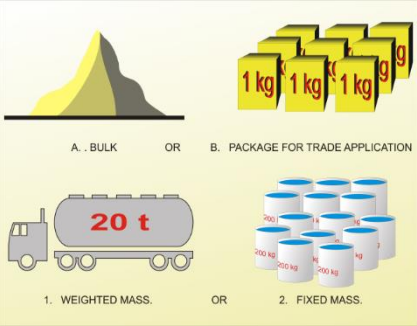
Introduction

This White Paper discusses the challenges, options and solutions for process manufacturers when packaging products for consumers and/or the processing industry. Product can be sold in bulk or in small packages for trade. Packages for trade may be filled according to a **defined weight** or the packages can indicate the **actual net weight** of the content. This white paper focuses packaged liquids in units smaller than 10kg (22 lbs).



Product can be sold in bulk or in small packages.

Purpose of White Paper

There are various validated facts about how packages are filled. This paper explains why it is important to dose the correct amount of material/product – be it small individual packages, bottles, cans or any other container. Challenges regarding accurate filling apply regardless of whether the process is run on a stand-alone small shop-floor level installation, or a "24-7" industrial filling process, remain the same, irrespective of automated or non-automated systems. The filling accuracy has a direct effect on cost and profit margins for any process manufacturer. Over-filling inevitably results in profit loss and product wastage and under-filling leads to unhappy customers and, in some cases, even constitutes a legal violation.

The opening of European boarders resulted in international standards and legislations on trade that warrant a scrutinizing view of accurate, fair and proper filling of packages of any type. The e-mark directive has been brought to life and applies to packages of up to 10kg and is based on average weight.

While the directive is aimed to standardize and control trade in Europe, the e-mark principle is beneficial to any process manufacturer, guaranteeing real savings on raw materials and/or products by over or under filling of packages that leads to savings on the bottom line. But there is more; an automated administered e-mark protocol makes additional checks redundant, saving valuable time and resources. The opportunity to do business in the EU market is an added benefit, directly resulting from filling procedures performed in accordance with the e-mark principle.

A process manufacturer must take great care to maximize ROI by choosing the most appropriate controller system for its purposes to minimize spillage and enhance overall output.

The Filling Process

Controllers for filling processes are designed to ensure the exact amount of package content, based on weight, is dispatched. The filling process is usually found at the end of a production process in any given process flow.

International trade applications make legal requirements obligatory. These rules are defined by the worldwide organization OIML. (International Organization for Legal Metrology) recommendation R61. For

Europe, the MID (Measurements Instruments Directive) is applicable, whiles the NIST Handbook 44, edition 2014, covering mass filling instruments in chapter 2.24, applies to the United States.

The required filling accuracies according to OIML recommendation R 61-1, edition 2004, are as follows:

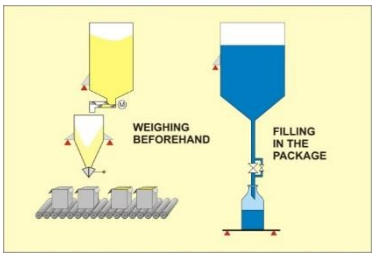
Value of the mass of the fills, F (g)	MPD of each fill from the average of the fills for class X(1) (as percentage of F or in grams)	
	Initial Verification	In-service Inspection
F ≤ 50	7.2 %	9 %
50 < F ≤ 100	3.6 g	4.5 g
100 < F ≤ 200	3.6 %	4.5 %
200 < F ≤ 300	7.2 g	9 g
300 < F ≤ 500	2.4 %	3 %
500 < F ≤ 1 000	12 g	15 g
1 000 < F ≤ 10 000	1.2 %	1.5%
10 000 < F ≤ 15 000	120 g	150 g
15 000 < F	0.8 %	1 %

Maximum permissible deviation (MPD) of each fill

Types of fillers based on weight

Packaging or filling liquids requires a different approach than filling solids and one needs to distinguish between non-automatic and automatic filling processes, taking various elements into consideration. Also, the filling process is distinguished between automatic and non-automatic filling.

