

1. Introduction

Controlling the portioning process is essential for cheese manufacturers. Being able to cut products accurately, with the minimum of waste and with throughput meeting customer demands, is vitally important in an increasingly competitive marketplace. This document describes illustrates how manufacturers can use automated ultrasonic cutting systems to control and optimise their portioning process.

2. Manufacturer's targets in product portioning

When considering manufacturing and selling cut products, there are three main objectives for the producer:

- i) Maximise *yield* – getting the maximum number of saleable cut products from a whole product , with due regard to portion quantity control and cut quality
- ii) Minimise *giveaway* – controlling portion weight as close to the target weight as possible, taking into account allowable variances according to Packers' Rules (see below)
- iii) Maximise *throughput* – cut and pack the maximum required number of products in a given production period.

3. Product weight and selling

Applicable products – in this case, cheese - are sold by **catch weight** or **fixed weight**.

3.1 Catch weight

Product is cut, weighed and then priced and sold according to a variable weight. Using a high quality cutting process, all cut portions can potentially be sold. Yield can be maximised through the implementation of a process which can portion the product into a pre-programmed number of portions, and to a high quality, meaning that wasted product is very low. Invariably this means automating the cutting process, typically with ultrasonic technology. Giveaway is not applicable, whilst the use of automated product handling guarantees a higher throughput than an equivalent manual operation.

3.2 Fixed weight

Production and retail of goods which are pre-packed, in pre-determined (fixed) weight or volume, are governed by the **average system**. Its aim is to provide a defined regulatory framework for the automatic filling of packages.

The underlying principle is that there is an inherent degree of variation in the content of packages, but there should be a system to define acceptable tolerances – principally to protect

cheese portion weight optimisation

the purchaser against short measures, but also to protect manufacturers against unfair competition.

Fundamentally, the average system allows a proportion of packages to fall below their stated quantity, but within a specified tolerance.

There are three rules ('Packers' Rules') which have to be followed:

- i) the actual contents of the package should not be less, on average, than the nominal quantity (known as Q_n).
- ii) No more than one package in forty may contain less than the nominal quantity by more than a specified amount called the Tolerable Negative Error ('TNE'). The nominal quantity less the TNE is known as the **T1** value.
- iii) no package should be short by more than twice the TNE. The nominal quantity less twice the TNE is known as the **T2** value.

The amount of TNE is determined by the nominal quantity on the package, and defined in the following table:

Nominal Quantity (g)	Tolerable Negative Error (TNE)
From 5 to 50	9% of nominal quantity
From 50 to 100	4.5g
From 100 to 200	4.5% of nominal quantity
from 200 to 300	9g
from 300 to 500	3% of nominal quantity
from 500 to 1,000	15g
from 1,000 to 10,000	1.5% of nominal quantity

As an example:

1. Cheese portions are sold at 200g. At this nominal weight, the TNE is 9g. No more than 1 in 40 portions may be less than the **T1** value, which is 191g, and no portion may be sold at a weight below 182g, the **T2** value
2. Cheese portions are sold at 450g. At this nominal weight, the TNE is 13.5g. No more than 1 in 40 portions may be sold at less than the T1 value, which is 436.5g, and no portion may be sold at a weight below 423g, the **T2** value

3. Automating the portioning process

Yield, giveaway and throughout can all be addressed effectively by automating the portioning process.

- 3.1 Yield** can be maximised through the implementation of a process which can portion the product into a pre-programmed number of portions, and to a high quality, meaning that wasted product is very low. Invariably this means automating the cutting process, and typically with ultrasonic technology. For fixed weight product, the yield can be maximised using an automated system with intelligent software
- 3.2 Giveaway** can be minimised by applying an operator- selected rule to the portioning process, ensuring the process is carried out within the Packers Rules and T1 and T2 tolerances
- 3.3 Throughput** can be maximised through the use of automated facility providing an integrated portioning process, which can operate faster and more effectively, and with better quality, than its manual equivalent.

The following examples for cheese portioning illustrates the principle.

Example 1

Manufacturer A cuts cheese from a whole wheel cheese with an approximate weight of 2kg, and the wheel with a typical range of +/- 200g.

He wants to cut portions at an approximate weight of 200g, and sells under the principle of catch weight. Therefore he configures his system to cut 10 portions, which will range from 180g to 220g catch weight. His yield will be high as he will be selling each portion by weight.

Automating the cutting process for this manufacturer will allow him to select the number of portions to cut and, coupled with ultrasonic cutting technology, he will be increasing accuracy, throughput and cut quality.

Example 2

Manufacturer B cuts cheese from a whole wheel cheese with an approximate weight of 2kg, and with a typical range of +/- 200g.

He sells at a fixed nominal weight of 200g and sells according to this. He therefore wishes to configure his system with a cutting schedule which gives him the maximum number of portions per cheese, whilst providing the following:

- i) Ability to cut x number of portions at the fixed weight and a extra portion at a lower weight w which may still be saleable
- ii) Ability to calculate x number of portions at a the fixed weight, then increasing the size of each portion by an amount x/w with no extra portion, then cutting x portions
- iii) Ability to calculate x number of portions, then cutting x+1 portions at a decreased size determined by an amount w, provided the weight of each portion conforms to the Packers' Rules.

This can be achieved with a pre-weighing system. Each cheese is weighed and the portion schedule calculated according to an available option. As an example, a whole cheese is weighed at 2.17kg. The options are:

- i) 10 portions at 200g and 1 portion at 170g
- ii) 10 portions at 217
- iii) 11 portions at 197.3g

4. **Automated systems – modes of operation**

For cheese portioning, an automated system will be typically be configured with three main options:

- 4.1 Fixed portions - using the above example, always cutting 10 portions. This is most likely to be used when selling by catch weight, or when the weight and dimensions of the pre-cut product (in this example, whole cheese) is consistently with tight tolerance.
- 4.2 Variable portions – this is the mode described above. It gives the best results in the case where the pre-cut product is variable, minimising giveaway.
- 4.3 Random portions – this will allow the user to pre-select a custom portioning schedule or varying number and size.

5. **Restrictions and limitations**

To allow automated portion control to work effectively, there are number of restrictions and limitations. These include:

- 5.1 The product should be of uniform side and shape. A basic portion control system assumes that weight is spread evenly across the whole of the product. However, it is possible to recognise a non-uniform product and adjust portion sizes according, using laser or vision technology.
- 5.2 The product should be of uniform density. Where products have variable content – for example, a holed product - then actual portion weight can be unpredictable.

5.3 The product should be fixed during the cutting process. Any movement will affect portion size, so an automated facility should include a means of holding and centralising the product whilst it is being cut.

One of the major issues for manufacturers is the minimisation of giveaway. Although much can be done through system software in conjunction with weighing and cutting equipment, it can be hard to predict exact giveaway figures *in advance* without the guarantee that all the above issues are addressed.

However, using the tools available through the control system software, it is possible to minimise giveaway, over time, using a series of iterative steps. The system is programmed with a set of rules and related parameters which define how the rules are applied; the system can be fine-tuned according to variances in the cheese prior to cutting and the quality and accuracy of cut portions, all of which should be recorded over a defined production period.