Milk Chocolate Applications —

Maintaining Quality and Solving Problems

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Chocolate, to some consumers, is the reward. It's the ultimate indulgence — truly a feel-good pacifier and part, as some chocoholics claim, of an important food group.

What's not to love about chocolate? It has a wonderful fragrance, delicious taste and smooth mouthfeel. But as appealing as chocolate is, it brings special quality and manufacturing challenges for producers of confections and baked goods. Why? Because chocolate has some unique behaviors that need to be understood and managed in order to produce the best products possible.

In this paper we'll review some of the challenges of chocolate issues from the perspective of the "real world," rather than from academic experiences and experiments. We will look at special considerations in selecting and using chocolate. We'll see how problems occur when we incorrectly identify process problems and their solutions. And, we'll evaluate some storage issues.

But first, we need to define the words "quality" and "problem" as they apply to enjoying and using chocolate. As we'll see, it depends on whom you ask.

In regard to quality, when you ask consumers, they'll tell you their criteria are appearance of the product, wonderful rich flavor, good eating quality, mouthfeel and value.

A candy manufacturer will cite all of the above and add a few others. These include the suitability of the chocolate in a particular application, the nature of ingredients to be combined and the cost and availability of the ingredients. Last, but not least, there's shelf life and stability of the finished product.

The chocolate manufacturer must be able to meet all of the candy manufacturers' needs and expectations, and duplicate them consistently batch after batch. Both the manufacturer of the chocolate and the candy producer view these considerations of quality in practical terms.

Of course, some criteria are common to the consumer, candy manufacturers and

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chocolate producers. These are the appearance, rich flavor and the structural integrity of the confection. In this business, of course, we translate these attributes into our own, more familiar terms.

- Where the consumer says "appearance," we may say "initial gloss," "gloss retention" and "bloom stability."
- Rich flavor becomes the "flavor release of the product."
- And, structural integrity means the touch stability of the product, as well as its hardness and heat resistance during distribution to points-of-sale.

Now that we have defined the attributes of quality, the definition of problems related to chocolate application is easier. When we see any of the above quality criteria out of synch, or even starting to drift from the norm, we know there's a problem.

KEY FACTORS FOR SUCCESS

In producing confections there are four specific areas where problems occur. The first is the selection of the type of chocolate. This is often the primary source of difficulties. Here, the level of milk fat in the chocolate is important.

The second critical issue is chocolate application, including storage and handling. This includes temperature concerns. The third is understanding oil migration, its negative effects and how to avoid or minimize them. We must understand the interaction of a chocolate coating with the confection's center during manufacturing, shipping and shelf life. And, finally, there are issues associated with the storage of finished products. We'll discuss each in some detail.

CHOCOLATE SELECTION CONSIDERATIONS

Current standards allow chocolate suppliers to produce milk chocolate with a minimum of 10 percent chocolate liquor, 3.39 percent milk fat and 12 percent milk solids.

Higher levels of milk powder and crumb in the chocolate recipe result in chocolates with richer flavor, but the chocolate user must keep in mind that high milk content in the chocolate will result in a higher percentage of milk fat in the total fat phase. The emphasis here is on percentage of milk fat because we know that trace amounts of milk fat in chocolate prevent bloom in finished products, but higher levels of milk fat will result in limiting functional attributes of chocolate.

Cocoa butter's sensitivity to high levels of milk fat results in slow crystallization during tempering and produces softer chocolates. Part of this incompatibility stems from the differences in melting characteristics. Milk fat is a liquid and cocoa butter is a solid at room temperature (70ºF).

We can get a perspective on temperature response of the mixtures of cocoa butter and milk fat from the Jensen cooling curves (Figure 1). Notice as the milk fat increases, the crystal-initiating temperature decreases and the crystallization rate decreases.

