Weather and humidity are factors that we deal with on a daily basis; sometimes we can feel humidity and other times we cannot. Similar to how it affects other aspects of our lives, humidity can play a pivotal role in the process of candy making. Quality issues in candy manufacturing can often be traced back to inconsistencies in humidity levels, and even slight humidity fluctuations can require procedural changes.

This article overviews humidity control in manufacturing environments including the impact of high and low humidity, the value of regulating humidity, controlling storage conditions and efficiencies, effects of cooling tunnels, and other aspects that may impact the development and production of different types of candy. Maintaining a proper humidity level is essential in a wide variety of food, beverage and confectionery applications to ensure appealing products and optimal production.

THE IMPORTANCE OF HUMIDITY CONTROL

Humidity refers to the amount of moisture or water vapor present in the air. Hygroscopic substances absorb moisture from the air, therefore any change in humidity will impact the consistency of that substance. Most confectionery items—chocolates, caramels, hard candies, chewing gums, toffees and others—are rich in sugar, making them hygroscopic at certain moisture levels. So when exposed to excessively humid conditions, confections will absorb more moisture, making them sticky, runny or moldy.

Humidity affects all processing. We see it often in our own kitchens or any facility dealing with bulk storage and sugar conveying. Maintaining effective control of humidity is critical in manufacturing environments, not only for consistent, high quality final product, but also for optimal performance of manufacturing processes.

Cooking candy sugar to the proper temperature requires achieving the appropriate balance of sugar and moisture. The ideal condition for candy making is a cool, dry atmosphere so that the candy will cool faster and reduce the likelihood of unwanted crystal formation. Remember, high humidity also occurs in cold temperatures. Because of this, cooling only a limited area is likely not enough and could even be worse than...
a warm warehouse or production area. While keeping air dry is the goal, air that is too dry could also harm the finished product. Hence, humidity control in a manufacturing setting is very important. Relative humidity (RH) needs to stay within a certain window to avoid these problems.

**MEASURING AND CALCULATING HUMIDITY**

You cannot manage what you cannot measure. Being able to accurately measure humidity is a crucial step in trying to manage and control it. Appropriate humidity control will lead to consistent operations, high quality products with longer shelf life, and improved productivity and operating costs.

The first step in measuring humidity is to cool the air and weigh the moisture within it. Then, we need to chemically absorb the moisture and correlate some other property to it, such as thermal conductivity. A graph illustrating thermal conductivity based on air temperature can be seen in Figure 1. Lastly, we use infrared spectroscopy and a sling psychrometer in determining humidity.

A hygrometer is an instrument used to measure the amount of humidity and water vapor in the atmosphere, soil or a confined space. Instruments used to measure humidity typically rely on the measurement of some other quantity such as temperature, pressure, mass or a mechanical or electrical change in a substance as moisture is absorbed. By comparison and calculation, these quantities can determine a measurement of humidity.

Relative humidity, or RH, is the ratio of water vapor present in a given volume of air at a given temperature to the maximum amount of water vapor the air can hold, expressed as a percent (Figure 2). It is dependent on temperature and the pressure of the system being calculated. The same amount of water vapor results in higher RH in cool air than warm air.

Wet-bulb temperature is the lowest temperature to which air can be cooled by the evaporation of water into the air at a constant pressure. It can be measured by using a thermometer with the bulb wrapped in a water-soaked cloth (Figure 3). The wet-bulb thermometer indicates a temperature close to the true (thermodynamic) wet-bulb temperature. At 100 percent RH, the wet-bulb temperature is equal to the air temperature, and therefore would be lower at lower humidity.
EFFECTS OF INCONSISTENT HUMIDITY IN PRODUCTION

Inconsistent humidity impacts every aspect of production. For example, humidity can cause powdered materials to clump, stopping production. When humidity and moisture levels are uncontrolled during manufacturing or coating of confectionery products, changes in the structure or dimension of the core interface may occur. This change inhibits natural flow as product sticks to high-speed processing and packaging machinery as well as wrapping material, slowing production and creating hygiene problems. It can also have a dramatic impact on how finished product appears and tastes.

