TECHNICAL ARTICLE

How to get control over your chocolate inclusions

BRINGING GOOD THINGS TOGETHER

Palsgaard®

Discover the intricate dance between ingredients, machinery, and expertise that chocolatiers face. From the challenge of handling delicate inclusions like puffy rice crisps to the art of achieving the perfect viscosity profile, we explore the secrets behind crafting impeccable chocolate creations. Learn about traditional manufacturing, integrated refiner/conche systems, ball mill refining, and key production parameters. Uncover how inclusions interact with viscosity and explore solutions for encapsulation and moisture control with **Palsgaard® AMP 4455** and **Palsgaard® PGPR 4190** emulsifiers.

Inclusions just aren't that easy

Producing consistently good-quality chocolate is not without its challenges. Viscosity, new forming requirements and a long list of other aspects keep chocolatiers and production managers on their toes – and living in constant fear of producing a large batch that needs to be re-worked.

Now let's add inclusions to those realities. Take puffy rice crisps, for example. They're the equivalent of extreme sports for the chocolate manufacturer. Under vibration, and with a very light density, they do their best to avoid the mixture completely, tending to float on top of it. Nuts, on the other hand, are far more dense and dive straight to the bottom. With perhaps just 15 seconds available for the chocolate to fit the mould, the ability to provide a perfect substrate for inclusions to position themselves and be properly enveloped in chocolate is worth its weight in gold.

The aim, therefore, is to transfer the flowing chocolate into a suitable working texture – one that can envelope inclusions and flow freely enough into difficult, obstructed spaces, yet without losing too much viscosity.

In short, inclusions can drive you nuts.

Start here

So what can be done to overcome these challenges? First, let's review the basics of chocolate manufacturing machinery and methods. That's because variations in these are key to determining what measures to take to achieve the right results.

The chocolate matrix is normally composed of cocoa liquor, sugar, cocoa butter, milk powder (milk and white chocolate), emulsifier(s) (phospholipids, PGPR), vanilla flavour. The workability and the final eating experience of the chocolate depend on the amount and type of the raw materials that the producer has chosen to put into the actual chocolate.

Producing the exact same recipe using different types of equipment will likely lead to quite different chocolates, varying in flavour, taste and viscosity profiles.

Yield value (YV) defines the force needed to initiate a flow in a non-Newtonian fluid such as chocolate. The YV is typically important when working at low shear such as when moulding/vibrating.

Plastic Viscosity (PV) defines the force needed to maintain a constant flow in a chocolate. The PV is important when working at medium to high shear such as in the enrobing process.

Traditional production

Manufacturing chocolate using a traditional machine setup requires mixing, refining and conching steps. In the first of these steps, the fat phase and all the powder materials are mixed together at approximately 122ºF (50ºC) to obtain a certain, soft clay-like refining texture. It is, in fact, the fat-to-particle ratio that regulates texture to be 'refiner-receivable'.

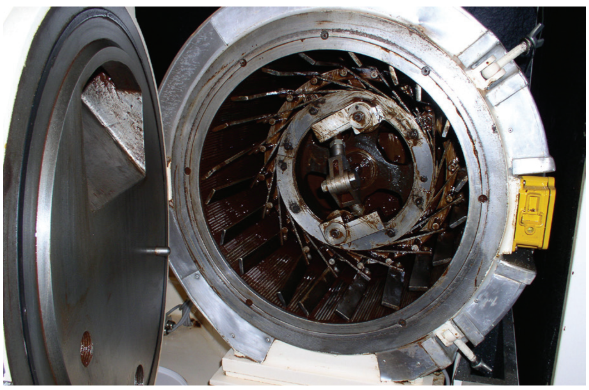
In the refining step, the mixer paste passes through rotating rolls. The rolls are hydraulically pressed together to create a defined gap between the sets of rolls until desired particle size has been reached. This size is determined by a number of factors such as time, temperature, speed of rotation and machine pressure. And in chocolate, with the human detection limit at around 18 to 20 microns, the maximum is usually in the interval of 20-25 microns for the largest particles.