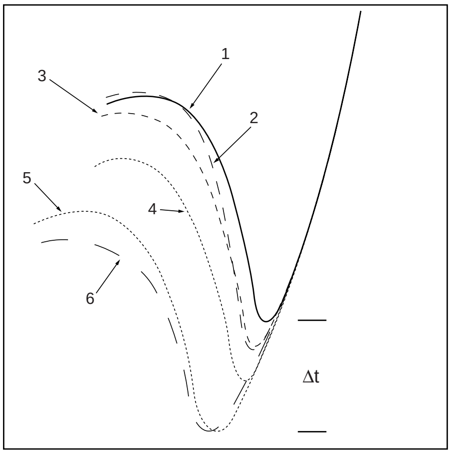
This has important consequences for the candy producer, because mixtures that contain both will crystallize at a much slower rate. The higher the milk fat content, the longer the tempering time. These mixtures also require lower tempering temperatures. A slow crystallization rate also means that the product needs a longer dwell time in the cooling tunnel.

There is another concern regarding the use of milk chocolate in a product which may have nut oil or another type of oil in the center. The stress on the cocoa butter from the milk fat, coupled with the interaction with other fats in the center, will drastically limit the shelf life. The solution? Start with a lower milk fat milk chocolate.

Form

As I've just noted, the type of chocolate is important. But its form is, too. Chocolate is available from the manufacturer in three different forms:

Cooling Curves of Cocoa Butter and Butter Fat



1. 100% CB
2. 100% Softer CB
3. 95% CB 5% BF
4. 90% CB 10% BF
5. 85% CB 15% BF
6. 80% CB 20% BF

Figure 1

- Liquid, which requires tempering
- Tempered and molded 10 lb blocks
- Tempered wafer discs

Each requires special handling and storage from the time the chocolate is delivered by the supplier until it is incorporated into finished goods.

Liquid Chocolate. Liquid chocolate should be stored in vertical or horizontal tanks with agitation. The agitators should be set on a timer, so that the chocolate is stirred intermittently — at least 10 to 15 minutes every hour. Keep in mind that when the chocolate is being used, the agitator must be on at all times. The agitation rate for vertical mixers is 17–18 rpm. Horizontal mixers require 13–14 rpm. These are all tank manufacturers' guidelines.

Solid Chocolate. The critical factor in using any chocolate that is already tempered is converting the solid chocolate into liquid without losing the temper state. This is achieved by warming solid chunks of tempered chocolate or tempered chocolate wafer disks to 90ºF, so that 85–90 percent of the cocoa butter melts. Gentle agitation is needed during melting and cooling to maintain a uniform temperature profile and to help to achieve a workable viscosity. (Chocolate melters require 15 rpm.)

Once most of the chocolate melts, we recommend holding the temperature at 88ºF or 90ºF, depending on the type of chocolate. Dark chocolates can be used at 90ºF, but milk chocolates, because of the milk fat, should be used at 88ºF.

This approach allows for some beta crystals to be left intact. This is important because beta crystals replicate during the cooling process — a coating response that is essential in order to achieve a stable crystalline form in the chocolate.

Temperature

The temperature of stored bulk liquid chocolate is critical, especially for milk chocolate. Its ideal storage temperature is 115º–120ºF.

Exposure to higher temperatures for an extended period of time will cause the milk proteins in chocolate to denature. This results in grainy texture, off-flavors and higher viscosity. Thus, monitoring and maintaining constant temperatures in the right range is very important.

Obviously, the heat source and the consistency of heat distribution is also important. For example, tanks in hot rooms tend to distribute heat more evenly than individually heated tanks. Jacketed tanks do have their merits, provided the jackets are designed to distribute heat evenly and consistently. The source of heat, such as hot water in the jacket, must be carefully monitored to guarantee that proper amount of heat is transmitted to the stored chocolate at all times.

Allowing cold drafts to blow on thermostats or other heat-regulating sensors can create problems, because this can trigger the heating in the hot room or heating medium in a jacketed vessel. The result is that more heat than needed reaches a product that is heat sensitive.

Excess heat applied very briefly may not result in the degradation of the chocolate, but excess heat, even by a few degrees, can

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stress the tempering machine, resulting in poorly tempered chocolate outputs. This is especially true if the heat exchanger for the tempering unit is already running at maximum capacity and can't cope with the increased heat load.

