TECHNICAL ARTICLE

# How to get control over your ice cream coatings

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Applying the right emulsifiers in the right way can make a world of difference to chocolate and compound ice cream coatings. Palsgaard Bakery & Confectionery Application Manager Arne Pedersen shares more than 40 years of experience in the field.

## How hard is coating?

"The best things in life are simple". Whoever originally made this uplifting statement definitely wasn't talking about ice cream coatings. Because consistently achieving that rewarding sensation of chocolaty crunch as you bite through to soft ice cream beneath, the cocoa flavour deliciously offsetting the ice cream's sweetness, is anything but simple.

The truth is that, for every TV ad that depicts a group of happy, relaxed consumers enjoying the sensations of chocolate-coated ice creams on a hot summer's day, there's a stressed and frustrated production manager doing all he or she can to overcome constant challenges of managing viscosity, different surface temperatures and more besides.

It doesn't have to be that way, however. In fact, achieving success with ice cream coatings is largely about using the right emulsifiers in the right way. Unfortunately, there's not much in the literature for manufacturers to lean on, even when they do recognize emulsifiers as a solution, so I'll primarily draw upon Palsgaard's internal know-how to offer advice that is likely to be of use.

In more than 40 years spent helping customers to smooth away their frustrations, we've seen just about every combination of challenges. And we've managed to refine our own emulsifiers and techniques to a point where there's now an effective toolbox that can overcome each challenge, enabling production people to smile along with their product's consumers.

## The beauty of coatings

Ice cream coatings are typically thin layers manufactured from inexpensive fats such as coconut oil or hydrogenated palm kernel. The total fat content is often above 60% so as to achieve a sufficiently thin layer and short crystallization time.

From stick ice creams to Eskimo bars, there are many products that can benefit from coating. A typical confectionery coating protects the filling, keeping it inside the praline and ensuring it won't dry out. Those enjoying the product can hold it with a minimum of mess, and when eaten, a good coating gives a pleasurable and varied experience, both in terms of mouthfeel and flavour release. Much of the credit for this must be given to the special properties of confectionery fats such as cocoa butter, which is uniquely hard and brittle below 30 °C (86 °F), yet which melts in the mouth at 35 °C (95 °F).

As the YV of the coating starts to increase you may risk ending up with 'pinholes' or in extreme cases separation of the coating on the ice cream.

## The dark side

What makes working with coatings so difficult? For one thing, ice cream is best produced when it's cold, while chocolate is easiest to work with when it's warm. For another, chocolate has almost no water content while ice cream is mostly water. So bringing the two of them together is hardly a match made in heaven.

But there are more challenges, and the list centres around the interaction between filling and coating, with problems showing up, for the most part, not during production but in the days and months that follow:

- The coating speed required is far faster than that of other, non-ice cream applications.
- Moisture will always migrate from the ice cream into the chocolate.
- Cracking may result if the chocolate is, for example, not sufficiently plastic.
- Fat can migrate from the filling to the chocolate coating, causing a greyish layer known as 'bloom'.
- Alcohol content in the filling may cause instability or even leaking.

I'll focus on the first three, most important issues for this article.

## Ready, set, dip!

In contrast to a traditional coating process, during which crystallization can build up over several minutes, the dipping/coating process required to marry flowing chocolate or chocolate compounds with cold ice cream needs to take place in a matter of seconds. The chocolate moves from a liquid to a solid state extremely rapidly, with no time for regulating the thickness of the resulting layer by blowing or vibration. Instead, the chocolate's rheology, the crystallization speed of the fat used, and the temperatures of the ice cream chocolate dictate this crucial parameter.

**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.

To the uninitiated, it may seem that by gaining control of the rheology and ensuring the optimal temperatures of both chocolate and ice cream, all their production problems could be solved. Unfortunately, it's not that simple. During a production run, the ice cream coating will change its rheology – and that changes the whole game.

## Water migration

Imagine for a moment, that you expose an almost water-free chocolate (good chocolate makers do their best to squeeze more than 99% of the water out of their product) heated to 35°C (95°F) to an ice cream that is mostly comprised of water – and resting comfortably at around -15°C (5°F). What happens? Melted ice cream mix will migrate to the hot chocolate, gradually increasing the latter's viscosity and Yield Value (YV). And if you've set your process parameters less than optimally – perhaps with overly warm chocolate or ice cream whose temperature has climbed just prior to dipping – this damaging effect happens much faster.

Why should you care about the YV of the coating starting to increase? Because you're likely to end up with a gradually thicker layer, the risk of 'pinholes' forming when melted and expanding ice cream mix bubbles out through the still-soft coating, longer crystallization time and, in extreme cases, separation of the coating on the ice cream.

