Engineering White Paper

MIXING CONTROLLERS FOR BAKERIES AND THE MANUFACTURING OF RAW MATERIALS FOR BAKERIES PENKO ENGINEERING B.V.

INTRODUCTION

This White Paper discusses the challenges, options and solutions for manufacturers creating food mixtures, such as out dough and dough products, bread, cookies, pasta and pastry out of multiple ingredients, raw materials.

PURPOSE OF WHITE PAPER

…… is to explain why it is important to create high-quality flour products for human consumption in the correct amount. Whether a dosing system is automated or non-automated, or whether it is of industrial proportion or simply a small system on laboratory level, similar challenges regarding accurate dosing apply which have a direct effect on cost and profit margins for the process manufacturer. Overdosing as well as under dosing directly influences the ratio between the components. As a result a wrong composition, so an end product with a poor quality, even might cause disapproval of the batch. So inaccurate dosing results in rejected batches, what means profit loss, product spillage, environmental pollution, delayed shipments, unhappy customers and may even cause a threat to the safety of food, so public health….

In addition to such losses, there is the added argumentation of operating inside a quality management system, the international legislation on product safety, such as hygienic requirement (EHEDG), what explains the need for a tracking and tracing system from the beginning to the end.
The advantages of fast weighing (PENKO instruments weigh at 1.600 samples per second) are faster throughput, less spillage and a consistent quality– leading to fast ROI.

RUDIMENTARY

Flour products are made in a large number of different types and compositions, ranging from daily bread to luxury pastry. For example, a distinction, requiring special mixtures, must be made between:

- bakery ingredients, ie semi-finished products, for further processing by „warm“ bakers.
- bake-off bread, a semi-finished product as well.
- bread, in various forms, from wedges to a loaf, and from white to whole wheat bread.
- cookies, from small to large, in countless varieties.
- pastries, works of art, from macarons and apple pie to Cornish pastry.
- pasta, by example spaghetti, macaroni or tagliatelle.

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Broadly speaking, the preparation takes place with the:

- supply and intake of raw materials.
- storage of raw materials.
- dosing of the variety of flours.
- dosing by example of bread improvers, water and/or milk respectively milk powder, sometimes on a separate weigher.
- mixing, during which frequently the yeast or leaven is added.
- moulding of the product.
- holding process in a proofer, necessary for the doughs to which yeast has been added.
- baking process.
- make up of pastries and tarts, by example with cream, fruits, chocolate, marzipan or nuts.
- eventually the packing and making the baked product fit for shipment.

The way of delivery of the finished product differs greatly. Many “warm” bakers weigh and pack the product in the store. Supermarkets prefer pre-packaged goods, where loafs and pastries are sold per piece or number and cookies usually by weight in small packages (≤ 10 kg).

BACKGROUND ON DOSING CONTROL

Controllers for dosing processes are designed to ensure the exact amount of mass per raw material is dosed. This dosing process is usually found in the “kitchen” of any given process flow. Apart of the legal and normative requirements for food for human consumption, depending of the destination of the finished product every mixing plant might have its own quality requirements, laid down in a management system and accordingly controlled by qualified measuring instruments. The ever increasing costs of materials, growing stringent environmental regulations, consistent quality and tracking and traceability, are insisting that process industries pay more attention to their quality conformity. The basic and most reliable measuring method to warrant all of the above is still defined by weight, regardless of whether the product is a liquid, a solid mass, granules or a powder, and gasses.

Weight provides, from a chemical point of view, correct data. Each type of molecule has its own specific mass. So by weighing you are in a way counting molecules. It does not matter what type of mixture you are preparing, the weight always is the truth. This way you are excluding a number of factors, such as:

1. temperature influences (expansion respectively shrinking).
2. compressibility.
3. changes in density.
4. aeration.

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As a standard any component should be dosed within a specified accuracy. This means the size of the smallest component in a batch is critical. Below a certain value a second weigher with a corresponding weighing capacity has to be selected.

The reception and intake of raw materials.