It should come as no surprise that heat issues can have a major impact on quality and on the bottom line, even if excessive heat occurs for just a matter of minutes. In three to five minutes, a continuous tempering unit, depending on its size, can temper from 50 pounds to more than 300 pounds of chocolate. At 25 percent chocolate pickup at the enrober, that translates to 200–1,200 pounds of finished goods, or roughly half a pallet of finished goods for a line with higher throughput rates. If the quality of the chocolate has been compromised, that can prove expensive. Production line personnel find the problem tough to diagnose because the system may be back to normal by the time the product reaches the end of the production line and is clearly off-spec.

Here's a common scenario. Let's suppose that the chocolate in the enrober overheated briefly, but the system is now back to normal. The enrober operator gets a complaint from the packaging operator, who reports that the bars are not shiny. The finished product looks dull.

The problem with excess heat occurred some 15 minutes earlier. It lasted just three to five minutes. By this time, the tempering and enrober operating parameters do not need any adjustments. They are operating normally again. But, the enrober operator forges ahead and tries to fine-tune them. The result? A constant jockeying that greatly affects quality over the course of the production for this entire batch of chocolate.

How do you prevent this from happening? Rather than leaving process temperature decisions up to the operator, we suggest having available a thorough knowledge of the history and current status of temperatures in all production phases from the holding tank to the enrober.

This data can be achieved by—

- conducting hourly checks at key points in the process, and
- installing temperature sensors in the line, including return loops, with circular charts to show the status (past and present) of hot rooms and of heating devices for jacketed tanks. This approach means that plant personnel can easily monitor temperature trends, so the maintenance crew can quickly identify the source of the problem.

The bottom line is that the more temperature information we can generate at key locations on an hourly basis, the better control we can have of the status of the process. Having accumulated historical temperature data helps the maintenance or process engineers answer two key questions:

- Is the heat source delivering the required heat consistently within a reasonable range of fluctuation?
- Is the cooling source removing the heat consistently within a reasonable range of fluctuation?

This same information can be helpful over the course of the entire year, because it reveals seasonal trends. For instance, plant personnel can spot the overload of water tower cooling capacities in the hot summer months. Obviously, this offers tremendous advantages when demand from various cooling systems is high and heat exchanger systems for the tempering unit and cooling tunnel are all consolidated into one common system.

We suggest monitoring the following:

- The temperature and feed rate of untempered chocolate feeding the tempering machine
- The temperature profiles of the chocolate in the tempering machine
- The status of the cooling media for the tempering machine
- The dwell time in the cooling tunnel

- The cooling tunnel temperature profile, including the amount of air and locations where air is blown
- The tunnel temperature when the tunnel is running at full capacity

This information allows process personnel to make quick decisions to prevent production problems or at least to minimize their occurrence.

OTHER PROCESS ISSUES

There are other production issues that we must also keep in mind. These involve enrobers and cooling tunnels.

Enrobers

Enrobers can be a source of product quality problems, because they trap crumbs, nut pieces and high-moisture-containing tails from centers. These can wreak havoc in chocolate. If they are left in contact with chocolate for an extended period of time, they lead to softening of the chocolate and can have adverse effects on its flow properties, so they must be screened and removed quickly.

Some of you are probably saying, "Our process is okay. We have crumb- and tail-screening devices designed in the chocolate return systems." But if these are positioned after the detempering stage, you may still have a problem, because, by the time the chocolate reaches the screen, it has already traveled through a pump where the crumb and tailpieces break into smaller pieces and are further homogenized into the chocolate. So we recommend screening before the chocolate is subjected to a high sheer mixing or pumping stage.

Enrober manufacturers must take this issue into consideration in designing new generation enrobers.

The Cooling Tunnel

Previously published studies and presentations clearly indicate that products coming out of the cooling tunnel are not really finished for at least another 24 hours. They suggest that the quality of these products depends on how well they are cooled, not just on how long they are cooled. A good understanding of the capability and the limitations of your tunnel's performance is critical. Chocolate users must recognize this before they release products for distribution. Otherwise, they may run into problems with products that have lack of gloss or poor touch stability. Eventually this results in bloom.

