Engineering White Paper

FOOD MIXTURES FOR LIVESTOCK
PENKO ENGINEERING B.V.

INTRODUCTION

This White Paper discusses the challenges, options and solutions for manufacturers creating food mixtures for livestock out of several ingredients, raw materials.

PURPOSE OF WHITE PAPER

…- is to explain why it is important to create food mixtures out of components 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 indirectly 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 requirements, 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

Feed for livestock is made in a large number of different types and compositions, depending on the species for which it is intended and their age. A distinction, requiring special mixtures, must be made for:

- pets, such as dogs, cats, rabbits, but also reptiles, fishes and birds.
- cattle, such as cows, sheep and pigs.
- poultry, such as chickens and turkeys.
- young or older animals, such as puppies, young cattle, chicks and the like.
- fish, such as salmon, trout and Victoria bass, see photo 1.

Photo 1. An example of a fish farm.

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Broadly speaking, feed mills, see figure 1, exist of the:

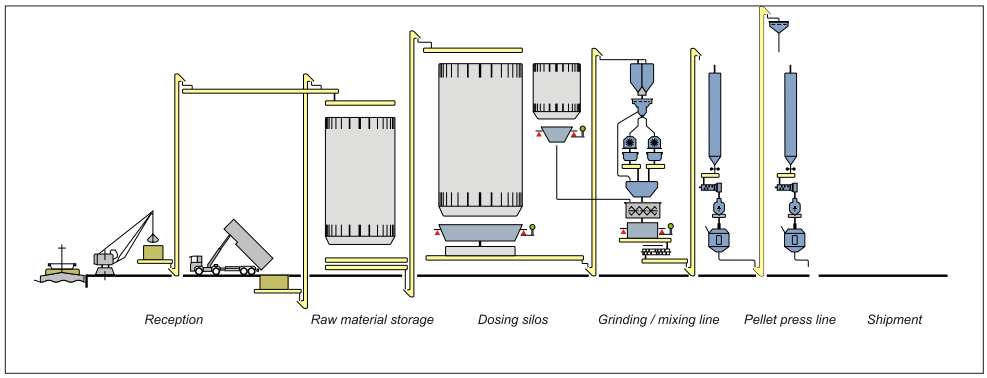

Figure 1. An overview of a complete feed mill installation

- supply and intake of raw materials
- storage of raw materials.
- dosing of large and small components, long bucket weighers or weighing hoppers, for grains and flour.
- grinding/mixing line with a sieve, hammer mill, dosing of water and fat, mixer and a pelletizer.
- (interim) storage of the finished product.
- shipment, as bulk material or as packed finished product.
  The way the finished product is shipped in depends of the destination, pet food is usually supplied in small packages (≤ 10 kg), that for livestock and poultry usually in bulk, while fish farms often prepare the food themselves

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, 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 cost 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.

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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.
The following, see figure 1, outlines in some detail the process sequence required to ensure consistent quality of a food mix. The schematic drawing describes the step by step process.

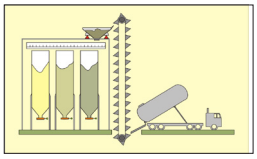

Figure 2. Receiving raw materials by truck.

The reception and intake of raw materials.

Raw materials used in large quantities, usually grains and flours, are supplied in bulk by ship or truck and afterwards, as shown in figure 2, stored in silos.
The use of a weighing bunker offers control over the loading and thus contributes to a good raw material administration. Moreover, the road trucks don't have to cross the weighbridge first, what saves a reasonable amount of movements around the factory, see figure 3.

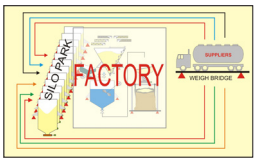

Figure 3. Weight control by means of a weighbridge causes many movements around the building.

As it concerns an entry check, so the control of a commercial transaction, this scale must comply with the legislation for metrology and be verified accordingly. Alternatively, the silos can also be loaded with a tow conveyor or pneumatically, in which case the entry check must take place prior to the internal transport.

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Proper control of transport to the silos for raw materials is essential. Only then a good raw material administration is possible and it prevents for an undesirable contamination of raw materials. Essential information, included in the raw material administration, is the name of the raw material, after laboratory approval or with a reference to the supplier, the lot number, with the date and time of arrival. When an own laboratory check takes place, separated raw material and dosing silos can be practical, as indicated in figure 1. In such a case the raw material can then be conveyed from the raw material to the dosing silo after release by the laboratory, see photo 2.

Photo 2. The silos for the interim storage of incoming raw materials.

Furthermore, by means of a silo register an available silo is selected for incoming raw materials. The connection between the raw material or dosing silo and the recipe takes place automatically using a routing system.
Raw materials to be dosed in small quantities, such as minerals, vitamins and medicines, are usually supplied in big bags, see photo 3, or bags.

Photo 3. The intake of raw materials into the process out of big bags.

