Back to Basics — Moulding

Selection of Coating for Moulding Application

Evaluation of the chocolate properties and what works best in your system will enable the selection of the coating to match and achieve your goal.

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The principle objective of a candymaker is to provide a product that will please the consumer and hopefully bring him back for a repeat purchase. The principle purpose of a chocolate manufacturer is to provide chocolate that meets the needs of the candymaker. This Back to Basics paper about moulding and the selection of coatings has three parts: definitions, chocolate properties and selection.

DEFINITIONS

In *Webster's Dictionary*, a coating is defined as

> a layer of any substance spread over a surface for protection or decoration; a covering layer.

In the confectionery industry, when someone speaks of a chocolate coating, it is in reference to a pure chocolate that contains properties making it flowable for a specific application. A confectionery coating is sometimes referred to as a compound coating — this would contain vegetable oil rather than cocoa butter but would still maintain flowable properties. I am specifically focusing on chocolate (versus compound) in this paper. An accurate and concise definition of chocolate is "an intimate mixture of solid particles suspended in fat." This mixture will develop the unique character that determines exactly how it will function in specific applications.

To help us understand this mixture, let's take a brief look at the manufacturing process for chocolate. It all starts in the area where cocoa beans are grown, approximately 20° north and south of the equator. These cocoa beans are then roasted, shelled and ground into chocolate liquor. Some of this chocolate liquor is pressed to remove its component parts — cocoa butter and cocoa powder. Chocolate is manufactured by mixing sugar, chocolate liquor, a portion of the cocoa butter and milk ingredients (if it is a milk chocolate). This mixture is then refined (particle size reduced) for a specific smoothness to the tongue. The flake is conveyed to a conche where flavor development, shearing action and further coating of the solid particles with fat occurs. Once the conching process is complete, the product will be standardized to a specific viscosity. This entire process along with controls and formulaton will determine the unique character of the chocolate and how it will function in a given application, such as moulding, enrobing and dipping. Let's look a little closer and see what role this unique mixture plays in the outcome of chocolate products for the moulding process.

CHOCOLATE PROPERTIES

The properties of a chocolate that would influence chocolate behavior for a moulding application are product flow (viscosity), particle size (fineness) and temperability (type of fat). Equipment and troubleshooting are also important.

Viscosity

Viscosity is a measurement used to describe the flow properties of a product, specifically its resistance to flow. Some ways of measuring viscosity are the MacMichael, Brookfield and Haake methods. All of these methods are used in industry today, with Brookfield being the most common.

MacMichael viscosity measurement began in 1915 using degree MacMichael as the measurement of this single-point system. The product is tested at a specific temperature, using a specific cylinder diameter and depth-measuring torque. It gives a number indicating how thick or thin a product is, but does not tell the complete picture about the flow characteristics of the product. This is not as commonly used today, but the original numbers generated from this method are still referred to when selecting a specific coating and are easy for us to relate to. For example, a 65 viscosity is very thin and refers to hollow moulding, a 145 viscosity might be used for enrobing or moulding with inclusions, and a 200 viscosity would be considered thick and can be used for solid moulding.

In 1988, the USA Brookfield viscometer or rheometer determined a two-point result showing a more absolute measurement of the chocolate performance or flow properties. Brookfield, at a specific temperature, can take readings at increasing rates of shear, followed by similar readings at decreasing speeds. Using Casson's calculations, typically on a computer program, plastic viscosity and yield value can be determined.

Rheology is defined as the study of the deformation and flow of matter with stress. Viscosity is the name given to this internal friction of fluids. Essentially, there are two types of liquids, Newtonian and non-Newtonian. Newtonian fluids are independent of shearing—you can stir as much or with as much force as you want and they will not change. Examples would be water, alcohol, liquid fat or glycerol.

Chocolate is non-Newtonian and its viscosity varies according to the rate at which it is stirred (sheared). It is affected by the presence of solids in suspension. As defined, chocolate is a suspension of particles in a fat phase. These products need a force to start them to flow. This is known as yield value. More specifically, the yield point should be defined as the shear stress at which not only deformation occurs but stationary flow begins. Examples of products with yield value would be ketchup, meringue or mayonnaise. Left on their own, they have their own "standup," meaning a high yield value.

Yield value (YV) is reported in dynes/square centimeter. Plastic viscosity (PV) is then the force needed to maintain this flow once it is moving, which is known as poise. Brookfield can measure these Casson values. Let's look at how to measure viscosity using a Brookfield viscometer. ➤

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Viscosity is controlled by the ingredients utilized in the formula, the amount of surface area created during the manufacturing process, the amount of fat in the system, and the type and amount of emulsifers.