We suggest that you talk to your tunnel suppliers for technical help to determine the exact temperature at specific tunnel locations. Sollich, a cooling tunnel manufacturer for the confectionery industry, uses a temperature-sensing device (Figure 2) called Scorpion Sensor to monitor temperatures at specific locations of the tunnel. This instrument works as a diagnostic tool and it is designed to measure tunnel performance. This offers a wealth of useful data.

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OIL MIGRATION

Now let's look at the next critical factor—the interaction between chocolate and fat-based centers or other types of centers that promote oil migration during shelf life.

Oil migration problems have been with us ever since we began incorporating nuts and nut oils in the centers of our candies and confections. We have devel-

Cooling Tunnel Sensor

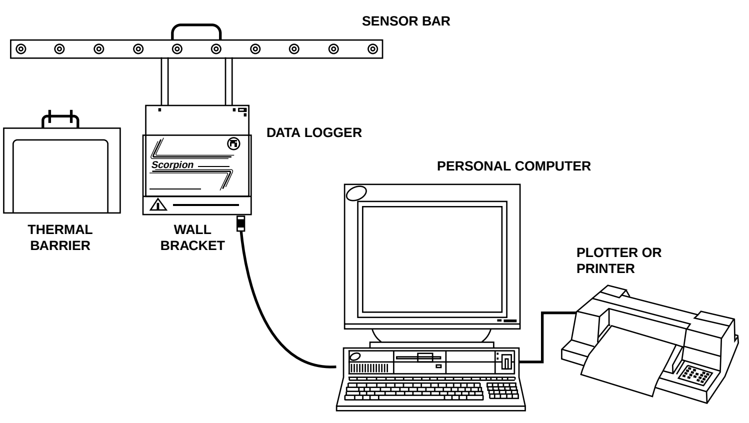


Figure 2

Fully fractionated and hydrogenated palm kernel oil has been used in product centers with nut meat or nut oil with a great degree of success. These fats also provide a sharp melting profile.

oped products that have gained great consumer appeal. They taste great. But we still have not developed technology to keep the oil from migrating from the center into the coating.

We know that using fats that are not compatible with cocoa butter in the centers contributes to these problems. But, regardless of the source of the oil, its behavior can be traced to one fact: Fats that are not compatible with each other tend to prevent one another from going into the crystalline phase. Eventually these incompatible fats will crystallize, but not into one matrix. They crystallize separately, resulting in a very poor crystalline matrix that allows oil migration.

The loss of gloss during shelf life is one of the early symptoms of oil migration. Eventually, this leads to a severe bloom and discoloration of the product surface. It doesn't affect taste, but it upsets the consumer due to poor appearance and texture.

Until some modern miracle occurs, we need to accept the fact that oil migration is inevitable. So what can we do? We can slow down the rate of migration and help increase shelf life. In essence, we're simply reducing the consequences of the detrimental effects of migration. There are several ways to do this.

One is to use a chocolate coating that is well tempered to provide the best crystalline matrix possible. This acts as an oil migration barrier. We will discuss this in detail in a moment when we talk about barrier coatings.

Current industry practice is to add nonfat ingredients such as milk solids, sugar, carbohydrates and proteins such as soy flour, peanut flour and cereal to tie up the oil. But despite these efforts and considerable ingenuity, these approaches are just stopgap measures that have not effectively solved the problem. The non-fat components mentioned above do not work, but we think they do, because we see changes in the apparent flow properties of the filling. But, as with so many things, this is just an illusion.

As an illustration, let's evaluate what happens with pure peanut butter. It has more than 50 percent peanut oil and it is a free-flowing liquid mass at 85º–90ºF. When we add sugar, nonfat milk components, soy flour and even cereal to the mixture, it becomes thick. Its consistency leads us to believe that the peanut oil is tied up nicely in all of these nonfat components. Given ideal conditions and machines, we might even say it is extrudable.

But here's the reality: these non-fat components do absorb oil, but they do not hold the oil. They act as wicking agents just like paper toweling mops up oil spilled on the kitchen counter. Oil is absorbed on one end of the substrate and is released to the other nonfat components that it touches.

And depending on the temperature conditions, the oil can travel. The higher the temperature, the greater the oil migration rate.

