

**A practical guide to sponge cake processing**  
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# **A practical guide to sponge cake processing**

*George Wright*

The inspiration for this topic has come from my colleagues, who have been involved with me in the commissioning of sponge cake plants. Today's 'food for thought' is based on my observations during a series of case studies of steel band baking plants. I wish to share with you some of my adventures in the 'Art of Coarse Baking'. Many of you will have an understanding of the process, but may need reassuring, that you are not alone - the problems you experience are shared around the world.

The single most common cause of failure is the lack of understanding between the product and the process. I will outline the process and highlight some of the problems and perhaps offer you more questions than answers to resolve these issues.

A continuous aerator mixer produces a batter which is deposited directly on to the oven band, baking a continuous strip of sponge to form the base cake, which can be cut or rolled after spreading with jam and cream producing swiss roll, mini swiss roll or layer cake.

## **Ingredients**

### *Flour*

In many countries around the world, we are restricted to using the only flour available. This means we can be producing a sponge with flour that is, 'not fit for the purpose', but we still have to produce commercial quality cake.

Modifying the formula, by reducing the flour ratio and incorporating starch, is one of the most common courses of action to counteract this problem.

### *Egg*

Fresh egg is considered to be satisfactory for the processing of sponge cake, but when the quality of the egg protein is variable, then inferior quality sponge cake products are produced.

This can be due to the eggs coming from many different suppliers, whose quality of food supplied to the hens is not controlled.

In this instance, the use of dried whole egg is favoured, as it can provide (when hydrated) a constant quality of whole egg, providing that sufficient 'standing time' is given to the egg after hydration, to optimise the function of the protein.

### *Emulsifier*

The recommended quantity of emulsifier varies between suppliers from 2.5% to 77% of the total batter weight. Cake manufacturers should comply with the recommended dosage rate given by the suppliers.

Companies entering cake manufacturing for the first time 'do not realise the implications of using ingredients' that differ in composition or quality.

During storage, the emulsifier progressively loses some of its efficiency, and this is a serious problem for manufacturers in countries who rely on an extended shelf life of their ingredients, or their purchasing departments, who do not discuss ingredient specifications with their technologists before buying the raw materials.

### **Baking powder**

There is a lack of process understanding of the rheological changes that take place in batter preparation, the physical changes that occur in the batter viscosity and expansion rate during baking.

Some manufacturers incorporate the baking powder into the first stage of pre-mixing with the eggs, acid and water. This will often result in lack of product expansion, due to a partial loss of gassing activity from the baking powder during mixing and batter standing time before depositing.

In warm climates, the recommended baking powder is usually of a slow acting type, such as sodium acid pyrophosphate (SAPP) which is added with the flour during the final stage of mixing.

### *Water*

The quality of the water influences the processing of sponge cake, and in several countries distilled water is used, either due to variations in pH or residual salts and impurities in the water.

In one location, a pH of 8.5 was recorded from the water and the resulting cakes suffered from excessive shrinkage.

## **Mixing**

The objective of this mixing cycle is to blend all the ingredients into a homogenous batter and incorporate air in a continuous system, where the batter specific gravity can be controlled.

### *Pre-mixing*

When compared with the conventional method of batch mixing, the use of a high speed shear mixer, for disintegrating and dissolving the emulsifier liquids and soluble ingredients, produces a stable and smooth batter.

I attribute this to the function of this mixer, producing a homogenous mechanical emulsion which is then transferred into the conventional batter or slurry mixer for incorporation of the flour and baking powder.

### *Premix holding tank*

The capacity, of this tank and method of filling, can influence the batter depositing efficiency, and consequently the quality of the end product.

The quantity of batter in the holding tank is subject to changes in batter rheology as it is held in the tank for varying lengths of time and becomes more viscous.

While discharging batter from the bottom of the tank, the flow rate is then interrupted by the incorporation of a fresh batch of batter into the batter held in the tank.

The fresh batter is more fluid and has an effect on the older batter as it is discharged in a laminar flow principle, leaving an accumulation of residual batter from the previous mixings in the tank.

