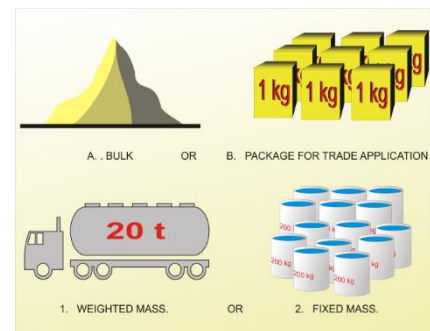## Introduction

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.

Product can be sold in bulk or in small packages.

Purpose of White Paper

There are various validated reasons as 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 24x7 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. Overfilling evidently results in profit loss and product wastage and under filling leads to unhappy customers and in some cases even constitute a legislative fallacy.

The opening of European boarders resulted in international standards and legislations of trade that warrant a scrutinizing view on 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 material and/or product by over or under filling of packages which leads to savings on bottom line. But there is more; an automated administered e-mark protocol makes additional checks redundant, saving valuable time and resource. The opportunity to do business in the EU market is an added benefit directly resulting from filling with in accordance with the e-mark principle.

A process manufacturer will take care to maximize on ROI by choosing the most appropriate controller system for his purposes to minimize spillage and augment output.

The Filling Process

Controllers for filling processes are designed to ensure the exact amount of a 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 O.I.ML. (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:
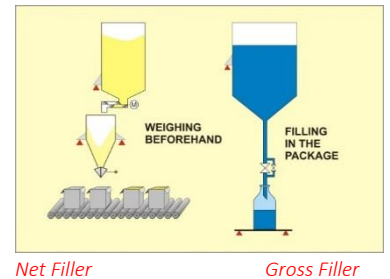
Value of the mass of the fills, F (g)	MPD of each fill from the average of the fills for class X(1) (as percentage of F or in grams)	
	Initial Verification	In-service Inspection
F ≤ 50	7.2 %	9 %
50 < F ≤ 100	3.6 g	4.5 g
100 < F ≤ 200	3.6 %	4.5 %
200 < F ≤ 300	7.2 g	9 g
300 < F ≤ 500	2.4 %	3 %
500 < F ≤ 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

Since packaging or filling liquids requires a different approach to 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   *Gross Filler*

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

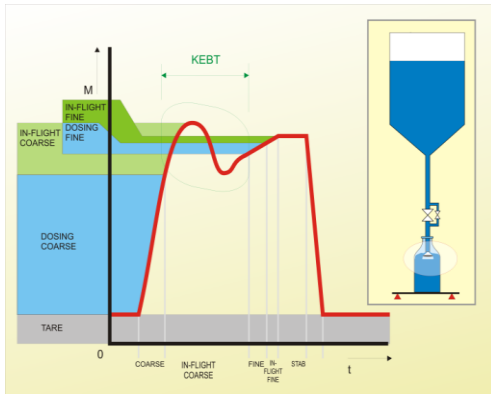## Specific characteristics of filling liquids

Figure 8: Spreading Liquid during a Fill Process

A typical problem occuring during a coarse dosing faze 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 8. This result in spreading the liquid during the filling process and thereby avoicing the "back splash"
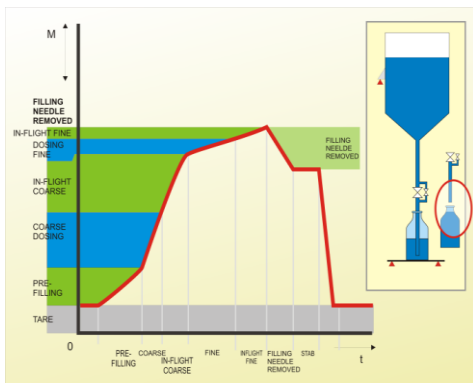

Figure 1: Bottom-up Filling Process

However, some liquids cause foaming when using a spreader. In this case – as seen in Figure 9 - 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 10.
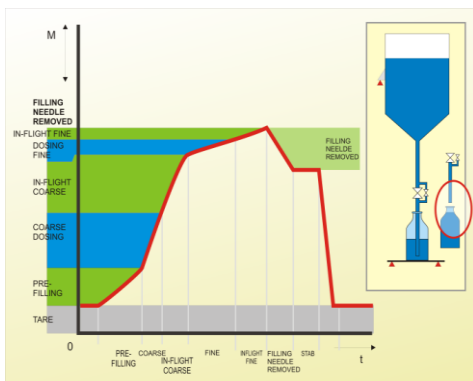

Figure 2: Bottom-up Filling Process

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 prooves 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, liquid starts sticking onto the tube.