When the small ingredient is dosed automatically, further automatic processing is possible after discharge of the big bag or cutting the small bag, see figure 4.

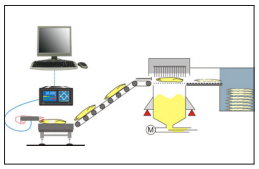


Figure 4.The control of packaged incoming raw materials.

When the raw materials are added to the process manually, a manual charging cabinet, see photo 4, is required. This cabinet frequently is combined with the inlet of the elevator after the dosing belt. As it concerns powders, the manual charging cabinet should be provided with a suction. Furthermore, these charging points can be equipped with a weighing system and an operator terminal, optionally combined with a barcode reader, what provides the desired dosing operations are visual for the operator and checked and registered via the system. This way it matches seamless with the tracking and tracing system.

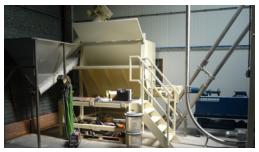


Photo 4. A cabinet for the manual addition of raw materials.

The dosing of the large components, long hopper weighers for grains and flour.

A detailed description of the dosing process can be found in the white paper „Mixing chamber controllers for the processing industry“. The various components are dosed one by one into a long weighing hopper, which frequently is combined with the belt conveyor in the direction of the elevator, see figure 1. Rotary valves with a coarse and fine speed are usual as dosing devices, alternatively an adjustable slide combined with, per silo/component, a flat gate valve. The adjustable slide is a long one, controlled by a hydraulic system, which will simultaneously change the outlet opening of all raw material silos almost steplessly. This outlet opening, which controls the dosing speed this way, can be set per raw material/silo by means of the formula. Therefore the silo/raw material is selected with the gate valve, coarse and fine dosing speeds are preset with the adjustable slide. Moreover, products with troublesome flow characteristics can be scraped off with rapid movements of the slide. When all large components are dosed in accordance with the formula, the batch is conveyed to the holding position above the grinding/mixing line using the belt conveyor and the loading elevator.

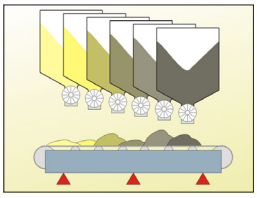


Figure 5. Dosing the large components on a belt conveyor.

The dosing of the small components, fat and water.

The small components, fat and water are added to the mixture in relatively small quantities. Furthermore, these components follow a slightly different route, see figure 1. They are directly after dosing directed into the mixer. That’s why for this applications separated small weighing systems are installed, see photo 5. As a matter of course this improves the production speed as well as the weighing and dosing accuracy. Depending on the mounting options, hanging, see figure 6, or standing, see figure 7, configurations are possible. The characters of powders, fat and water are incompatible, what requires at least three weighing systems. Optionally, when the dosing times allow this, a combined weighing frame can be used, see figures 8 and 9. The discharge of these weighers is integrated in the program of the grinding/mixing line.

Photo 5. The weighing system for the small solid components.

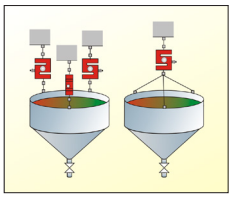


Figure 6. Hanging water or fat weighing systems.

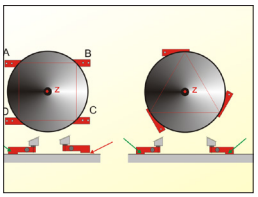


Figure 7. The foundation of a standing arrangement for the small ingredients weigher.

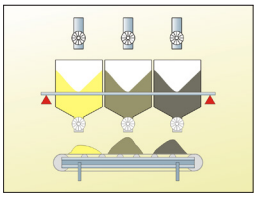


Figure 8. A combined weighing frame for the small solid ingredients.

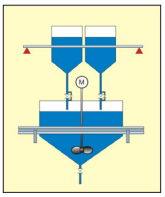


Figure 9. A combined weighing frame for the liquid ingredients.

The grinding/mixing line with a mixer, hammer mill and pelletizer(s).

See figure 1. In the grinding, mixing and pelletizer line, the mixture undergoes various operations. At first it is sieved, then pulverized in the hammer mill(s), after which it is treated in the mixer. In the mixer the small components, fat and water are added. When the mixture, in other words a mixture in powder form, is ready so far, it goes, possibly via a continuous mixer, into one of the silos for the finished products. If further processing is required, it is conveyed to the pelletizer. Both routes, to the finished product silos or the pelletizer(s), require internal transport with an elevator and a drag chain. In a number of cases it is necessary to perform an additional operation after pelletizing, for example spraying it with a brightener or flavouring substance. Appropriate methods for these are to control/regulate the pellet flow on a belt conveyor and simultaneously dose the brightener or flavouring substance by means of negative weighing on it. For these systems, we refer to the white papers on belt weighers and negative (LIW) weighing systems.
In order to guarantee a smooth production flow, where necessary, holding positions have been placed in the grinding/mixing line. This prevents for delays due to discharge and charging times. Good status indicators and sensors for empty and full detection are essential for the safety, so the quality, of such a production line. After all, these detectors make good monitoring of the route followed and the progress possible. The formula tracking system is important too. Not only you know which mixture is in a certain part of the line, it also ensures that the correct, formula-dependent, operations are performed. The information about all operations performed are documented in the tracking and tracing system.