The dry conching step requires the refiner flake to be blended at temperatures of approximately 140-160ºF with the rest of the fat. During the wet conching step, emulsifiers and flavour are added. The temperature selected depends on the type of chocolate: white, milk or dark, and the objective is to achieve the desired flavour profile and to adjust the viscosity profile to the chocolate's specification.

PRODUCTION USING A REFINER/CONCHE SYSTEM (MACINTYRE)

Integrated refiner/conche systems offer an alternative method of chocolate manufacture, performing the functions of a pre-mixer, refiner and conche all in a single machine. Refiner/conches can be used for making chocolate, compounds, coatings and fillings for small to medium production capacities.

Almost all raw materials go into the refiner/conche from the beginning. There is a limitation to texture during the refining part of the process as the machine needs a certain low viscosity during the process to avoid "tumbling" and to conduct an acceptable refining process within a reasonable time frame.



The first step in a refiner/conche approach is refining. The pressure of rotating blades towards the inner rippled wall is adjusted until the desired particle size is reached (a process that may take some hours, depending of the size of the machine used). When a final particle size of , for example, 25 microns has been reached, refining is interrupted and, without stopping, the machine is now used as a conche.

Conching continues after pressure has been released, at which point a wheel is turned to release pressure and end the refining function. The remainder of the fat is added during or at the end of the refining process. Emulsifiers are then added to modify viscosity to meet required specifications, and flavour is added as the final ingredient.

MANUFACTURING CHOCOLATE USING BALL MILLS

There are many different types of ball mill refining equipment in the marketplace – and a variety of different ways to conche the chocolate after refining. To begin with, powders are mixed with cocoa butter and cocoa liquor, along with some of the recipe's emulsifier. When the chocolate matrix is pumped through a tube filled with steel balls, the balls begin to roll (providing additional emulsifiers are added to liquefy and lower the chocolate's viscosity), and the chocolate is refined until the desired particle size has been achieved. The product is then mixed, and its viscosity profile can be fine-tuned.

Key manufacturing parameters

Given the influence of the production process and machinery on the outcome of identical recipes, it is worth digging deeper into the production parameters that demand close attention in order to achieve chocolate of the right quality.

On the refining side of things, the smaller the desired particle size, the higher total fat the chocolate matrix demands. While this may not, at first, seem entirely logical, breaking any particle into, for example, four smaller fragments doubles its surface area. And each fragment's surface needs to be covered in fat before the rest of the fat in the matrix can create distance between the particles.

Then there are the conching considerations. Forming the chocolate's final viscosity profile is highly dependent on the conching machine used and the way it is operated. Gathering useful data on this parameter requires a modern viscometer, as well as a suitable measuring geometry and a water bath able to hold the sample at a constant temperature.

There are other important factors, too, in achieving a successful outcome. For example, the more intensive dry conching and shear applied, the lower the viscosity profile. There are process temperature limits, too, due to different types of chocolates and raw materials. And finally, the more volatiles that can be evaporated during the conching stage, the lower viscosity profile that can be achieved.

The challenge of inclusions

Chocolate inclusions span everything from coffee beans or fragments, to jellies, extruded corn or rice, dried fruits, cookies, to other types of chocolate or confections.

When adding inclusions to a chocolate recipe, the chocolate's viscosity profile requires adjustment. On the one hand, a more liquid viscosity profile is required. On the other, manufacturers must avoid the feet formation that often accompanies such a profile when placed on a drying surface.

A viscosity profile measures three production-related shear rates that will inform us of the result we can expect during tablet moulding, hollow figure spinning and enrobing applications where blowing is applied. A 'normal' moulding profile, that is to say, one with a normal viscosity profile that generally works without problems for solid moulding of standard tablets, resembles that depicted in Figure 1.

How does chocolate actually behave under different production situations at different speeds? By taking the chocolate through various viscosities, we learn what it can handle. Can it, for example, be used for producing Easter eggs in a spinning mould? Does it fall short for blowing applications by not having sufficient enrobing viscosity? Can it handle the extreme speeds of spraying?