Example: Brookfield Model DV-III Programmable Rheometer, small sample adapter, 27 spindle.

- Brookfield reading at 40°C, 20 RPMS.
- 20 RPMS X 3.4 (some say 3.7) = MacMichael reading (NCA).
- Readings at speeds of 5, 10, 20, 50 and 100 RPMS forward and back can be plugged into a computer equation calculating YV and PV.
- Exact values must be determined based on supplier, equipment and historical data.

A lower yield value is desired for moulding so product will flow evenly into a mould, especially with inclusions, so proper shakeout can occur and removal of air pockets is successful. A higher yield value is desired in enrobing to prevent decorations from collapsing and to avoid feet formation in the bottom of pieces.

Emulsifiers also influence flow properties of chocolate (Figure 1). The standard of identity for chocolate allows up to 1 percent emulsifers. Soy lecithin is the most typical emulsifier utilized in chocolate manufacturing. Lecithin has both lipophilic (fat-loving) and hydrophilic (water-loving) properties. This surface active agent greatly affects chocolate fluidity. The addition of 0.3–0.4 percent lecithin has the same viscosity-reducing effects as over ten times this amount of cocoa butter. At greater than 0.5 percent levels of lecithin, the chocolate viscosity actually starts to increase.

Emulsifiers

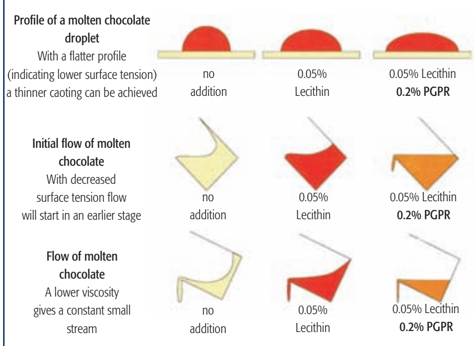

Figure 1

Polyglycerol polyricinoleate (PGPR), a unique surfactant, is another approved emulsifier for the chocolate manufacturer that greatly reduces and can even eliminate yield value of chocolate. PGPR will also reverse the effects of minor increases in the moisture content of chocolate caused by a high humidity or coating high-moisture products. The exact amount required depends on the yield value you would like to achieve. Typically, a combination of lecithin and PGPR can be used to manipulate chocolate to meet your needs.

Viscosity is controlled by the ingredients utilized in the formula, the amount of surface area created during the manufacturing process, the amount of fat in the system, and the type and amount of emulsifers. Ranges of viscosity for moulding can be from very thin to very heavy. Cold press technology is quite independent of viscosity and can achieve the perfect pieces using its unique systems.

Particle Size

A particle is any object having definite physical boundaries in all directions without respect to size. Traditionally, fineness (how coarse or fine) is determined by handheld micrometers measuring only the largest particle in the sample. This measurement can be in inches or microns. A blend of approximately one part oil with three parts chocolate mixed together and tested on a rotational micrometer will give the largest particle in the mixture.

It is a great tool to use online in the production process or for a quick check as products are received into your manufacturing plants.

The micrometer does not tell you the distribution of the particles — only the largest particle. ➤

Laser-light-scattering measuring equipment has been developed and is widely used to look at all the particles of a mass today. This unit can identify the size and amount of all particles within the determining range of the instrument. One way of measuring is to take a very small amount of sample, disperse it into a solvent and inject that mixture into a measuring unit. Particles will diffract the laser beam at different angles depending on their size. The laser beam is focused on a field of particles and then the angle of diffraction is observed. Smaller particles diffract light at wider angles and different intensities than larger particles. This type of fast QC check can tell the distribution of the particles — information that is needed to evaluate fat requirements, yield value and mouthfeel.

Moulding products may require a range of particle size dependent on the finished product. A more fine product will increase the surface area, increasing viscosity and causing flow issues into the mould. If viscosity is critical, a more fine product will require more cocoa butter to maintain required viscosity, creating a higher cost product. If a product is being manufactured with inclusions that create noise in the chewout, a fine particle size might not be necessary. Consideration of all of these options will help select the ideal coating.

Type of Fats

Again, we are focusing on cocoa butter products here because cocoa butter is the ultimate fat with desirable melt in the mouth, enabling proper flavor release. Cocoa butter with its unique melting characteristics as shown in Curve 1 of Figure 2 requires tempering. Tempering is the process of inducing partial crystallization of cocoa butter to ensure a finished product with acceptable gloss and shelf stability when cooled properly. Proper temper and storage result in an increased absence of bloom.

