Using the Right Amount of Yeast

Most bakers adjust the amount of yeast they use to achieve a desired proof time and finished product volume. But the results are not always predictable because there is an interaction between gas production by the yeast and gas retention by the dough. Bakers can take this interaction into account to optimize yeast usage and bakery throughput.

**Gas Production and Retention**

The amount of gas production during proofing and baking depends mostly on proof time, yeast characteristics, and yeast dose rate. The amount of gas retention depends mostly on processing conditions and ingredients. But there are a number of other factors that affect the interaction between gas production and retention:

- **Higher proof temperatures** increase gas production and decrease gas retention. Low temperatures give strong doughs that rise slowly, while high temperatures give weak doughs that rise quickly.

- **Higher water absorption**, above that necessary for dough development, also increases gas production and decreases gas retention. Diluting dissolved solids makes yeast more active, but diluting gluten reduces dough strength.

- **Sugar** increases gas production at levels up to about 5 percent but decreases gas production at higher levels because of osmotic pressure.

- **Salt** decreases gas production because it increases osmotic pressure even more than sugar.

- **Calcium propionate** decreases gas production, especially in acidic doughs with low pH.

- **Flour protein** and added gluten increase gas retention and tolerance.

**Yeast Dose and Product Volume**

The graph below shows the effects of varying the amount of yeast used in a white pan bread made by a typical flour brew process. The dotted line is the amount of gas produced and shows that increasing the yeast amount gives a similar increase in gas production over the whole range of doses. The solid line is the finished product volume and shows that increasing the yeast has a different effect on volume at different dose ranges. In the middle range, increasing the yeast gives a similar increase in volume, but at low and high dose ranges it has no effect.

Increasing yeast doesn’t always increase finished product volume, because there is a limit to gas retention. Conditions that affect gas production move the yeast/volume curve left or right so that more or less yeast is required for the same finished product volume. Conditions that affect gas retention move it up and down so that both the amount of yeast required and the attainable finished product volume are affected.

In the middle range of the yeast/volume curve, the finished product volume is very sensitive to the yeast dose and to conditions that affect gas production. This is a good place to operate to be able to respond to factors that affect gas retention (like flour quality). The baker can use yeast dose to control finished product volume and compensate for recipe or process variations.

At the high range of the yeast/volume curve, the finished product volume is very sensitive to conditions that affect gas retention. This is a good place to operate to minimize factors that affect gas production (such as yeast stability in frozen dough).
European artisanal bakers use yeast amounts and proofing conditions that are much different from American wholesale bakers. In some cases the reason is a traditional product whose characteristics depend on the way it is produced. But in other cases the differences just represent another way of achieving the same result. The following table compares yeast and proofing data for four typically European products:

<table>
<thead>
<tr>
<th>Product</th>
<th>French Baguette</th>
<th>German Mixtbrot</th>
<th>Danish</th>
<th>English Dr. Allinson</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yeast Dose</td>
<td>2%</td>
<td>2%</td>
<td>5%</td>
<td>2%</td>
</tr>
<tr>
<td>Proof Time</td>
<td>4 hrs</td>
<td>1 hr</td>
<td>40 min</td>
<td>40 min</td>
</tr>
<tr>
<td>Proof Temp.</td>
<td>78°F</td>
<td>85°F</td>
<td>77°F</td>
<td>85°F</td>
</tr>
</tbody>
</table>

French baguettes require low yeast levels and long proof times. German Mixtbrot is an especially dense product that needs little gas production. Danish uses a relatively high yeast dose to give a short proof time despite high sugar. Dr. Allinson does not require much yeast because of the one-hour prefermentation and an unusually high water absorption. Overall, the biggest difference in European systems compared with American is their lower proof temperatures. European proof temperatures typically range from about 75°F to 90°F, while U.S. and Canadian wholesale bakeries range from about 100°F to 115°F.

**Measuring Gas Production and Gas Retention**

The interactions between gas production and retention make them difficult to measure properly. Fermentometers measure gas production by pressure or volume, but not gas retention. The Farinograph and similar devices measure the dough rheology that affects gas retention, but not under proofing conditions.

The Chopin Rheofermentometer is a new instrument that simultaneously measures gas production and gas retention under realistic proofing conditions. It consists of a sealed chamber where a dough piece is placed under a weighted piston. As the dough rises, the piston movement is measured to determine the rate of expansion and the strength of the dough. At the same time, the total gas production by the yeast is measured along with the amount that escapes from the dough into the chamber. Subtracting the amount released from the total gives the amount retained.

The Rheofermentometer is controlled by a microprocessor, which calculates the results and produces graphs for “Development of the Dough” and “Gaseous Release.” The Gaseous Release graph reproduced below shows the results for a whole wheat bread. The top line represents total gas production and the bottom line, gas retention. The T’1 value is the time to maximum volume; Tx is the time when permeability appears. A retention coefficient is calculated by dividing the retained volume by the total volume, which in this case was 94%.