BASIC BATCH COATER OPERATING PARAMETERS AND SETUP

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This article discusses the basic operating parameters and setup for a perforated pan film coater.

Film coating is a widely used process in tablet manufacturing. Applying a clear or colored aqueous or solvent-based coating can improve a pharmaceutical tablet’s appearance, taste, and/or swallowability; make it stronger or easier to handle; or modify its API-release properties. Tablet coating isn’t an overly complex process, but proper coater setup and operating parameters ensure that your tablets are coated evenly and adequately without defects.

While the coating formulation and the equipment design also impact coating quality, in this article we will focus on the qualitative relationships between key parameters when using a fully perforated pan film coater. Understanding these parameters and their effects on the coating process will help you perform basic setup and problem solving with your coating system. Note that this
article isn’t a comprehensive guide to coater setup and operation; it’s just a beginning step toward continuous improvement and training for coating equipment operators.

**Film coater basics**

A typical perforated pan tablet coater, as shown in Figure 1, is comprised of the following basic components:

1. A coating pan (or drum) with internal mixing baffles;
2. A spray system consisting of one or more atomizing spray guns mounted inside the coating pan and connected via a hose and pump to a solution tank;
3. A process air handling system, including a fan or blower, an inlet filter, heating elements, and a dehumidification unit with cooling coils and/or desiccant; and
4. An exhaust air handling system, including a fan or blower and an exhaust filter (not shown).

During coating, an operator loads a batch of tablets into the coating pan, which rotates on a horizontal axis. As the pan rotates, the mixing baffles lift and mix the tablets, creating a cascading motion in the tablet bed. The spray guns atomize and direct the coating solution at the cascading tablets, coating them evenly as they pass through the spray zone. At the same time, the process-air fan forces heated, conditioned air into the pan to dry the coated tablets, and the exhaust fan creates negative pressure inside the coater, drawing the process air through the tablet bed and carrying away the evaporated moisture or solvent.

A batch coater’s critical operating parameters include the batch size, the coating-pan speed, the spray-gun setup, the spray rate, the tablet bed temperature, and the process airflow rate and dew point.

**Figure 1**

Perforated pan tablet coater

<table>
<thead>
<tr>
<th>Exhaust blower</th>
<th>Heating elements</th>
<th>Inlet blower</th>
<th>Cooling coils</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mixing baffle</td>
<td>Coating pan</td>
<td>Solution pump</td>
<td>Solution tank</td>
</tr>
<tr>
<td>Spray gun</td>
<td>Tablet bed</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Batch size**

Batch size is perhaps the most fundamental coating parameter since it helps you determine all the other parameters. The size of your batch will directly affect pan speed, spray gun setup, spray rate, bed temperature, and process airflow. Your coating equipment supplier can provide you with a batch size range for your coating pan measured as a percentage of the pan’s total working volume.

For example, Freund-Vector’s production-size units are designed to accommodate batches of 25 to 95 percent of the pan’s total working volume. To determine whether and where your batch size fits into your coating pan’s batch-size range, you’ll need to use the bulk density of the tablet cores you’re working with to calculate the total volume of your batch and divide that by your coating pan’s total working volume.

Since most coating pans can accommodate a wide batch size range, you may need to adjust your operating parameters depending on where your batch size falls in that range. For example, when working at the lower end of your pan’s range, it’s common to use a lower-profile baffle to ensure proper mixing of the tablet bed. This will decrease any chance of overspray that could occur as a result of the standard baffles protruding from the smaller tablet bed. When running outside of your coating pan’s range, it’s common to see tablet coating defects, the most common being low tablet weight gain caused by overspray and coating buildup on the baffles and pan wrap.

**Coating-pan speed**

Once your batch size is established, you can determine the proper rotational speed for your coating pan to provide even coating and consistent weight gain on the tablets. If you run your pan too slowly, the tablet bed may lag or pause intermittently. When this occurs, some tablets may spend too much time in the spray zone and become over-wet, which could lead to sticking or picking defects. If the pan speed is too fast, the tablets may begin to move erratically through the spray zone rather than traveling uniformly with the rest of the bed, which can produce undercoated tablets. The goal is to achieve a uniform, cascading motion as the tablets travel through the spray zone.

**Spray-gun setup**

Once you’ve determined the proper pan speed, you can set up your spray guns. The number of spray guns will be determined by the size and design of your coating pan. For example, Freund-Vector coating pans use between one and 12 spray guns spaced evenly 7 inches (177.8 millimeters) apart. If the spray guns are spaced inconsistently, you may see an overlapping spray pattern or dead spots in the spray zone. This can cause over-wetting or streaking, either of which will negatively affect coating uniformity.