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 inflight 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, includes 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.
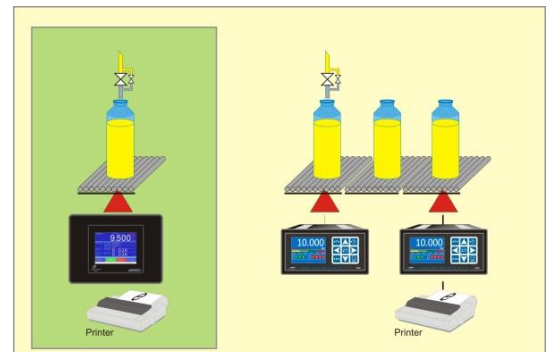
Competitive Advantage

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 much more samples per second, inevitably resulting in a smart way of weighing for any industrial operational environment.

Certified and approved instruments will give the manufacturer a competitive advantage to distribute products across the European region and promises customer satisfaction time on 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 wastage, spilling and unwanted pollution of the process line. Any system down time for cleaning and/or maintenance results in undesirable losses in revenue, while product and material savings add up directly to bottom line.

Product Solution

Sophisticated state-of-the-art filtering processes allow PENKO instruments to excel in these applications. All instruments are 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-marking protocol, is available for registration purposes. The software allows for data to be sent directly to a printer or alternatively to a centralised 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).

Insert an image caption

In an event where filling on average weight is not permitted, this feature still offers excellent data analysis opportunity on filling results.

As a matter of course, PENKO instrument are equipped with a high resolution filtering system consisting of an internal resolution of 24bit, combined with high speed of **1600 samples per second** and offers an immensely accurate measuring system. PENKO is the only way for smart weighing in any operation environment.

Products

SGM800

The SGM800 range of digitizers/controllers is a compact device for use as standalone controllers in network configurations, fulfilling a specific filling function. All models offer 3 inputs and 4 outputs. Depending on the requirements, various models are available including portal Ethernet (TCP) with protocols Modbus, FINS, Ethernet-IP and ASCII, portal RS232/422 with protocol Modbus and ASCII as well as portal Profibus with protocol Profibus-DP. Protocols for printers, web browsers, and configuration-software. PENKO devices can be connected using Ethernet (TCP), CAN, RS232/422 and USB portals.

Model:SGM800 range

Model 1020

The basic indicator is compact, durable and user friendly. It offers 3 inputs and 4 outputs as well as Ethernet and USB communication portals.

As an option the 1020 allows for an analogous output and various communication portals including RS232, RS422/RS485, CANbus and Profibus-DP.

Model FLEX-2100

This three-in-one device combines a stunningly-simple touchscreen interface, a core of sophisticated hardware and a clever calibration system. It offers 8 inputs/8 outputs, communication via RS232, RS422/ RS485, CANbus, Ethernet-IP and USB. Additional options are analogue output and Profibus-DP communication.

The FLEX-2100 also includes all the features of the 1020.

Model FLEX

This most versatile apparatus is an all-in-one compact, reliable and user friendly indicator/controller, suitable for automatic and non-automatic weighing.
 The FLEX has an integrated PLC, offers an expandable number of inputs/outputs including remote I/O's; its communication portals include RS232, RS422/RS485, CANbus, Ethernet-IP and USB, making it highly suitable for complex weighing applications. Digital and analogue inputs/outputs are optional, as well as Profibus-DP communication.

The FLEX range has all the features of the models 1020 and FLEX-2100.

Conclusion

PENKO instruments control the filling system and the checking application all in one. All PENKO systems are "Slave" systems.

Filling packages to correct and specific weights 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.

At PENKO we understand that there is no "one-size-fits-all" solution. We engineer the most efficient way per industry, per product, per manufacturer, working out the best and most effective way this can be done.

For Non Automatic Weighing Systems, Check Weighing Systems, continuous totalizing with Loss-in-Weight and Belt Weighing, discontinuous totalizing with Hopper Weighers, Grading Systems by means of Weighing and Batch Control on Weight for Mixing Plants please read the related White Paper found on our website.

For more information: www.penko.com

US Dealer:

Karl R Cornelius
National Sales Manager
Powerforce, LLC
(865) 318-5532