As a consequence, there is preferential flow of 'fresh mix' in respect to the aged mix' as the batter as it pumped out from the pre-mix holding tank

## **Depositing**

### *Manifold depositor*

The flow rate of the batter as observed leaving the manifold is influenced by the frequency at which the fresh batter is discharged into the pre-mix holding tank, but also the physical and chemical changes in batter viscosity as it stored in the tank. Flour hydration for example causes batter specific gravity to increase.

As well as the variation in flow rate of batter across the manifold, large irregular air cells are seen in the deposited batter. These air cells coalesce during baking to contribute to bubbles or bottom surface blistering.

Balancing the flow of batter through the manifold requires good powers of observation and patience, as constant minor adjustment is required to set the manifold gap to produce an even flow of batter across the band.

Changing the manifold gap for different product types compounds this problem, as the setting of the gap needs to be re-established.

## **Baking**

### *Oven*

The condition of the oven band plays an important role in sponge cake quality.

A new oven band should be surface treated before use by applying beeswax or edible oil, then polishing. This will produce a sponge base that is a mirror-like image of the oven band surface.

This can also be applied to an oven band that has been in production for several years. The band should be free of accumulated carbon on the top surface, and be of a polished condition.

### *Release agent*

The quality and quantity of the release agent affects the bottom surface of the sponge. A starch-based suspension was found to provide the better attributes for sponge release and bottom surface appearance.

Conductive heat transfer from the oven band, coagulating the proteins and caramelising the sugars, also contributes to bottom surface appearance.

### *Zone integrity*

The application of zone integrity minimises heat spillage from one zone to another, thereby providing control of heat and humidity between zones.

This is of particular influence in the first zone, where a humid baking environment is considered important for the expansion and development of the sponge cake. This can be achieved by closing the extraction dampers in the first zone, allowing for moisture loss from the product to create a humid baking environment.

Steam can also be introduced but it must be of a controlled velocity and distribution.

### *Baking Profile*

The independent control of top and bottom heat is not always a feature of baking ovens.

Due to the sensitive nature of the sponge batter, when heat is applied a greater proportion of bottom to top heat in the first zone, and subsequent control in the final zones, has proved to be beneficial in product expansion, flexibility, surface finish and moisture loss during baking.

### *Sponge bottom surface blistering*

Sponge cake can suffer from bottom surface blistering (localised bubbling) causing the sponge to rise off the oven band as observed at the oven exit. This fault can also be observed through the oven inspection windows.

This fault is caused by the expansion and coalescing of the irregular and random distribution of large air cells within the batter, contributing to excess crumbing and tearing of the bottom surface of the sponge as the sheet is transferred over the stripping knife,

### *Secondary processing*

On occasions the sponge sheet tears and cracks as it is being transferred around the turnover drum and undergoes mechanical folding and rolling.

Depending on the diameter of the drum, the sponge sheet can be subjected to changes in surface tension as it goes around the turnover drum. Poor synchronisation in the drive conveyor speeds contributes to this tearing, and cracking of the top surface.

A relatively dry top sponge surface can also be a problem. Surface cracking detracts from the product appearance and also influences the chocolate coverage, which can affect the product shelf life if coverage is not complete.

The baking loss and residual moisture of the sponge contributes to the sponge cake's flexibility for secondary processing.

## **Product and process faults**

### Variations in batter density

- Variations in the pre-mix batter consistency
- Air incorporation within the batter, as it is discharged from the mixer into the holding tank
- Laminar flow of the batter from the holding tank

- Preferential flow of the fresh batter being pumped into the holding tank which contains the batter from (the previous mixings)
- Variations in flow rate of batter through the manifold.

## **Solutions**

Adopt the shear method of pre-mixing to produce a homogenous batter

Discharge the batter into the holding tank from the bottom

Design features of the pre-mix batter holding tank to be vertical. angular taper of discharge

Surface treat the inside of the holding tank to improve 'slip'

Batter deposit by the principle of sheeting rolls

Oven hand cleaning polishing and surface conditioning

Lateral position of the drive-drum to be in constant alignment with the stripping knife

Heat ratio control for independent top and bottom heat

Temperature indicators for the top and bottom of the baking chamber

Improved visual access and increased number of inspection windows