Once the spray guns are installed, you can turn on the pan and adjust the angle and distance of the guns relative to the tablet bed. These adjustments need to be done as the tablets are tumbling to ensure proper coverage of the tablet bed. To do this, divide your tablet bed into thirds and adjust the guns so that they are perpendicular to the tablet bed and are aimed to deliver the solution between the bed’s first (highest) and second (middle) thirds. If the guns are aimed too high, the spray will coat the tablets near the top of the tablet bed, where the bed depth is shallower. This can cause coating to build up on the pan wrap, decreasing yield and adversely affecting product...
uniformity. If the guns are aimed too low, the coated tablets may not have enough time to tumble and dry before other tablets tumble on top of them. This can cause over-wetting of the tablet bed and potentially lead to coating defects such as sticking and picking.

After the spray-gun angle and direction is set, ensure that the guns are the correct distance from the tablet bed. For most aqueous coating solutions, Freund-Vector recommends a distance of 8 to 10 inches (203.2 to 254.0 millimeters) between the spray-gun nozzle and the tablet bed. For processes using solvent-based solutions, that distance should be decreased to 6 to 8 inches (152.4 to 203.2 millimeters) to compensate for the solvent's increased evaporation rate. In either case, locating the spray guns too close to the tablet bed can cause spray blowback, which will decrease your yields.

The next step is to adjust the guns' atomization and pattern air. The spray guns use high-pressure air to atomize the coating solution into fine droplets during spraying. The amount of air pressure determines the droplet size—higher atomizing air pressure results in smaller droplets, and lower atomizing air pressure results in larger droplets.

The amount of atomizing air you should use depends on the type of coating solution you're applying. High-viscosity solutions require higher atomizing air volumes than lower viscosity solutions to achieve a similar droplet size. If your atomization air is too high, the droplets will be smaller, and a higher percentage of the liquid in the droplet will evaporate before the droplet reaches the tablet surface. This can cause the tablet surface to appear rough and is referred to as "spray drying" or "orange peel." If your atomization pressure is too low, the droplets may be too large and might not have enough time to spread out across the tablet surface and dry before coming into contact with another tablet, which can lead to sticking and picking problems. The goal is to create a uniform droplet that will spread over the tablet surface and dry without sticking to other tablets.

Once you’ve achieved the proper droplet size, increase the guns’ pattern air to create a uniform spray curtain across the tablet bed. For multiple-gun coaters, the spray from each spray gun should be a uniform fan without any overlapping between guns, as shown in Figure 2a. If the pattern air pressure is too low, you’ll create dead spots in the spray zone where the coating spray won’t reach the tablets (Figure 2b). If the pattern air is too high, the spray pattern will overlap between adjacent spray guns, which can cause streaking (Figure 2c).

The simplest way to test a spray gun’s atomization and spray pattern is to remove the spray bar from the machine and spray some solution onto a large piece of paper while matching the distance between the spray nozzles and the tablet bed in your coater. This will allow you to check the droplet size and see if there are any dead zones or overlapping spray patterns.

**Spray rate and bed temperature**

The coating solution spray rate and the tablet bed temperature for your application will be dictated by the coating solution formulation you’re using. Spray rates for production pan coaters can range anywhere from 50 to 225 grams per minute per gun for aqueous coatings, and bed temperatures can range from 22° to 60°C. Consult your coating supplier to determine the proper spray rate setting and bed temperature for your coating solution. Operating outside of your solution’s specific range can cause coating defects, so it’s critical that you use the information provided by your supplier when setting up your coating process.

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**Figure 2**

Spray-gun pattern air pressure

_a. Ideal spray pattern_

_b. Pattern air pressure too low_

_c. Pattern air pressure too high_
Process airflow and dew point

The final coating parameters we'll discuss are the process airflow and dew point. The process airflow is very important because it carries heat, which encourages evaporation and dries the coated tablets. The volume and moisture level of the process air determine the coating system's drying capacity. As with the other parameters, your optimal process airflow will vary depending on the coater's size, manufacturer, and other variables. For production-scale coating pans, Freund-Vector recommends starting with a process airflow of 550 cubic feet per minute per spray zone and adjusting the air volume up or down depending on the coating quality produced. However, you should consult with your coating equipment supplier for the recommended process airflow for your unit.

The process air dew point is important for maintaining optimal spray rates in your coating system. Some customers I've worked with were using unconditioned process air and needed to decrease a coater's spray rate by as much as 50 percent to compensate for a change in local weather conditions. For this reason, we recommend conditioning the process airflow for any coating trial to remove moisture and achieve a dew point of 10°C. This is commonly done using a chiller; however, for some moisture-sensitive products, such as effervescent tablets, dew points as low as -5°C to -10°C are necessary, which requires the use of a desiccant unit.

Work with your supplier

Coating equipment suppliers have a great deal of experience with and information about the coating systems they provide. The major producers of tablet coating materials also offer an array of tablet coating and solid dosage seminars. These seminars can be especially useful because they help coating equipment operators understand not only the coating process but also granulation and tableting, which affect coating performance.

Thanks to advances in coating equipment and materials, the film coating process in fully perforated coating pans has become a less complex unit operation. However, it still requires skill, attention, and an understanding of the parameters and variables involved. By continuously educating yourself on techniques, learning from the experiences of others, and working closely with your coating equipment supplier, you can ensure the success of your coating process.

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