But wait! Can't you counter an increasing layer thickness by simply raising the temperature in the chocolate bath and thinning it down again? Yes, you can, but I wouldn't recommend it. Doing so speeds up water migration and causes heat damage to the ice cream itself. Of course, you may be thinking of adding more fat, which would help to reduce thickness, though it would add to costs and its fluctuating use would make final costing a difficult exercise.

In fact, there are many adjustments one could make during a production run, but such an approach is unlikely to create the right environment for smooth runs and a consistent result.

## Cracking the code

An ice cream whose outer layer of chocolate cracks too easily while being eaten or, worse, is already cracked before the wrapper is removed might be considered to have a serious effect on consumer judgements of a particular brand's quality.

The more plastic a coating is, of course, the better it can withstand changes on the product's inside. Yet, both coconut oil and palm kernel fat form relatively hard, brittle layers upon cooling. One way to counter this is to boost plasticity by adding approximately 8% liquid oil (maize, peanut, sunflower or rape seed oil).

Milk and white chocolate contain milk fat in addition to cocoa butter, increasing softness and plasticity, and showing less contraction during crystallization. But, if it's ice cream coatings you're interested in, I highly recommend you add 4 to 5% of anhydrous milk fat even with dark chocolate, especially in extruded ice cream types where the hard centre leaves no room for contraction. Finally, many countries also allow CBEs (cocoa butter equivalents) to be added without losing the status of a real chocolate, further supporting plasticity.

## Wanted: High-performance coatings

By now, alert readers will have realized that the answer to these issues is to in some way change the coating's recipe so that it acts in the same way throughout the entire production run, despite being exposed to various amounts of melted ice cream mix. That may sound like a tall order, but repeated successes have informed us that the right combination of emulsifiers, determined via both expertise and experimentation, can create a buffer against variations in the rheology. And it can help to create an ice cream coating that is stable, uniform and resistant to viscosity changes during a production run.

## Emulsifiers save the day

Many confectionery manufacturers have traditionally used lecithin, (E322) to regulate the rheology of an ice cream coating. In chocolate, lecithin is typically dosed around 0.4% as this is where the optimal functionality is found – and is this exceeded the YV will increase. In ice cream coating, typically 0.7 – 0.8% lecithin, derived from soybeans or sunflower oil is used in order to have a buffer against water migration during the production process. This is working but it is possible to achieve a far better result!

To achieve still more resilient buffering against water migration – and to improve the flow properties of the liquid chocolate mass, emulsifiers of a different kind are the weapons of choice.

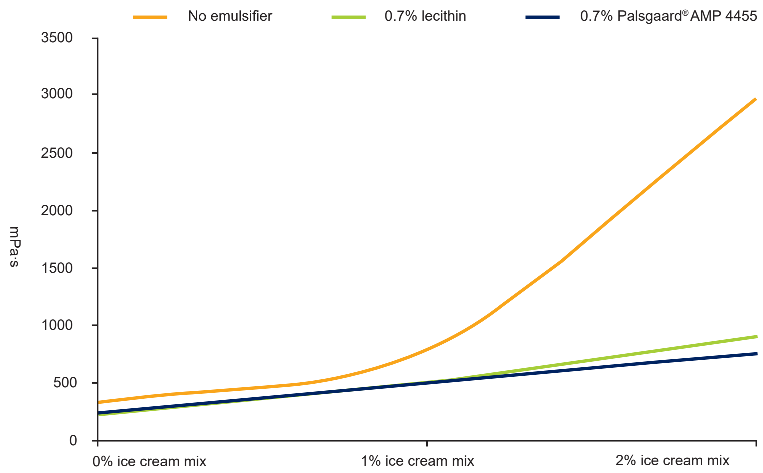
## Ammonium phosphatide

Ammonium phosphatide, also known as Emulsifier YN or E442, is a product typically made from rape seed oil or sunflower oil. It's more effective than lecithin in the battle against water migration, and it can be added in higher dosages without negatively affecting YV (thus avoiding the dreaded 'thickening effect' often associated with chocolate production). And it's this unique dosing ability that makes Emulsifier YN so perfectly suited for ice cream coating applications.

In recent years, we've thoroughly tested the effect of both lecithin and Emulsifier YN in our labs and in actual production. Clearly, compared with the emulsifier-free ice cream coating, the addition of lecithin or Emulsifier YN (in the form of sunflower-based **Palsgaard® AMP 4455** for our tests) delays the thickening effect – as shown in Graph 1. To put it more precisely, the graph shows the increase in viscosity at shear rate 2 [1/s] (speed of the chocolate) when applying various amounts of ice cream mix to a coating with and without lecithin or **Palsgaard® AMP 4455** added.

