Engineering White Paper

FILLING SYSTEMS FOR SOLIDS, POWDERS AND GRANULATES, ≤10 KG
PENKO ENGINEERING B.V.

▶ 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 solids, powders and granulates, in units smaller than 10 kg.
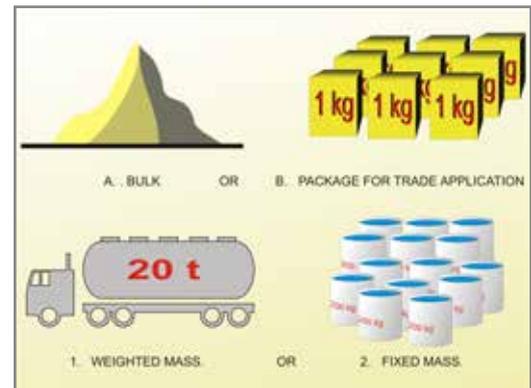

Fig. 1 differences in packages

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, boxes, sacks or any other container. Challenges regarding accurate filling apply regardless of whether the process is run on a standalone 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 constitutes a legislative fallacy. The opening of European boarders resulted in international directives and standards that warrant a scrutinizing view on accurate, fair and proper filling of packages of any type. The prepackages directive 76/211/EEC "on the approximation of the laws of the Member States relating to the making-up by weight or by volume of certain prepackaged products" 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 remove barriers to trade inside 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 in accordance with the e-mark principle. The referred directive prescribes selling of solids based on weight, what makes filling on weight the logic choice. Differences in density have no influence, just like changes in temperature and aeration. Moreover weighing instruments are accurate and approved for these applications.

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.

Some call it process automation – we call it PENKO

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▶ **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 OIML (International Organization for Legal Metrology) recommendation R61. In Europe, the MID (Measurements Instruments Directive) is applicable, while 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 directive MID, 2014/32/EU, appendix VIII, chapter III, table 5, are as follows:

Value of the mass of the fills, F (g)	Maximum permissible deviation of each fill from the average class X (1)
m ≤ 50	7.20 %
50 < m ≤ 100	3.6 g
100 < m ≤ 200	3.60 %
200 < m ≤ 300	7.2 g
300 < m ≤ 500	2.40 %
500 < m ≤ 1 000	12 g
1 000 < m ≤ 10 000	1.20 %
10 000 < m ≤ 15 000	120 g
15 000 < m	0.80 %

For good understanding, this table is similar to those in the OIML, recommendations R61 and R87.

TYPES OF FILLERS BASED ON WEIGHT

Since packaging or filling of solids, powders or granulates, requires a different approach to filling of liquids. One needs to distinguish between non-automatic and automatic filling processes, taking various elements into consideration. 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..

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In accordance with the directive for prepackages, 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. Packaging of variable weights, as an example of irregularly shaped, usually natural, products such as fishes, fruits and potatoes.
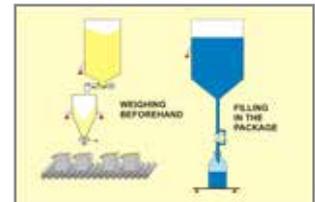

Figure 2
Net Filler   Gross Filler

The weighing accuracy rarely is the problem. In many cases, the scale accurately reflects the deviations caused by the other components of the filling system. The spread is therefore largely determined by the combination of feed rate/measuring speed and product properties. On the basis of a few examples, supplemented with mass/time graphs, we explain the factors that determine the filling accuracy. When the preset weight is reached, the filling controller stops the supply. At that moment there still is material on its way, a screw does not stop at once and a valve does not close immediately. That's why the final weight is above the preset weight. See fig. 3. Limiting this inflight reduces the spread.
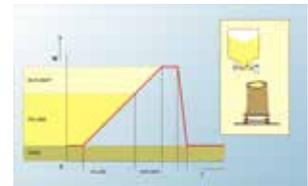