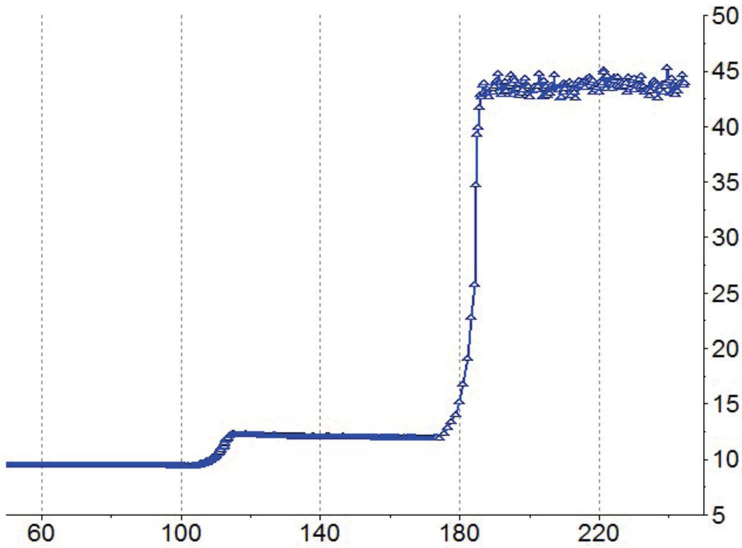


Figure 1: Example of 'Normal' Moulding Profile

Processability

To get to the bottom of this, it is useful to work with a flow curve method that generates the 'Casson' yield value and plastic viscosity. The Casson model describes what we might term the 'processability' of chocolate.

Basically, different types of moulds require different chocolate profiles. The smaller and more narrow the mould, the lower the chocolate's viscosity needs to be. And changing the speed of the chocolate produces different viscosity results (non-Newtonian flow behaviour). Furthermore, if impressions and logos are desired, additional liquid chocolate profiles are needed.

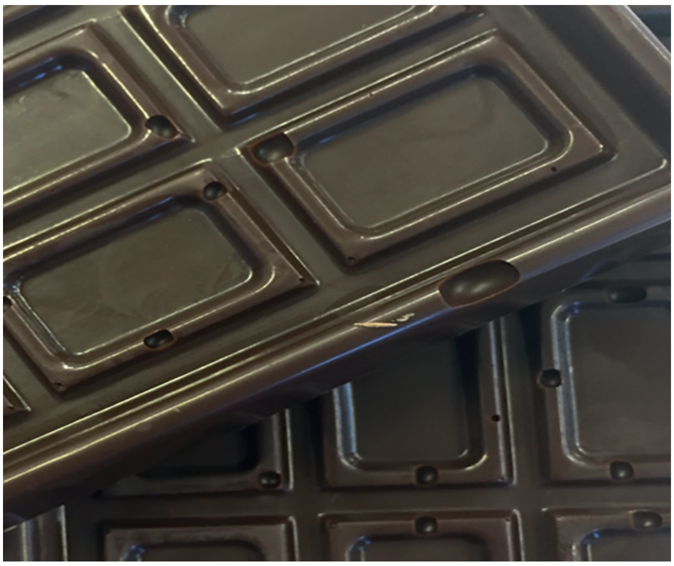
It's also important to establish enrobing profiles. The method used to do so is identical, but the results must be read differently. That's because layer thickness is often established at blowing speed with relatively fast shear rates, whereas moulding takes place at relatively slow speeds. The speed of the chocolate in a chocolate forming machine is therefore measured at approximately the same speed in a viscometer.

Inclusions and viscosity interact with the chocolate

What happens if we take a relatively fine chocolate that works well in a solid tablet moulding line and apply chopped nuts, for example? The chocolate will now behave differently – and it is no longer suitable. Attempting to produce solid 100-200g tablets, therefore, will result in a product with holes in its surface. - as shown in Figure 2

Why? One reason is that, by adding chopped nut pieces, we have added even more surface area that needs to be covered in the chocolate fat phase.

Figure 2: Incorrect viscosity may result in holes in the chocolate.



Another is that, by adding physical solids, blocking can occur within the mould. To overcome these challenges, therefore, we need to work with a chocolate that has a lower viscosity profile – enabling it to live up to the physical requirements of a mould containing inclusions.

