the nozzles at all times that the nozzle is not over the bottle.

Overflow fillers can be a good choice for filling flammable products. They are simple enough that they can be built with pneumatic controls and pumps. The absence of electricity makes them inherently safe. This eliminates the **complexity** and **risk** normally inherent in making an electrical machine "Explosion Proof".



Conclusion

Overflow fillers are an excellent choice when the product is relatively low cost and high filling accuracy is required. They are also the first choice when

there may be variability in internal container volume, especially if end users will be able to compare fill levels on the store shelf.

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John Henry is the Changeover Wizard and the author of multiple books on packaging machinery, including *Machinery Matters: John Henry on Troubleshooting*, *Packaging Machinery*, *The Packaging Machinery Handbook*, *Secrets of buying Packaging Machinery* -with Rich Frain, and *Achieving Lean Changeover: Putting SMED to Work*.



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