Fig.3 Filling solids with a speed

This brings us to figure 4. With a coarse/fine control, as you can see, the inflight is reduced. So you reduce the fluctuations in inflight or spread.
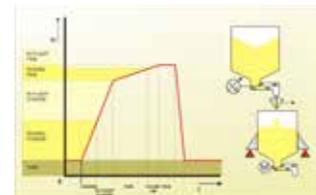

Fig. 4 Dosing coarse and fine

If it is an airy product, it is often necessary to compact the product. This reduces the volume by making the product more solid, so that it fits into the packaging, and the packages can be stacked. In order to avoid influencing the weighing due to the vibrations associated with compaction, it is advisable to temporarily interrupt the dosage, see picture 5. This does not necessarily have to be on the tipping point from coarse to fine. It always is a good conclusion of the filling cycle.
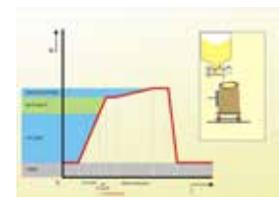

Fig. 5 Filling with interim compacting

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FUNCTIONAL REQUIREMENTS: NET FILLER CONTROLLER

This includes sacks and boxes

- Positive(in)/negative(out) weighing
- Negative weighing with stock checking
- Fill-time control with alarm
- Coarse/fine dosing with optional analogous speed regulation
- Active in-flight calculation/package – or passive inflight calculation/lot
- Control on tolerances
- Signal "weighing ready/release discharge"
- Store and/or print filling results

SOME DESIRABLE BUT NOT MANDATORY EXTRAS INCLUDE:

- Automatic stock replenishment
- Check "closed" status on discharge valve
- Display a "dosing active" signal
- Automatic weigher discharge, including check package present
- If necessary, compacting in the package
- Restart option

FUNCTIONAL REQUIREMENTS: GROSS FILLER CONTROLLER

This includes sacks and boxes

- Check for package present
- Check for package 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 tolerances
- Signal "weighing ready/release discharge"
- Store and/or print filling results

SOME DESIRABLE BUT NOT MANDATORY EXTRAS INCLUDE:

- Display a "dosing active" signal
- Automatic repeat filling program or repeat filling program after release
- Check stock
- Lift or lower packages from conveyor system

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▶ **COMPETITIVE ADVANTAGE**

A filtering system, using a measuring system with high internal resolution in combination with the fastest possible speed, offers an immensely accurate control 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 undesired 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, providing an e-mark 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 as an e-mark registry. This process eliminates expensive and time consuming check weighing and allows for easy export into the European Economic Area (EEA).
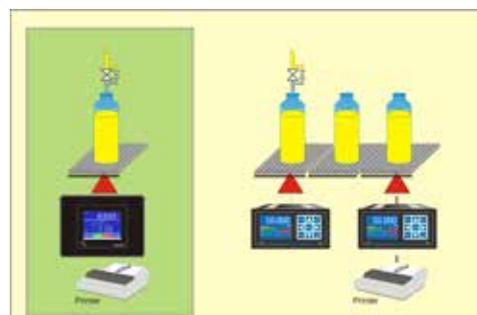
In an event where filling on average weight is not permitted, this feature still offers an excellent data analysis opportunity on filling results.

As a matter of course, PENKO instruments are equipped with a high resolution filtering system using a measurement system with an internal resolution of 24bit, combined with high measuring speed of 1600 samples per second, what results in an immensely accurate controlling system.

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SGM800

The SGM800 range of digitizers/controllers is a compact device for use as standalone controllers in network configurations, fulfilling a specific filling function. Models offer either 3 inputs or 4 outputs except for the SGM810 which only has one analogue output. 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 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, CAN Interface 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, CAN interface, Ethernet-IP and USB. Additional options are analogue output and Profibus.

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, CAN interface, 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.

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▶ **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 specific weight what influences 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