Raw materials used in large quantities, usually flours, are supplied in bulk and conveyed pneumatically into a silo. The flour usually is weighed in advance by the supplier, the miller. As it concerns a commercial transaction, this weighing system must comply with the Metrology Act and be approved accordingly. Proper monitoring of transport to raw material silos is important. Only then a good raw material administration is possible and an undesirable contamination of raw materials prevented. Essential information that belongs in the raw materials administration is the name of the raw material, after laboratory approval or mentioning the supplier the lot number, and the date and time of arrival. When a laboratory check takes place, it may be practical to have an interim storage. After release by the laboratory, the raw material can then be transported to the dosing silo, see photo 1.

Photo 1. A group of silo's for storing multiple types of flour.

Furthermore, an available silo for incoming raw materials can be selected by means of a silo register. The transport to the available silo with a link to the formula is automatically controlled with a routing system. Raw materials to be dosed in small quantities, such as yeast, bread improvers and milk powder, are usually supplied in sacks, buckets or big bags, see photo 2.

Photo 2. The input into the process of smaller components, supplied in big bags.

If an automatic dosing of these small components is chosen, further automatic processing is possible after releasing the big bag or cutting the bag, see figure 1.

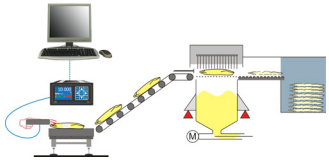

Figure 1. The input into the process of raw materials supplied in bags.

When raw materials are added manually to the process, a manual dumping cabinet, see photo 3, is required.

Photo 3. A cabinet for the manual input of raw materials.

As it concerns powders, the hand dump should be provided with a suction. Furthermore, these dumping points can be designed for weighing and provided with an operator terminal, optionally combined with a barcode reader, so that all desired dosing operations can be read by the operator and be checked and registered via the system. This way it fits seamlessly into the tracking and tracing system.

The dosing of the main components, weighers for the various types of flour.

A detailed description of the dosing process can be found in the white paper „Mixing chamber controllers for the processing industry". The various types of flour are dosed one by one. Depending on the size of the installation, this can be done centrally for several production lines using pneumatic transport, see figure 2.

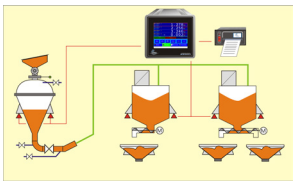

Figure 2. The pneumatic internal transport of batches of flour to multiple processing lines.

Alternatively, the required types of flour can be weighed in a weighing bunker and then transported to the kneader by means of a transport trolley, see figure 3.

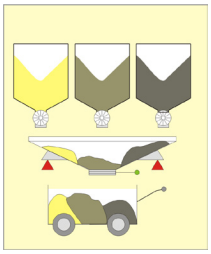

Figure 3. Weighing of flour before internal transport.

Alternatively, the flour can be dosed directly into the transport trolley by placing it on a weighing platform directly under the dosing silos, see photo 4.

Photo 4. A weighing platform for weighing raw materials.

In many cases it is practical to dose the types of flour directly into the mixer, see figure 4.

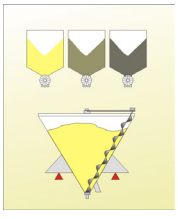

Figure 4, The dosing of several types of flour, directly into the mixer.

Another option is of course to position a mobile mixer, see photo 5, on a weighing platform for dosing and release it after mixing by example in the moulding machine.

Photo 5. A mobile mixer.

Dosing of small components, such as fat, water, milk or milk powder, yeast and egg contents.

These small components are added to the mixture in relatively spoken small quantities. In connection with the accuracy, this is therefore dosed in a small scale, depending on the installation, automatically or manually on a small weighing platform, see photo 6.

Photo 6. A built-in weighing system for manual dosing.

By means of an operator terminal, such a weighing arrangement can be perfectly integrated into the entire process, including tracking and tracing.

See figure 5. The selection of components can easily be monitored with bar code readers or transponders. This way a complete and comprehensive report of the entire dosing processing, of automatic as well as manual actions, is created, with the programmed and actually dosed weights, the component names and eventually the lot numbers.
The small components are then added directly or with a time delay to the mixture

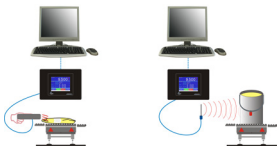

Figure 5, The identification of products by means of bar codes or transponders.

The mixing process.

The modern technology allows dough mixers and kneaders, see photo 7, made weighing with an acceptable accuracy in spite of the relatively spoken high dead weight.