Experimentally, this has been found to be the best measuring method for describing the conditions in an ice cream dipping process. It is also a good illustration of the changes which may happen during a production day. It is clear that compared to the emulsifier free ice cream coating, both the addition of lecithin and **Palsgaard® AMP 4455** is delaying the increase in the measured value – or in other words delaying the thickening effect caused by the increasing water content in the coating during a production day. However, adding either one to the chocolate will reduce the plastic viscosity more than the YV and, since water especially increases the YV, neither Emulsifier YN nor lecithin forms a truly optimal solution.

***Graph 1:*** *Rheology on ice cream coating - The effect of lecithin and Palsgaard® AMP 4455.*




## PGPR

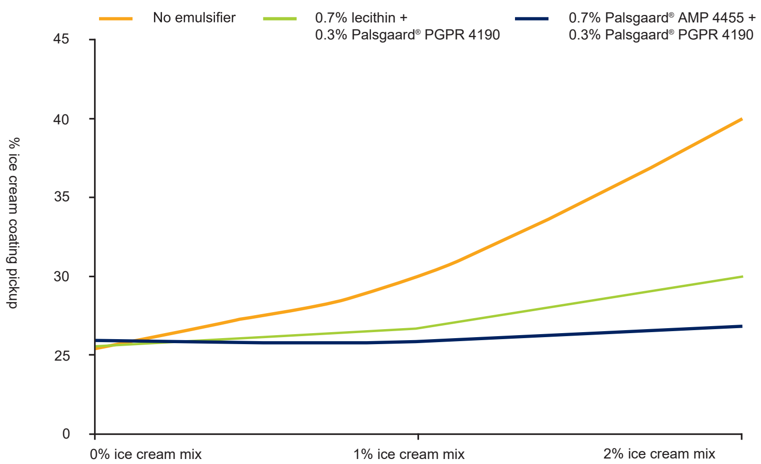
A better result, as it turns out, is achieved by combining Emulsifier YN with another emulsifier, known likewise by at least three names: Polyglycerol Polyricinoleate, PGPR or E476. PGPR is exactly the right ingredient when you're trying either to achieve a decreased YV or to avoid an increased YV. It can be used together with lecithin, but our data shows that by putting the special properties of PGPR together with those of Emulsifier YN, the negative effect of water in an ice cream coating is neutralised and a stable and uniform production day is ensured – without a thickening effect during the day. Additionally, PGPR makes it possible to reduce fat content in coatings by up to 7%, as demonstrated in Table 1.

***Table 1:*** *Typical recipe suggestions for ice cream coatings*

| | STANDARD RECIPE % | IMPROVED WATER ABSORPTION % | REDUCED FAT % |
|---|---|---|---|
| Cocoa powder | 12.00 | 12.00 | 12.00 |
| Skimmed milk powder | 5.00 | 5.00 | 5.00 |
| Coconut oil or palm kernel fat | 51.90 | 51.90 | 44.90 |
| Liquid oil | 8.00 | 8.00 | 8.00 |
| Sugar | 22.25 | 22.25 | 29.25 |
| Palsgaard® AMP 4455 or soya lecithin | 0.80 | 0.50 | 0.50 |
| Palsgaard® PGPR 4190 | - | 0.30 | 0.30 |
| Vanillin | 0.05 | 0.05 | 0.05 |
| Total | 100.00 | 100.00 | 100.00 |
| Total fat content | 62.0 | 62.0 | 55.0 |

We've confirmed the performance of the PGPR/ Emulsifier YN combination in actual production trials, too, dipping a series of ice creams held at -18 oC (64.4 oF) into a 40 oC (98.6 oF) coating, then examining coating pick-up. The results, shown in Graph 2, tell a powerful story. Without emulsifiers, pickup quickly climbs as the ice cream mix is increased, resulting in a heavy thickening effect, while a combination of lecithin and PGPR significantly reduces this tendency. The best results, however, showing only a marginal increase in pickup even at 2% ice cream mix, were achieved by combining AMP and PGPR, ensuring stable and economical production runs.

***Graph 2:*** *%Pick up of ice cream coating - dipping test*




## Keep it cool

Beyond an effective emulsifier combination, if I had one piece of advice for manufacturers struggling to achieve cost-effective coating consistency it's this: It is of utmost importance that the temperature of the ice cream is as low as possible – preferably -15o C. Ensuring this will help to reduce moisture migration and avoid the formation of pinholes.

## Coating counsellor

In most cultures, when a relationship between two parties begins to break down, a counsellor can provide guidance – and in the hands of an experienced professional, differences can be resolved and harmony restored.

For coatings and ice cream, Palsgaard plays that role, bringing customers into our application centres to revisit their recipes, experimenting with recommended emulsifier mixes and production techniques until all is well.

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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