During the non-automatic filling process, the final weight of package content is determined by an operator, while during an automatic filling process, this is done by a machine.



Net Filler *GrossFiller*

In accordance with the e-mark ruling, filling packages of ≤10kg is done based on average weight.

We therefore distinguish between 3 major filling processes:

1. Net fillers: the mass is dosed into a container and weighed prior to being dumped into an empty package.
2. Gross-fillers: the mass is dosed directly into the package and then weighed.
3. Filling in accordance with legislated regulations.

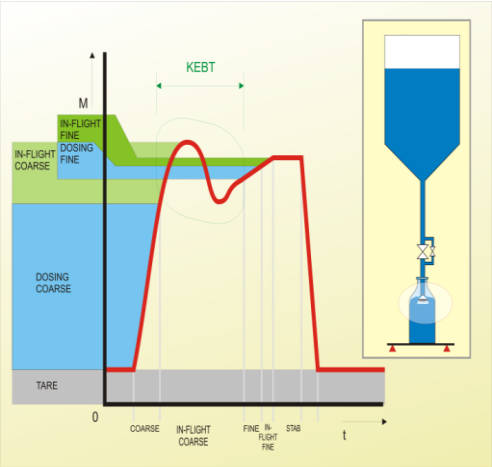


Figure 1: Spreading during fill

A typical problem occurring during a coarse dosing phase when filling liquids is that during the filling process, the liquid moves upwards through the bottle neck with the same speed as the liquid is being dosed.

This can be prevented by using a spreader as shown in Figure 1. This result in spreading the liquid during the filling process and thereby avoiding the "backsplash".

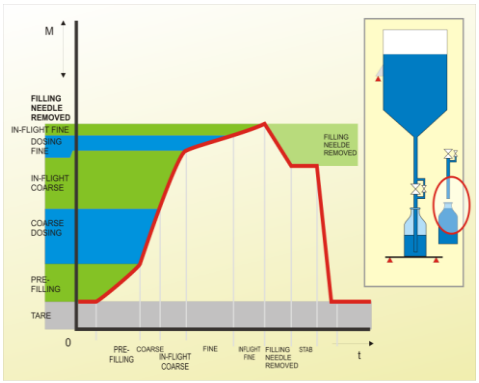


Figure 2: Bottom-up Filling Process

However, some liquids cause foaming when using a spreader. In this case – as seen in Figure 2 - it makes sense to fine dose first, until the bottom of the bottle is covered and then to commence with the usual coarse and fine cycle.

When, in spite of using a spreader, or when starting the fill process on a 'fine' cycle, the liquid still creates foam, the solution is to fill the bottle from the bottom up. This means that the process begins with coarse filling whereby the fill-needle initially descends to the bottom of the bottle and moves upwards slowly as the filling proceeds. This is shown in in figure 3.

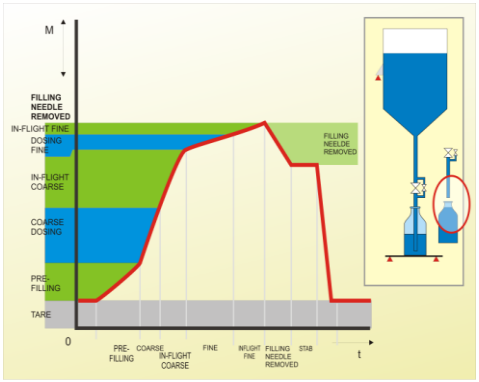


Figure 3: Bottom-up Filling Process

Controllers can regulate this lift relation to the filling speed. If required, this procedure can be integrated in a fine-coarse-fine dosing cycle. The Archimedes principle is responsible for a possible misreading, if the needle is not pulled up in perfect relationship to the fill volume.

The Archimedes principle states that the volume of the needle under the liquid surface multiplies with the density of the liquid, thereby giving an incorrect volumetric measure. Optically, it appears that the liquid volume reduces during the fill process as the needle is extracted from the bottle.