If we look at specific recipes for semisweet chocolate and milk chocolate, the major difference is that semisweet chocolate typically contains very little or no amount of milkfat. Milk chocolate must contain a minimum of 3.39 percent milkfat and high-quality milk chocolate will contain more.

The ratio of milkfat to cocoa butter can result in different functional properties of chocolate. Milkfat tends to soften chocolate, making it more plastic and less heat resistant than semisweet chocolate. Since milkfat is 75 percent liquid at room temperature and does not share the same crystal form as cocoa butter, it is incompatible and creates a softening effect. As the level of milkfat to cocoa butter increases in the Jensen cooling curve, the crystal-initiating temperature decreases and as a result the time required for a complete crystallization becomes longer. Practically speaking, the more milkfat, the longer a product

Tempering is the process of inducing partial crystallization of cocoa butter to ensure a finished product with acceptable gloss and shelf stability when cooled properly.

Cooling Curves of Cocoa Butter and Butterfat

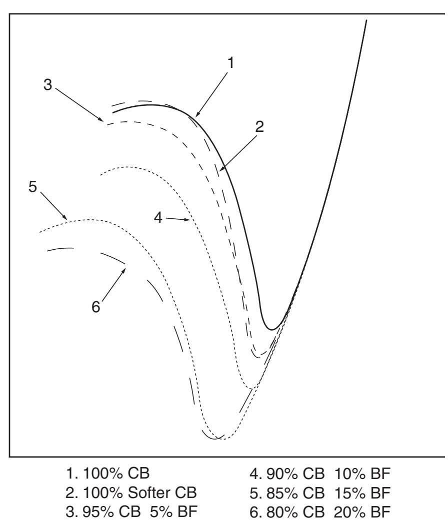

Figure 2

Specifications can be geared to maintain flavor, appearance and cost, and also to focus on specific characteristics the manufacturer must achieve during the production process.

takes to seed and set up properly. It is known that a small amount of milkfat in semisweet chocolate aids in bloom stability. In moulding, contraction is critical for successful demoulding of products. Improper ratios of milkfat to cocoa butter may result in soft products leaving fat behind in the mould, causing the next round of products to have mottled fat on the piece.

Rules of thumb:

- Less than 5 percent milkfat will require modification to tempering and cooling parameters.
- A 1:3 milkfat to cocoa butter ratio is ideal.
- 2–3 percent milkfat in semisweet chocolate will provide protection against bloom.

PRODUCT DESIGN/SELECTION FOR MOULDING

When selecting a chocolate for the moulding process, certain questions must be asked:

- What type of finished product do I want?
- Do I need a milk, semisweet or white chocolate?
- What flow properties do I need to request?
- What fineness do I need for my product?

Let's explore a product specification sheet so we know what to look for and what to request. Specifications can be geared to maintain flavor, appearance and cost, and also to focus on specific characteristics the manufacturer must achieve during the production process.

A typical supplier of chocolate will provide a specification sheet for chocolate including but not limited to the following:

- Product ingredient listing in descending order.
- Physical parameters (viscosity, fineness, fat).
- Microbiological parameters (product safety).

Product Ingredient Listing

An ingredient listing will include in descending order a list of what is in the product with the largest amount of ingredient first down to the smallest.

Example #1: sugar, cocoa butter, chocolate liquor, milk, soy lecithin (an emulsifier), vanillin (an artificial flavor).

One interpretation of this ingredient listing is that this milk chocolate contains a low amount of milk, therefore it would contain a low amount of milkfat to cocoa butter ratio and typical tempering parameters would produce quality products.

Example #2: sugar, milk, chocolate liquor, cocoa butter, soy lecithin (an emulsifier), vanilla.

Due to milk being the second ingredient in the listing, it is a high milkfat-containing chocolate, therefore the milkfat to cocoa butter ratio might be higher and may require slightly lower tempering parameters and a longer cooling time. This product may yield a softer finished product.

Example #3: sugar, chocolate liquor, cocoa butter, milkfat, soy lecithin (an emulsifier), vanillin (an artificial flavor).

This is a typical semisweet chocolate containing milkfat to aid in bloom prevention.

Physical Parameters

Some physical parameters that could be listed on a specification sheet might be viscosity, fineness and percent total fat.

A viscosity of 190–200 MacMichael, 55–60 Brookfield at 20 RPMS, 40°C, would indicate a heavy or thick product, while a viscosity of 65–75 MacMichael, 19–22 Brookfield at 20 RPMS, 40°C, would indicate a very thin product.

If you were to specify in plastic viscosity (PV) and yield value (YV), this would be where to analyze what works best in the specific moulding application. ➤

Fineness (Particle Size)

Fineness specification would typically be reported in inches or microns. A particle size of .0006–.0008 inches or 15–20 microns would be very fine and silky smooth to the tongue. It would be desirable for flavor release and complement a smooth, creamy center.