Powdered sugar also tends to give the perception that it is preventing the oil from migrating. What the sugar particles are really doing is using the oil for lubrication of each particle. This oil will start to move at higher temperatures, too.

This phenomenon has been demonstrated very clearly by Wootton and his co-workers from Australia. In their work (Figures 3 and 4), icing sugar and peanut oil mixtures were held next to each other, enabling the oil to migrate between them. One mixture had 33.3 percent peanut oil in sugar and the other had 18.8 percent peanut oil in sugar. Both were stored at 15ºC and 30ºC and the oil content of both was determined at intervals of 2 weeks. The effect observed in this test was solely due to temperature and not due to differences in solid fat content, since peanut oil contains no solid fat. The tests show that migration takes place more slowly at the lower temperature, even though the amount of liquid oil is the same. The graphs show that the equilibrium oil content of 26 percent was reached quicker at 30°C.

The conclusion is that we cannot control oil migration with a nonfat component that is used as a migration-slowing agent.

Migration-retarding Fat

Fats and oils are quite stable in a solid state. They move from areas of higher to lower concentrations only when they are in a liquid state. For this reason, oil migration control can be accomplished by using oils that can stay in crystalline form. The type and size of the crystal and its melting point are critical factors, but using high melting point, fully hydrogenated vegetable oils derived from soybean, cottonseed and canola isn't the answer. These impart a waxy mouthfeel, do not release flavor and do not behave as well as other fats at ideal chocolate-application temperatures because they become highly viscous.

What Works?

Fully fractionated and hydrogenated palm kernel oil has been used in product centers with nut meat or nut oil with a great degree of success. These fats also provide a sharp melting profile. They have good flavor release and work well at ideal chocolate-application temperatures. Keep in mind, however, that palm kernel oils are not compatible with cocoa butter, so their application is limited by: the concentration of nut oil; process time; and process temperatures. This system offers limited shelf life because palm kernel oil is highly incompatible with cocoa butter.

Fractionated domestic oils made with palm, soybean and cottonseed oils are also useful in managing oil migration problems. These oils provide the ideal crystalline matrix to hold the oil, because cocoa butter is more compatible with them than it is with palm kernel oil. The limiting factor here is that these fats do not

The goal is to have 50 percent of crystallization occur before and during — not after — depositing.

Fat Migration — Model Studies

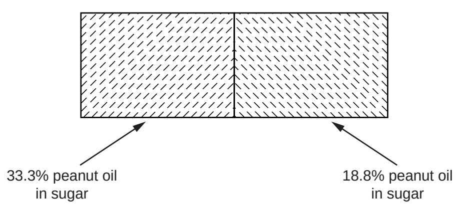
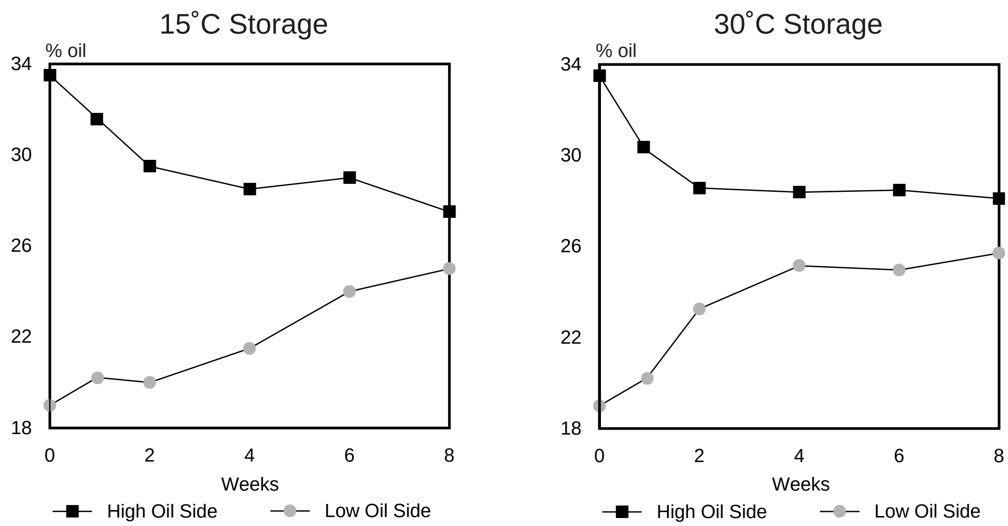