This requires the necessity of a "negative in

flight" correction. In spite of this correction, bottom up filling proves to be less accurate, resulting in a bigger standard deviation. This is caused by differences in the size of the needle under the surface as, for example, when liquid starts sticking onto the tube.

Specific characteristics of filling liquids

Functional requirements: Net Filler Controller

- Positive(in)/negative(out) weighing
- Negative weighing checks stock
- Fill-time control with alarm
- Coarse/Fine dosing with optional analogous speed regulation
- Active tare and in-flight calculation/package – or passive tare and in-flight calculation/lot
- Control on tolerance
- Signal *"weighing ready/release discharge"*
- Store and/or print filling results
- Repeat a filling program

Some desirable but not mandatory extras include:

- Automatic stock replenishment
- Check "closed" status on unloading valve
- Receive "dosing active" signal
- Automatic weigher unload, including package check and vibration
- Restart option

Functional requirements: Gross Filler Controller

This includes bottles, drums, barrels and IBC's (liquids)

- Check for package
- Check if package is empty
- Control fill time and set alarm
- Coarse and fine dosing with optional analogous speed regulation
- "Top-up" fill, if required

- Active tare and in-flight calculation/package – or passive tare and in-flight calculation/lot
- Control on tolerance
- Signal "weighing ready/release discharge"
- Store and/or print filling results

Some desirable but not mandatory extras include:

- Display a "dosing active" signal
- Move filling needle up or down; "bottom-up" filling possible
- Automatic repeat filling program or repeat filling program after release
- Check stock
- Lift or lower packages from conveyor system
- Up/down control of filling needle for "bottom-up" filling

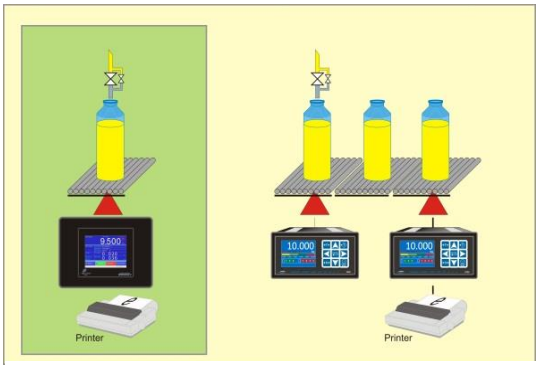
Competitive Advantage

A filtering system that consists of a high internal resolution, in combination with the fastest possible speed, offers an immensely accurate measuring system. It filters out unwanted mechanical noise and takes many more samples per second, inevitably resulting in a smarter way of weighing for any industrial operationing environment.

Certified and approved instruments will give any manufacturer a competitive advantage to distribute products across the European region and promises customer satisfaction, time after time.

Saving on filling time, by means of a fast and accurate process, as well as saving product or raw material due to precise quantity filling, manages waste, spilling and unwanted pollution of the process line. Any system downtime for cleaning and/or maintenance results in undesirable losses in revenue, while product and material savings add up directly at the bottom line.

Product Solution



Sophisticated state-of-the-art filtering processes allow quality measuring instruments to excel in these applications. All instruments should be certified with an accuracy of 10.000d and approved in accordance with the MID directive and OIML recommendation R61. Unique software, based on the e-mark protocol, is available for registration purposes. The software allows for data to be sent directly to a printer or alternatively to a centralized storage base on a personal computer to an e-mark registry. This process eliminates expensive and time- consuming check weighing and allows for easy export into the European Economic Area (EEA).

In the event filling on average weight is not permitted, this feature still offers excellent data analysis opportunities for gathering filling results.

As a matter of course, today's sophisticated instruments are equipped with a high resolution filtering system consisting of an internal resolution of 24-bit, combined with high speed of **1600 samples per second** and offering an extremely accurate measuring system. This scenario will ensure smart weighing in any operatng environment.

Conclusion

Filling packages to correct and specific weight, while adhering to legislative regulations in the most effective way, remains a challenge throughout the processing industry and will vary from one manufacturer to another. Consideration not only needs to be given to over/under filling challenges, but each product – particularly natural products – has its own intrinsic weight and volume that influence the packaging process.

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