The effects of both high and low humidity in production are investigated in more detail below and summarized in Figure 4.

High Humidity Effects

Two of the basic ingredients used to make candy are sucrose and corn syrup, so the majority of candy is highly hygroscopic in nature. This can lead to candy that does not cool correctly (sticky, tacky, cloudy), is prone to mold formation and is softer than desired. In addition, high humidity can cause grainy and irregular coating, sugar blooms and flavor changes (Figure 5). Bloom is defined as the phenomenon in which fat and sugar crystals rise to the surface of chocolate candy when it absorbs unwanted moisture during packaging. High humidity can also ruin texture and make confections soggy and visually unappealing. Unwanted moisture can also affect productivity such as equipment blockages and production stops caused by powder clumping. This leads to a decrease in production efficiency due to high yield loss and potential hygiene problems.

Measuring Wet Bulb Temperature

- Thermometer has a wet cloth around bulb
- Air blows past cloth
- As water evaporates, bulb is cooled
- Difference between dry and wet bulb temperatures is related to relative humidity (RH)
  - No water will evaporate at 100% RH, therefore, dry temperature = wet bulb temperature
  - Largest $\Delta$ temperature with driest air

Product Issues Related to High and Low Humidity

<table>
<thead>
<tr>
<th>High Humidity</th>
<th>Low Humidity</th>
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</thead>
<tbody>
<tr>
<td>Sucrose and corn syrup are highly hygroscopic</td>
<td>Panning – will dry too quickly</td>
</tr>
<tr>
<td>Sticky, runny, high water activity</td>
<td>Fragility – cracking</td>
</tr>
<tr>
<td>Makes the process slow and creates hygiene problems</td>
<td>Moisture migration</td>
</tr>
<tr>
<td>Could lead to reduced shelf life and product returns</td>
<td>Product degradation</td>
</tr>
<tr>
<td>Product won’t cool correctly – sticky</td>
<td>Product loss</td>
</tr>
<tr>
<td>Reabsorb moisture, softer texture or grain</td>
<td>Material transport</td>
</tr>
<tr>
<td></td>
<td>Dry material can be abrasive causing equipment to wear</td>
</tr>
</tbody>
</table>

Effects of High Humidity on Confections

- Cloudy appearance
- Grainy and irregular coating
- Sugar bloom

Two of the basic ingredients used to make candy are sucrose and corn syrup, so the majority of candy is highly hygroscopic in nature.
**Low Humidity Effects**

In many cases, dry air is ideal for production; however, air that is too dry can also cause problems that could be avoided with appropriate humidity monitoring. Confectionery panning is one such case, where low humidity can cause product to dry too quickly. Other issues with low humidity include fragility, where product is very dry and prone to cracking, along with moisture migration. Overly dry material can also be abrasive, leading to excessive equipment wear.

### Humidity Control in Various Confectionery Processes

<table>
<thead>
<tr>
<th>Process</th>
<th>Recommended Relative Humidity</th>
<th>Details</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hard Candy Packaging</td>
<td>35%</td>
<td>Will absorb moisture quickly in high humidity conditions due to its very dry state after cooking production.</td>
</tr>
<tr>
<td>Coating and Polishing</td>
<td>40% to 45% RH</td>
<td>Monitoring humidity during coating and polishing is very important since inconsistent humidity can cause coating to be irregular. The recommended RH for consistent coating and polishing is 40 percent.</td>
</tr>
<tr>
<td>Sugar Crystallization</td>
<td>35% RH or lower</td>
<td>Sucrose is highly hygroscopic; therefore, the recommended RH for sugar crystallization is 35 percent or lower.</td>
</tr>
<tr>
<td>Screening</td>
<td>Relative humidity dependent on application</td>
<td>Typically below 50% RH. Must be below the dew point to eliminate any possibility of condensation on cool metal or a polyscreen.</td>
</tr>
</tbody>
</table>

**Processes Where Humidity Control Is Important**

Humidity control plays a critical role as detailed in the following confectionery processes and summarized in Figure 6.

1. **Hard Candy Packaging**: Due to its very dry state after cooking, hard candy will absorb moisture quickly in high humidity conditions. It is recommended that the RH for hard candy packaging is maintained at 35 percent in order to keep the candy from absorbing moisture from the air during the packaging phase.