The (interim) storage of the finished product.

For the storage silos for the finished product, see photo 6, in generally the same requirements are applicable as for the raw material silos.

An available silo is selected by means of a silo register. The administration of the finished product, including the information from the tracking and tracing system, records where it is located and if it can be packed or delivered as bulk material. And here too, reliable status indicators with sensors for empty and full detection, are needed to safeguard the internal conveying. For smaller installations, this storage can be combined with the shipping positon; the next chapter

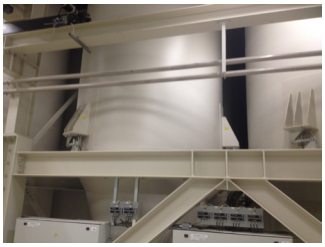
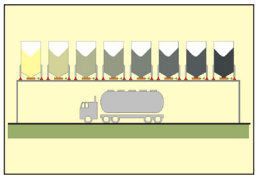


Photo 6. Weighing silos for the storage of finished products.

The shipping of finished product.

Just like incoming raw materials, the finished product sold in bulk must be checked before shipment with an approved weighing system. After all, it is a trade transaction, so the appropriate legislation applies. In this case, too, the advantage of weighing the bulk material in advance, so before loading the truck, is it avoids the necessity to drive around the building to and from a weighbridge anymore. A good solution is making the finished product silos weighing or storing the product in a weighing cell per delivery, see figure 10.



Figuur 10. Filling a truck by means of weighing silos.

Alternatively, the truck can be loaded with a mobile weighing hopper, see figure 11.

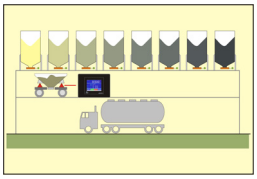


Figure 11. Filling a truck by means of a mobile weighing hopper.

Instead of using a mobile weighing hopper, the product can of course also be conveyed into the right direction, such as the cell of the truck, via a mobile conveyor, by example a belt conveyor, see figure 12.

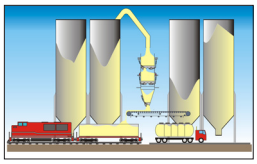


Figure 12. Filling a truck via a mobile belt conveyor.

In the last two cases, it is not always possible to make the weighing hopper of a sufficient size to weigh the amount, the quantity to be loaded, in one go. Then it is possible to use a small weigher and load the mass sold discontinuously, see photo 7. When the truck is loaded out of a storage silo, the possibility is there to approach the desired quantity exactly with the last weighing. Discontinuous totalizing scales are described in our white paper “Hopper Weighing Systems, discontinuously totalizing “.

Photo 7. An installation for the discontinuous totalizing loading of bulk material.

A bagging/packaging installation for the finished product.

Appropriate legislation applies too for the product you deliver in a packed form. If you use a check weighing system, you will find the relevant information in our white paper “Check Weighing Systems”. For the filling of packages for trade by weight you can rely on our white papers “Filling Characteristics”, “Filling Systems for Solids, Powders and Granulates” and, in the case of packaging ≤ 10 kg, “Prepackages”. An example of a bagging station for food mixtures is shown in photo 8.

Photo 8. A filling station for big bags.

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

Photo 9. The computer screen with production information.

By means of such software modules, see figure 13, the personal computer is the ideal man/machine interface and a solid start for a quality control system. Moreover the manage any moment full information about the production process and the material flow.

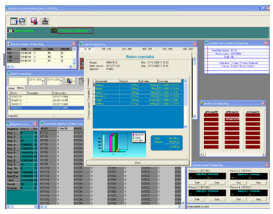


Figure 13. A screen overview with process information.

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
- Automatic repeat of the dosing/blending sequence or repeat program after release
- 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
- Control of other measured values, by example temperature and pressure
- Store and/or print dosing results
- Manual interventions with interlock

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, pre-programmed standard process sequences

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, 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 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 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.

RIO700 AND 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 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 type RIA.

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., 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.

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.

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.

CONCLUSION

PENKO instruments control the dosing system(s) as well as the mixing application all in one. All PENKO systems are “Slave” systems.
Preparing food mixtures 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 feed industry 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 health and growth of livestock – 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 and Belt Weighing, discontinuous totalizing with Hopper Weighers, Grading Systems by means of Weighing, Mixing chamber controllers for the processing industry and Mixing control in concrete plants.
For more information:: www.penko.com

Photo 13. An overview of instruments and controllers..