A particle size of .0018–.0020 inches or 45–50 microns would be a more coarse product and perceived as sandy to the tongue and could be incorporated into products containing crisp rice or nuts. It has been stated that a fineness greater than 20 microns is perceived by the tongue.

Percent Fat

A reading of 24–26 percent fat would indicate a very low fat content for a chocolate and a resultant high flow characteristic and most likely a lower-cost product.

A reading of 34–36 percent fat would indicate a higher fat content for a chocolate and a very flowable, thin product with a higher cost.

Microbiological Specifications

Microbiological standards are basic to the confectionery industry and would be performed using AOAC/BAM methodology by an accredited laboratory. With good manufacturing practices, there should be no issue meeting microbiological requirements.

- APC: <25,000/g
- Coliforms: <0.3/g MPN
- *E. coli:* 0.3/g MPN
- Yeast and mold: <100/g
- *Salmonella:* neg/750 g

PUTTING IT ALL TOGETHER

Let's look at several scenarios to help us decide what coating we need to select for a specific moulding application.

Solid Moulding

Solid moulding typically can tolerate a heavier viscosity. Selecting a fineness for solid moulding is very dependent on meeting flavor release requirements and whether or not you are adding any inclusions. The intricacy of the moulds will also influence your selection.

An example of a solid moulded specification sheet might be as shown in Figure 3—it would be used for a solid moulded chocolate due to the high viscosity, low fat and also low fineness.

One-shot Depositing/Shell Moulding

One-shot requires the center viscosity to be very close to the coating viscosity. The particle size must match the center of the piece. For example, if you are pairing a truffle center with a coating, the specification will require a very fine coating. If nuts or crunchy centers are desired, a more coarse coating will work fine.

Figure 4 shows the coating heavy and the center thin. You can see how it changes the forming inside the piece, risking the integrity. Figure 5 shows the coating thin and the center heavy, risking the chance of the center leaking out through the coating.

An ideal coating and center viscosity

Solid Moulded Specification Sheet

Milk Chocolate A

Description: A blend of sugar, cocoa butter, milk, chocolate liquor and soy lecithin (added as an emulsifier). The product is refined, conched and standardized for flavor, color and viscosity.

Physical Characteristics

1. Fineness	.0008–.0010 inches 20–25 microns
2. Standard Viscosity	190 +/- 10 NCA 53–59 Brkfld, 20 RPMS, 40°C
3. Moisture	Less than 1%
4. Color and Flavor	To match standard
5. Total Fat	27.5% +/- 1%

Figure 3

With good manufacturing practices, there should be no issue meeting microbiological requirements.

shows exact fill and the integrity of the piece is perfect (Figure 6).

An example of a one-shot/shell moulding specification sheet might be as shown in Figure 7; this could be used for moulding with inclusions or one-shot depositing due to its compatibility with center viscosities and ease of flow into the mould with inclusions.