Photo 7. A dough kneader.

That's why, as already mentioned above, the dosing process can take place completely partly in the mixer. Mixing processes are often a combination of dosing cycles, time delays, controlling the mixer with one or more speeds, eventually manual dosing or additional actions such as sampling and the discharge process. Moreover, the sequence will differ per type of dough, so formula. For manual operations it is practical to provide an operator terminal at or near the mixer, see photo 8.

Photo 8. An operator terminal, combined with a mimic diagram.

After execution and approval all actions can be recorded in the production protocol, complete with the weight information, and can be found in the tracking and tracing file. During intermediate dosing in the mixer it is advised to stop the stirrer for a while. Due to the absence of unrest on the weighing signal, the weight can be perfectly checked what means an exact switch off is guaranteed. The weighing system can monitor the empty weight of the mixer too, so the discharge procedure can be carried out efficiently, including the monitoring of the open and closed limit switches of the mixer closure.

The further process up to and including the finished product.

As soon as the dough is ready, it undergoes a number of treatments, depending on the desired end product. They take place in the:

- moulding machine.
- proofer.
- oven, the baking process.

Thereafter, in particular pastry undergoes further finishes, such as spraying with whipped cream, applying glaze and filling it in layers, as an example with fruit, and the like.

The treatment of the finished product.

Products, such as cakes, are usually packed when selling. The sale of cakes as well of loafs takes place per piece, but each must be equal to or heavier than a specified minimum weight. For the verification of this we refer to our white paper „Check Weighing Systems".

On prepacked products, such as cookies, the number and/or weight must be specified. In the second case, the Metrology Act applies. If you use a check weighing system for checking weight, you will find the relevant information in our white paper "Check Weighing Systems". For filling of packages for trade applications by weight, you can rely on our white papers „Filling Characteristics", „ Filling Systems for Solids, Powders and Granulates" and, as it usually concerns packages ≤ 10 kg, „Prepackages".

Prefer prevention above curing.

Where most quality control systems aim to register exactly and eventually cure afterwards the mistakes made, PENKO weighing goes for prevention. The connection between the BCS quality control system and the dosing controller(s) takes place on the following areas:

- production planning, see photo 9.
- formulas.
- reporting.
- administration of used raw materials.
- control of the raw material stock.
- production orders.
- establishment of the sequence in the formula.
- reporting of the raw material day program.
- register of eventual manual actions.
- traceability of the mix.

By means of such software modules, see figure 6, the personal computer is the ideal man/machine interface and a solid start for a quality control system. Moreover the management possesses at any moment full information about the production process and the material flow.

Photo 9. The computer screen with production information.

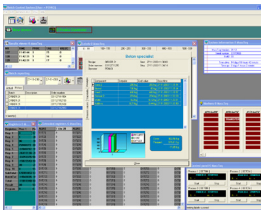

Figure 6, A screen overview with process information.

DOSING/MIXING SOLUTIONS

Functions, FLEX-2100 and FLEX:

- Positive(in)/negative(out) weighing
- Dosing net or gross
- Coarse/fine dosing with optional analogous speed regulation
- Active taring and in-flight calculation
- Control on tolerance
- Dosing time control and set alarm
- Mixing time control
- Repeat a dosing sequence
- Control of all kind of analogous signals
- Control of manual additions
- Manual interventions with interlock
- Monitoring of valve positions
- Overload protection
- Level control of raw materials in silo's and/or tanks
- Routing of raw materials
- Routing of premixes
- Additional processing, such as mixing time
- Control of other measured values, by example humidity and pressure
- Store and/or print dosing results
- Automatic repeat of the dosing/blending sequence or repeat program after release

BCS extra's include:

- Registration of operators
- Raw material stock control
- Silo register, material per silo
- Library with formula's
- Day production programs, number of batches per formula and required sequence
- Interruption facility in the day program
- Tracking and tracing
- Batch reports
- Report of additional process parameters
- Alarms registration
- Macro's, preprogrammed standard process sequences

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COMPETITIVE ADVANTAGE

A high resolution filtering system combined with high speed – high accuracy measuring, offers smart weighing results for any operation environment.
All instruments are designed and manufactured with an accuracy of 10.000d. The combination of measuring at high speed (1600 conversions/s) with a high internal resolution (16.777.216), smart filters and sufficient computing capacity, make the SGM700, 1020 and the FLEX range suitable for any dosing, mixing and blending application. The combination of the high resolution and conversion speed guarantees the best achievable weighing accuracy, even when dosing at high speed, and thus prevents wastage because of wrong compositions.

