

**ENGINEERING WHITE PAPER: MIXING CONTROLLERS  
FOR MANUFACTURING CONFECTIONERY.  
PENKO ENGINEERING B.V.**



**INTRODUCTION**

This White Paper discusses the challenges, options and solutions for manufacturers creating confectionery, such as liquorice, sweets, peppermint, marshmallows and fudge, out of multiple ingredients, raw materials.

**PURPOSE OF WHITE PAPER**

... is to explain why it is important to create high-quality confectionery 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**

Confectionery products are made in a large number of different types and compositions, ranging from candy canes and liquorice laces to peppermint and chewing gum. Each type requires its own mixture with typical raw materials. Broadly speaking, the preparation takes place with the:

- supply and intake of raw materials.
- storage of raw materials.
- dosing and mixing of the relevant raw materials.

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- when applicable dosing of special raw materials in small quantities, sometimes on a separate weigher.
- interim storage in a buffer tank.
- cooking process.
- vacuum installation.
- pouring into moulds and solidifying.
- finish, for example with a polishing drum.
- packing and making the confectionery product fit for shipment.

The way of delivery of the finished product differs greatly, it takes place in bulk packages, rolls, boxes and/or bags. Sales take place per piece or by quantity, but for the consumer usually by weight in small packages ( $\leq 10$  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 confectionery 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, or a gas.

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.

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.

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**ENGINEERING WHITE PAPER: MIXING CONTROLLERS  
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► **The reception and intake of raw materials.**

Raw materials used in large quantities, usually sugars, are supplied in bulk and conveyed pneumatically into a silo. The sugar usually is weighed in advance by the supplier, the sugar factory. 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 type of sugar, 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. The check on weight of the stock of sugar, stored in a silo.

Such a silo can easily be checked on weight. The same of course applies to liquids, supplied in bulk, see photo 2. Raw materials to be dosed in small quantities, such as aromas, gum arabic, colorings and flavorings, are usually supplied in bags, buckets or big bags. These can be checked on weight when arriving and made recognizable, see figure 1.



Photo 2. The check on weight of the storage of liquids.

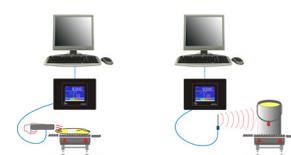


Figure 1. The check on weight and type of incoming raw materials.

This makes it possible to enter the data into a tracking and tracing system, the basis of a comprehensive production monitoring. When is chosen for an automatic dosing of these small components, further automatic processing is possible after releasing the big bag or cutting the bag, see figure 2.

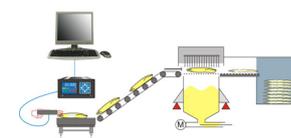


Figure 2. The input into the process of raw materials supplied in bags

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**ENGINEERING WHITE PAPER: MIXING CONTROLLERS  
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**The dosing of the various components.**

A detailed description of the dosing process can be found in the white paper „Mixing chamber controllers”. The basis of the dosing and mixing process is dissolving the raw materials in water, see figure 3.

This is usually combined with a dosing process, in which the various components are weighed one by one. So at first enough water is dosed and then, as much as possible with rotating agitator, the sugar. Since agitators cause vibrations, what creates disquiet weighing information, it is usual to switch off the agitator during the last part of the dosing cycle, so when the preset set weight is approached. The dosed quantity can be deducted automatically from the stock of raw materials and also, with component name and lot number, integrated into the production protocol. A specific procedure applies to each subsequent component. Photo 3 shows an example of a combined mixing and dosing tank..

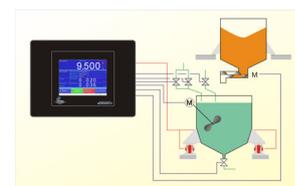


Figure 3. A dosing and mixing tank for water, sugar and other raw materials.



Photo 3. A combined mixing and dosing installation.

It is practical to dose components, being a part of the mixture in relatively small quantities, depending on the installation, automatically in a small weighing tank or manually on a small weighing platform, see photo 4.

By means of an operator terminal, such a weighing arrangement can be perfectly integrated into the entire process, including tracking and tracing. The selection of components can easily be monitored with bar code readers or transponders. Subsequently one adds the small components directly, or delayed in time, to the mixture. This way a complete and comprehensive report of the entire dosing process, 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 interim storage.**

The continuation, consisting of the cooking process, the vacuuming, the moulding and the finishing, for example polishing, is continuous. This requires an intermediate storage, one or more than one, buffer tank(s) see photo 5.