Figure 3

Effect of Temperature on Fat Migration



Wootton et al, Rev. Int. Choc. 26 (1971) 266-271

Figure 4

The critical factor is the set point temperature of the total fat phase of the filling.

release flavor as quickly as fractionated and hydrogenated palm kernel oils. The one exception to this is the fractionated domestic fats that are made with a higher ratio of cottonseed or palm oils. The unique fatty acid ratios found in these oils tend to provide a better crystalline matrix to hold the liquid oil.

Forming the Fat Matrix

Several other considerations are important for success in selecting the correct fat to retard fat migration. The melting point and melting profile help us estimate the set point of the fat matrix in which the oil is going to be held. One also needs to determine where in the production process to promote the formation of the fat matrix. This is important because it drives other decisions, too.

Here's an example to help illustrate some of these complex issues.

Let's assume that one is producing a candy with a center high in oil. A suitable matrix-forming fat will be part of the ingredients in the filling. Experimental samples suggest that the center is stable, which means longer shelf life. Sensory tests indicate that flavor release is acceptable. You want to scale this product up to full production using the depositor in a shell-molding operation.

The filling must be properly cooled and precrystallized before it is transferred to the depositor hopper. The goal is to have 50 percent of crystallization occur before and during — not after — depositing. Precrystallization produces small seed crystals that assure proper crystallization later in the process. This is important because small crystals are ideal for an oil-holding matrix. Otherwise, a product with a high concentration of oil in the center would have a detrimental effect on the chocolate shell.

The critical factor is the set point temperature of the total fat phase of the filling. This is determined by the ratio of the nut oil to the matrix-forming fat. The higher the nut oil ratio, the longer it will take to induce crystallization. Rapid, controlled cooling of the filling will result in the formation of a fat matrix with smaller crystals. This is the same technique used in the manufacture of bakery shortenings.

In addition to precrystallizing, the distance between the cooling and precrystallizing vessel and the depositor hopper is important. The matrix formed in the filling will be destroyed if the filling is subjected to high sheer mixing, agitation or high sheer pumping. So, the longer the distance between the vessel and the depositor, the greater the destruction of the fat matrix. Of course, this completely defeats the purpose of adding the matrix-forming fat, because the oil will no longer be bound by the fat matrix and the matrix won't re-form in a highly desirable small-crystalline structure.

To avoid this problem, locate the cooling vessel directly above the hopper, so that cooled filling can be discharged by gravity feed, rather than by pumping. (Figure 5).

It's also important that the filling in the depositor hopper be at the ideal viscosity at application temperature. This can be accomplished by fine tuning the ratio of fats in the total fat phase of the filling.

Finally, plan to use the filling in the hopper quickly, especially if there are agitator paddles in the hopper. As already noted, excessive agitation in the hopper can lead to severe destruction of the fat matrix in the filling.

Barrier Coatings

Oil migration can also be managed by using barrier coating technology.

We create a barrier between the chocolate and the oil-rich center. Panning applications already use nonfat ingredients as a barrier. Barrier solutions are made with one, or combinations of several, hydrocolloids, such as gum arabic, gum acacia, modified starch and dextrin in sugar solutions with specific total solids. Precoating oil-rich centers (such as nuts and nutmeat-containing centers) with gum solutions made with gum acacia and sugar solutions, can help prevent the nut oil from migrating into the chocolate.

The confectionery industry needs to explore further to see if we can expand this technology into other confectionery applications. For example, the use of a non-fat barrier system in enrobing operations or spraying centers for products that can't be panned would be interesting. Perhaps the benefits would be similar to those seen in panned goods.

Some have had success using a vegetable fat in a barrier coating. The criteria for fat selection in barrier coating are similar to those in the fat matrix approach. The vegetable fat used in the barrier coating must be compatible with cocoa butter, must be able to retard fat migration and, of course, must have good eating qualities. These vegetable fat barrier coatings can also be used as bottomers where oil migration due to gravity is a concern.