2. **Coating and Polishing**: Monitoring humidity during coating and polishing is very important since inconsistent humidity can cause coating to be irregular. The recommended RH for consistent coating and polishing is 40 percent.

3. **Sugar Crystallization**: Sucrose is highly hygroscopic; therefore, the recommended RH for sugar crystallization is 35 percent or lower.

4. **Screening**: The recommended RH for screening depends on the application, but it is typically below 50 percent. It must be below the dew point in order to eliminate any possibility of condensation on cool metal or a polyscreen.

### Optimal Compressed Air System Configuration

![Diagram of a compressed air system configuration](image-url)
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Humidity Control in Manufacturing Environments

It is crucial that you engineer a system that provides the ideal environmental conditions that meet the needs of your material, both in ingredients and in processing.

EQUIPMENT TO CONTROL HUMIDITY
Various factors contribute to proper humidity control.

Environmental conditions should be considered, including production area size and the use of air conditioning equipment, dehumidifiers, and both roof and wall insulation are all factors to consider when managing humidity. Outside weather can affect conditions as well, so be sure to be within the range of 40 to 55%rh within the room. If used, compressed air needs to be monitored when it is in contact with production. An optimal compressed air system configuration can be seen in Figure 7.

During storage, allowing candy to dry in an airtight container with an effective desiccant (drying agent) for a few hours can promote the absorption of excess moisture that can lead to diminished candy quality. It also helps to run air conditioning at a lower temperature, making sure that the air is dry as well. It is recommended to store product at 40%rh.

It is crucial that you engineer a system that provides the ideal environmental conditions that meet the needs of your material, both in ingredients and in processing. For example, storage of panned products post-processing is recommended at 40 to 50%rh. Higher rh can cause sticking, while lower rh can cause cracking of seal coats. Using proper equipment throughout your system will help provide humidity control.

1. Enclosing belt coaters: Using an enclosed belt coater is a reliable way to uniformly coat product while protecting it from moisture and other elements. This equipment helps deliver appealing products that meet quality standards by maintaining consistent product moisture level. An example of an enclosed belt coater can be seen in Figure 8.

2. Desiccant air dryers: A desiccant air dryer is a specialized drying system that works by removing water vapor from compressed air. The air in a desiccant dryer is circulated in a closed loop between the drying hopper and dryer to ensure low air humidity at all times. A typical desiccant air dryer can be seen in Figure 9.

3. Spray dryers: Spray drying is a method of producing a dry powder from a liquid or slurry by rapidly drying the product with a hot gas. Dehumidification of dryer inlet air prevents sticking, increases production capacity, reduces downtime and allows for consistent high-powder quality.

4. Controls and instrumentation: Installing controls and instrumentation is important, as doing so integrates critical control points to capture important production data in real time. This data helps in controlling and optimizing processing techniques to ensure consistent productivity and quality.
5. Dry air systems – air delivery: Dry air systems (Figure 10) remove any excess moisture caused by high humidity. These systems can include a traditional panning system with delivery of controlled-temperature air blown into pans.

6. Cooling tunnels: Cooling tunnels, also seen in Figure 10, ensure controlled temperature reduction in both batch and continuous process systems. Tunnels allow for controlled, slow drying of product, providing efficient and reliable cooling.

CONCLUSION

Controlling humidity can increase productivity, improve the consistency and quality of finished products, produce less waste and higher yields, and lengthen product shelf life. Implementing these procedures can lead to more efficient production, packaging and storage, promoting lower operating costs.

While we cannot control the outside weather and humidity, we can control the conditions in which we manufacture our products. Continuous monitoring of humidity levels is necessary since even slight changes in humidity can necessitate procedural changes. Knowing the processes where humidity control is important, understanding how to measure humidity and using proper equipment to control humidity during manufacturing are all key steps to take when managing the humidity in your facility.

REFERENCES


Google, Humidity Control in Confectionery Manufacturing Applications; The Bry-Air webpage

Google, Managing Humidity in Confectionery Operations – Cotes A/S; the Cotes webpage