Viscosity Effects—Coating heavy, center thin

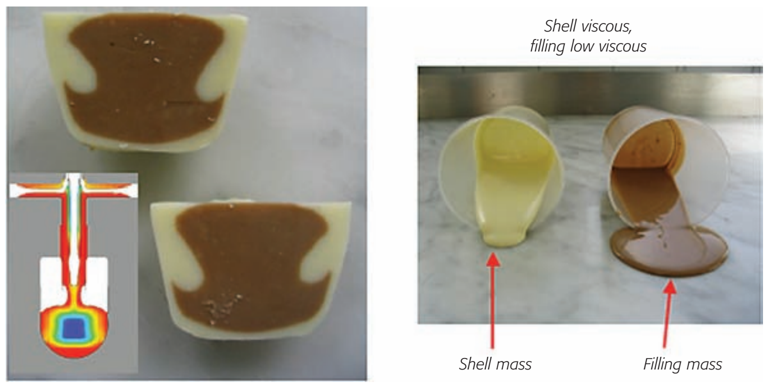

Figure 4

Viscosity Effects—Coating thin, center heavy

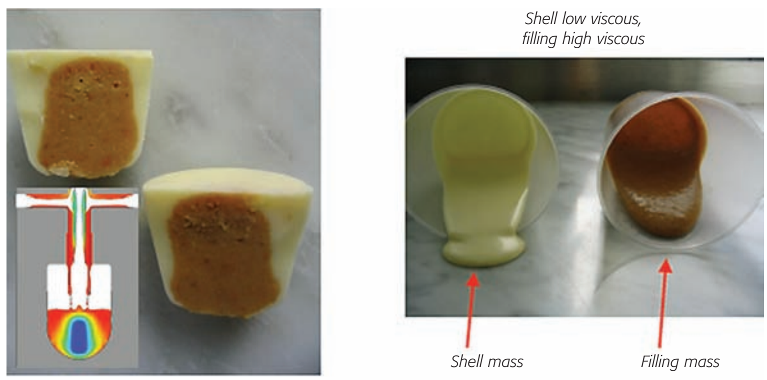

Figure 5

Viscosity Effects—Coating and center matched

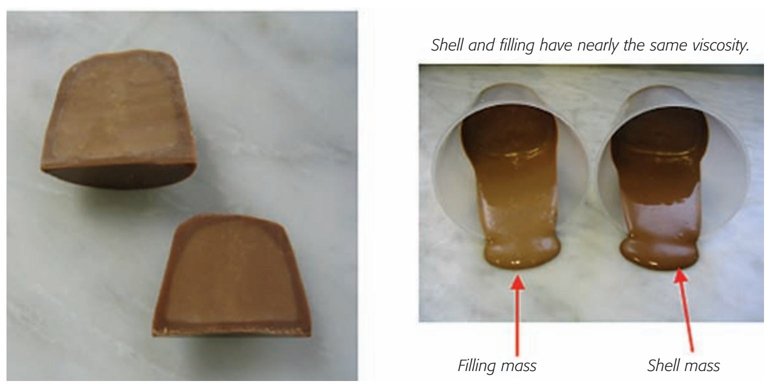

Figure 6

➤

Hollow Moulding

Hollow moulding requires a thin, flowable viscosity for complete coverage of the mould during filling, agitation and rotation. Particle size is typically based on the desired mouthfeel or price point.

An example specification sheet for hollow moulding might be as shown in Figure 8.

This coating would most likely be used for a hollow moulded product to aid in total coverage of the mould, filling all the intricate designs in the mould. Note the high fat content.

The coating shown in Figure 9 would be used for either a lower-price product or a product containing inclusions such as crisp rice or nut pieces.

Example ranges for moulded products are in Figure 10 for a reference.

CONCLUSION

In summary, it is critical to define the goal of the final product. Are you targeting a specific particle size, flavor melt characteristic or price point? There is quite a diverse selection of milk, semisweet and white chocolate available. Evaluation of the chocolate properties and what works best in your system will enable the selection of the coating to match and achieve your goal.

Ultimately, the perfect coating is the one that meets the flavor profile at the intended price point and that runs well on your plant machinery. □

Hollow moulding requires a thin, flowable viscosity for complete coverage of the mould during filling, agitation and rotation.

One-shot/Shell Moulding Spec. Sheet

Milk Chocolate B

Description: A milk chocolate manufactured from a blend of sugar, cocoa butter, milk, chocolate liquor, soy lecithin (added as an emulsifier) and vanillin (an artificial flavoring). The product is refined, conched to create a mild chocolate flavor and standardized for color and viscosity.

Physical Characteristics

1. Fineness	.0006–.0007 inches 15–18 microns
2. Standard Viscosity	145 +/- 5 NCA 41–44 Brkfld, 20 RPMS, 40°C
3. Moisture	1% max.
4. Color and Flavor	To match standard
5. Fat	32% +/- 1%

Figure 7

Hollow Moulding

Milk Chocolate C

Description: A blend of sugar, cocoa butter, whole milk, chocolate liquor, soy lecithin (added as an emulsifier) and vanillin (an artificial flavoring).

Physical Characteristics

1. Fineness	.0009–.0011 inches 23–28 microns
2. Standard Viscosity	65 +/- 5 NCA 18–21 Brkfld, 20 RPMS, 40°C
3. Moisture	Less than 1%
4. Color and Flavor	To match standard
5. Fat	36%–38%

Figure 8

Hollow Moulding with Inclusions

Milk Chocolate D

Description: A blend of sugar, cocoa butter, whole milk, chocolate liquor and soy lecithin (added as an emulsifier). The blend is refined, conched and standardized for flavor, color and viscosity.

Physical Characteristics

1. Fineness	.0018–.0020 inches 46 –50 microns
2. Standard Viscosity	145 +/- 5 NCA 41–44 Brookfield, 20 RPMS, 40°C
3. Moisture	Less than 1%
4. Color and Flavor	To match standard
5. Fat	29%–31%

Figure 9

Example Ranges

Type	Viscosity (NCA)	Fineness (microns)	Fat (%)
Solid	140–200	15–50	28–32
Hollow	60–70	15–50	32–36
One-shot	140–150	15–30	30–32

Figure 10