The chocolate coating used as a barrier to minimize oil migration must be properly tempered and cooled. One can produce a chocolate with a very fine granular structure if one starts with well-tempered chocolate that has not been subjected to too many heating and cooling cycles prior to and after application. One must also cool it under optimum tunnel conditions.

Why? Because well-controlled tempering and cooling produces crystallization that yields a large number of very small beta crystals. These crystals form into a tighter crystalline matrix that is hard and has the ability to retard fat migration.

Another way to look at this crystallization behavior is to recognize that many smaller crystals have greater surface area than fewer large crystals, so more liquid uncrystallized cocoa butter and milk fat can be entrenched efficiently in the matrix.

Here's how that works. Visualize sand particles in a sand bed. Let's say that 10 pounds of sand will hold 2 pounds of water. If that sand is ground to a finer powder, that same 10 pounds of sand will hold 4 pounds or more of water, depending on the size of sand particles and the particle size distribution. Similarly, cocoa butter with the smallest crystals will result in a tighter matrix, producing a fine granular structure. It holds more oil and can be useful as a barrier to minimize oil migration. This stronger structural integrity also means that it is more heat stable.

Oil migration can also be managed by using barrier coating technology.

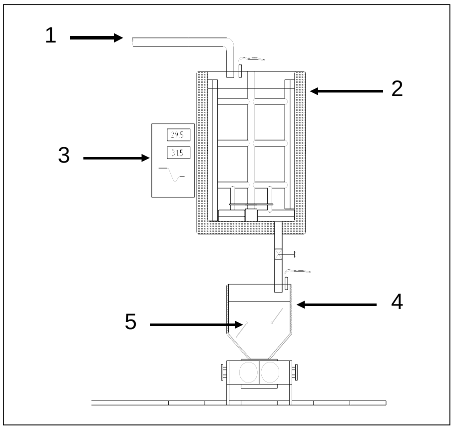
STORAGE ISSUES

Storage of finished products offers challenges because of many variables. We must consider the centers and their composition, the thickness of the chocolate coating and the presence of nuts and nutmeats in the product.

We also handle molded and enrobed products differently. Here are some generalized considerations:

Heat. When products exit the cooling tunnel, we must recognize that the cocoa butter in the chocolate has not completely crystallized. In fact, previous work has suggested that the amount of cocoa butter

Critical Process Considerations: Pre-crystallizing Vessel and Depositor



1. Filling Feed Line
2. Pre-crystallizing Vessel
3. Temperature Controls
4. Depositor Hopper
5. Agitator Paddles

Figure 5

The use of a nonfat barrier system in enrobing operations or spraying centers for products that can't be panned would be interesting.

Solid Fat Content of Cocoa Butter and Butter Fat Blends

	100% Cocoa Butter	95% Cocoa Butter 5% Butter Oil	90% Cocoa Butter 10% Butter Oil	85% Cocoa Butter 15% Butter Oil	80% Cocoa Butter 20% Butter Oil	100% Butter Oil
SFC @						
50°F/10°C	84.2	80.1	75.2	73.8	72.8	35.8
70°F/21.1°C	70.0	62.5	50.0	37.5	30.4	10.8
80°F/26.7°C	61.7	53.8	42.2	24.8	14.1	8.0
92°F/33.3°C	9.2	7.1	5.8	3.6	2.9	

Source: Aarhus Inc.

Figure 6

not crystallized is 10 percent or more and it can take 24 hours or more for a complete crystallization. This is more pronounced in milk chocolate with higher milk fat content, because milk fat depresses the solids profile. As seen in the SFC profile, it also delays the crystallization process (Figure 6).

If crystallization is incomplete and still underway, the heat of crystallization is going to be released from the product. Exposing products to temperatures higher than 65ºF at this point will result in latent heat being trapped in the wrapper, leading to disruption of cocoa butter crystal size and quality on the surface of the product.

Two things can happen at this point. The first is that the desirable small stable crystals that we've worked so hard to produce will melt. They will recrystallize into undesirable large crystals that yield a dull product. The beautiful gloss on the product when it exited the cooling tunnel will no longer be there.