Photo 4. An example of a weighing platform for dosing small quantity components manually in advance.



Photo 5. A dosing and mixing tank, discharging into two buffer tanks for feeding two separate production lines.

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When several production lines are in use, one buffer tank is provided per line. This way, different products can be manufactured at the same time. To keep the contents of the buffer tanks on a sufficient level, they are equipped with a low level detector, a high level detector and, for safety reasons, a protection against overflowing. The usual procedure is, each buffer tank functions as a master and commands the dosing and mixing system in such a way that both the correct mixture is created and the amount of mixture per buffer tank is between the high and low level sensor. These buffer tanks often have a temperature controlled heating, what makes the subsequent cooking process can be carried out faster.

It is also usual for the process control system to have an additional program for emptying the installations and then rinsing them; a „cleaning in place“ process. For this, the dosing/mixing tank and the buffer tank(s) are equipped with spray balls with their own water connection.

**The further process up to and including the finished product.**

As soon as the mixture is ready, it undergoes a number of treatments, depending on the desired end product. These include:

- cooking process, see photo 6.
- a vacuum installation.
- the pouring into moulds and solidifying.
- the finish, for example by means of a polishing drum.
- packing and preparing for shipment, see photo 7.

**The treatment of the finished product.**

On prepacked products, such as sweets and lollipops, 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 „Characteristics of Filling Systems“, „Filling Systems for Solids, Powders and Granulates“ and, as it usually concerns packages ≤ 10 kg, „Prepackages“.



Photo 6. A production line with two buffer tanks and a cooking installation.



Photo 7. Filling of boxes with sweets.

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FOR MANUFACTURING CONFECTIONERY.  
PENKO ENGINEERING B.V.**



► **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 8
- 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 required raw materials for the day program.
- register of eventual manual actions.
- traceability of the mix.

By means of such software modules, see figure 4, 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 8. The computer screen showing production information.

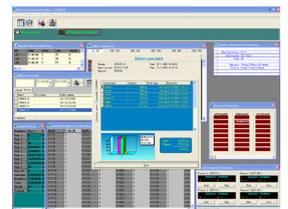


Figure 4. A screen overview with process information.

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**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 alarm settings
- 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 silos and/or tanks
- Routing of raw materials
- Routing of premixes
- Additional processing, such as mixing time, cooking and solidifying
- Control of other measured values, by example temperature and pressure
- Store and/or print dosing results
- Automatic repeat of the dosing/blending sequence or repeat program after release

**BCS extra's are:**

- Registration of operators
- Raw material stock control
- Silo register, material per silo and/or tank
- 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, pre-programmed standard process sequences

Engineering White Paper

**ENGINEERING WHITE PAPER: MIXING CONTROLLERS  
FOR MANUFACTURING CONFECTIONERY.  
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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 (1.600 conversions/s) with a high internal resolution (16.777.216), smart filters and sufficient computing capacity, makes the SGM700, 1020 and the FLEX range suitable for any dosing, mixing, blending and filling application. The combination of the high resolution and conversion speed guarantees the best achievable weighing and dosing accuracy, even when dosing at high speed, and thus prevents wastage because of wrong compositions.

**PRODUCT SOLUTIONS**

**SGM700**

The SGM700 range of digitizers consists of compact devices 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 the protocols 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 9. The digitizer type SGM700

**RIO700 EN RIA700.**

Types RIA700 and RIO700 are universal, compact, remote I/O sets, meant as extension for the controllers FLEX. 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 RIO/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 10. In- and output set type RIA.

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**ENGINEERING WHITE PAPER: MIXING CONTROLLERS  
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**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 protocols 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 10. 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 11. Weighing controller type FLEX-2100, version for panel mounting

**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 12. Weight controller type FLEX, suitable for panel mounting

**MODEL FLEX MultiChannel**

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 13. The 4-channel version of weighing controller type FLEX, suitable for panel mounting

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Photo 14. An overview of the instruments and controls.

## CONCLUSION

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

Preparing confectionery 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 sector and will vary from one manufacturer 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 influences 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 Bakeries, Mixing Control in concrete plants and Mixing control for Feedmills.

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