PRODUCT SOLUTIONS

MODEL SGM700

The SGM700 range of digitizers is a compact device for use as standalone converter between the load cell(s) and any PENKO controller. A selection can be made, depending on the model, out of 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 between PENKO devices are available on Ethernet (TCP), CAN, RS232/422 and USB portals.

Photo 10. The digitizer type SGM700.

MODEL RIO700 AND RIA700.

Type RIA700 and RIO700 are universal, compact, remote I/O sets, meant as extension for the controllers FLEX and FLEX-2100. For mapping to the controller no software changes are required. The display shows the live input and output status. When the connection fails, the display shows an error and the outputs are switched off. The RIO and RIA 700 are easy DIN-rail mountable. They can be used single or as a buslink system. Up to 40 RI0/RIA's can be coupled into one buslink system. RIO700 offers 8 digital inputs and 8 digital outputs, RIA700 4 analogous inputs and 2 analogous outputs.

Photo 11. I/O set RIA.

PENKO
an ETC Company

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 communication portals including RS232 and RS422/485 with protocol Modbus and ASCII as well as optional portal Profibus with protocol Profibus-DP. Protocols for printers, web browsers, and configuration software between PENKO devices are available on CAN, RS232, RS422/485 and USB portals

Photo 12. The indicator type 1020.

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, an integrated plc, communication via an Ethernet (TCP) portal with the protocols Modbus, FINS, Ethernet-IP and ASCII, portals RS232, RS422/RS485 with the protocols Modbus and ASCII. Protocols for printers, webbrowsers and configuration software between PENKO-instruments are available on Ethernet (TCP), CAN, RS232/422 and USB.
Additional options are an analogue output and a portal Profibus with protocol Profibus-DP.

Photo 13. Weighing and dosing controller type FLEX2100, panel mounting version

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 an Ethernet (TCP) portal with the protocols Modbus, FINS, Ethernet-IP and ASCII, portals RS232 and RS422/RS485 with the protocols Modbus and ASCII, as well as optionally a portal Profibus with protocol Profibus-DP. Protocols for printers, webbrowsers and configuration software between PENKO-instruments are available on Ethernet (TCP), CAN, RS232/422, and USB, making it highly suitable for complex weighing applications. Digital and analogue inputs/outputs are optional. The FLEX range has all the features of model FLEX-2100.

Photo 14. Weighing and dosing controller type FLEX, suitable for panel mounting

MODEL FLEX MultiChannnel

This most versatile apparatus possesses all the features of the models FLEX and FLEX-2100 with additionally the capacity to control up to four weighing systems in one instrument simultaneously and, where necessary, cross linked.

Photo 15. The 4-channel version of weighing and dosing controller type FLEX, suitable for panel mounting

Photo 16. An overview of the instruments and controllers.

CONCLUSION

PENKO instruments control the dosing system(s) as well as the mixing application all in one. All PENKO systems are “Slave” systems.

Preparing flour and dough products to correct and specific weights within the requirements of a quality management system in the shortest time possible and the most effective way, remains a challenge throughout the bakery sector and will vary from one bakery to another. Consideration not only needs to be given to challenges of the prevention for wrong compositions, but each product – particularly those determining the public health – have their own tolerances that influence directly the requirements on the dosing and mixing process.

To engineer the most efficient way per application, per product, per manufacturer, there is no “one-size-fits-all” solution. Engineers at PENKO work out the best and most effective way this can be done for you.

Following White Paper will discuss Load Cells, the Mounting of Load Cells, Non Automatic Weighing Systems, Weighing Systems for Maritime Applications, Check Weighing Systems, Filling Systems, continuous totalizing with Loss-in-Weight, continuous totalizing with Belt Conveyors, discontinuous totalizing with Hopper Weighers, Grading Systems by means of Weighing, Mixing controllers for the processing industry, Mixing control in concrete plants and Mixing control for feedmills.
For more information: www.penko.com