Other effects of adding inclusions

The challenges don't stop there, however. Given that inclusions need to be covered with cocoa butter, relatively less fat is now available for creating distance between the molecules in the chocolate matrix.

Inclusions, such as nuts, are high in nut oil, and happily allow some of this fat content to migrate to the chocolate, contributing to the unsightly effects of chocolate blooming. Figure 3 provides an example of fat blooming, with nut oil migrating into a milk chocolate and blooming spreading out from the nut inclusions.

At the same time, many inclusions, such as dried fruits, are high in moisture, disturbing the chocolate's own moisture levels and affecting viscosity control. Of course, it's not a one-way street: The chocolate fat phase can also migrate into the inclusion before crystallisation, changing its texture so that those nuts aren't quite as crisp and crunchy as consumers expect.

Perhaps the most obvious solution to these problems is to encapsulate the inclusion. This can be done with film-forming agents such as gum arabic solution or acetylated mono-glycerides. Coating the inclusion with a fat barrier may also work to prevent fat blooming. And last, manufacturers can choose to seal the inclusion with a film of chocolate.

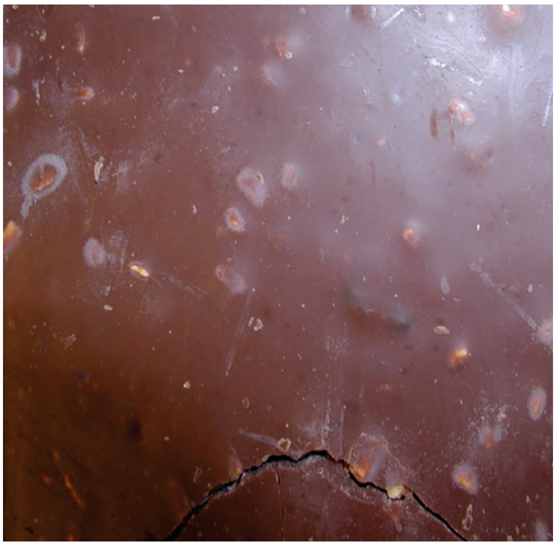


Figure 3: Migration of nut oil makes the chocolate bloom

More liquid please

One thing is quite certain: Adding inclusions requires a more liquid chocolate to ensure the inclusions are covered and the chocolate still fits the mould perfectly. But how much more liquid does the chocolate need to be? The best way to discover this, naturally, is to conduct trials. Once the new specifications have been identified, the recipe can be altered to match them in one of two ways.

The more traditional approach is to simply add more cocoa butter until viscosity numbers are met – but with cocoa butter at a premium, and the adverse effects on taste and texture of adding too much cocoa butter, there's a better solution: the use of more efficient emulsifiers such as phospholipids (lecithin or emulsifier YN) together with PGPR. The hydrophilic PGPR binds the water, lubricating sugar surfaces with a fat-like coating and causes friction between particles to be lowered.

A good emulsifier system can reduce interaction among particles by coating sugars so they are unable to absorb as much moisture and thus lead to a thickening in viscosity. And vegetable-based emulsifiers (phospholipid AMP and PGPR), also known as sunflower-based **Palsgaard® AMP 4455** and **Palsgaard® PGPR 4190** have the added advantages of being non-GMO, non-allergenic.

While there is no direct effect on chocolate production, these ingredients can be made using sustainable palm oil ingredients. Such emulsifiers are a powerful addition to the chocolate maker's toolbox, allowing more accurate control over the various parameters in chocolate production, and making it possible, for example, to reduce cocoa butter without affecting viscosity.

Success in a nutshell

In conclusion, the essence of successfully adding inclusions to your chocolate products is fourfold: Establish a proper viscosity profile; find out if a sealing process is required; make the necessary recipe changes; and produce or order a suitable chocolate for the task at hand. Get these aspects right and from here on, adding inclusions to a chocolate should be a piece of cake.

Contact us to order samples of **Palsgaard® AMP 4455** and **Palsgaard® PGPR 4190** to try out in our vast library of recipes, or visit **www.palsgaard.com** for more information.

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