The second problem is that, depending on the level of the heat stress to which the product is subjected, the quality of the crystalline matrix will deteriorate to a less stable beta prime form. This will result in surface bloom within days of distribution. The solution to both problems is to hold the products in a staging area for at least 24 hours at 68ºF and 60 percent humidity to allow the fat matrix crystallization to be complete before products are moved to a warehouse located outside of the manufacturing facility. Additionally, stack the boxes to promote heat transfer and don't shrinkwrap pallets for at least 24 hours, if possible.

Storage temperatures and humidity should be based on the shelf life expected from the product. For longer shelf life use lower temperature and lower humidity. C.D. Barnett has detailed guidelines for optimum storage conditions for specific types of confectionery products. But even with this type of information, one must still use discretion and design a storage protocol based on experiments with your products.

Odors. Chocolate can pick up odors, especially when products are in storage for six months. This phenomenon occurs because odors are more volatile than flavors and tend to diffuse through packaging materials, even ones that we would not expect them to penetrate. So chocolate products should be stored in warehouses dedicated to confectionery products only. Also, avoid storing non-mint and mint-flavored products close to one another. Finally, use dry, odor-free pallets to avoid a pine or woody smell.

CONCLUSION

We've covered some of the most important criteria to remember during chocolate production, chocolate application, storage and delivery of the product to consumers. This is, of course, from a practical, real world perspective and it is by no means exhaustive.

First and foremost, chocolate manufacturers must clearly understand the needs, production constraints and cost constraints of their customers — the chocolate users.

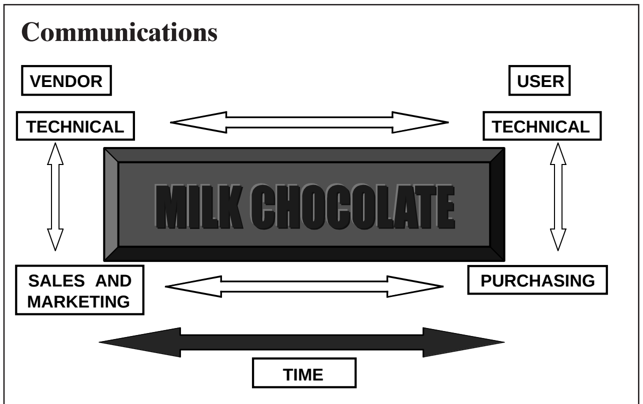


Figure 7

First and foremost, chocolate manufacturers must clearly understand the needs, production constraints and cost constraints of their customers — the chocolate users.

Not all chocolate users have the same types of equipment, production layouts and flexibility to use different forms of chocolate, so the chocolate that is delivered must be flexible enough to meet chocolate-user capabilities and facilities.

Communication

To accomplish the mutual goals of the chocolate manufacturer and the chocolate user, there's one other recommendation that is essential — communication.

You need a solid understanding of the final objectives of the project in order to optimize quality and cost. The chocolate user must recognize the technical objectives and balance these with cost objectives to achieve optimum product performance.

For this reason, solid communication among the technical and commercial groups from both the manufacturer and the user of chocolate is a prerequisite. Toward that end, I suggest a two phase/four group communication matrix (Figure 7).

The quality and level of communication among these four groups will determine how quickly and effectively the project objectives can be accomplished.

As we've seen, the chocolate user needs to be aware of the many considerations in storing, handling and processing the incoming chocolate, since not all chocolates are created equal. One size does not fit all. We must recognize the characteristics of the incoming chocolate and select one that can meet the quality standards needed in the finished goods.

We must understand, too, that the shelf life of finished products depends not only on the type of chocolate used but also on how it is processed, applied and stored.

The overall goal is to slow down the movement of fats and oils that are sensitive to cocoa butter. Oil migration is a fact of life. If you use milk chocolate high in milk fat in a product that has a high level of nut oil in the center, you can't expect it to be shiny, bloom-free and hard after six months, but carefully selected, matrix-forming fats can help manage this problem.

It is critical that we use the selected fat correctly. We can't completely stop oil migration, but with suitable matrix-forming fats, proper application parameters and process design and procedures, we can slow down the rate of migration and, as a result, extend shelf life.

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