Neutralizing Values

When a leavening acid (shown here as HA) reacts with a carbon dioxide source like baking soda, it produces water and carbon dioxide gas according to this general neutralization reaction:

\[ HA + \text{NaHCO}_3 \rightarrow NaA + H_2O + CO_2 \]

All leavening acids react with carbon dioxide sources to produce gas. The potential gas production depends on the amount of the carbon dioxide source. The actual gas production depends on the ratio of total leavening acids to carbon dioxide source. The neutralizing value (NV) is the parts by weight of baking soda from which all available carbon dioxide will be released by 100 parts by weight of a leavening acid:

\[ NV = g \text{ NaHCO}_3 \text{ neutralized by } 100 \text{ g acid} \]

Leavening balance is achieved by using the neutralizing value to match the amount of leavening acid to the amount of baking soda so that the maximum amount of carbon dioxide is released.

A Guide to Chemical Leaveners

**CHARACTERISTICS**

**Baking soda** is the most common carbon dioxide source. It is low in cost, high in purity, easy to handle, and leaves no aftertaste. Flour and other ingredients are slightly acidic, so baking soda will release some carbon dioxide if added by itself but will produce more when more acid is added.

**Baking powder** contains baking soda, one or more leavening acids, and a filler. The leavening acids are added in their powdered form as salts which do not react until they dissolve in water. The filler (starch or calcium carbonate) stabilizes the product by keeping the baking soda and leavening acid separate and standardizes it to the desired strength.

**Leavening acids** are selected primarily on the basis of reactivity—how fast they react and at what temperatures. Reactivity depends mostly on solubility, which in turn depends on chemical composition, particle size, and special treatments such as coating.

**Single-acting baking powders** contain a single leavening acid and can be slow-acting or fast-acting. Slow-acting types are the most common and use a slow-acting acid like SALP that reacts very little until heated in the oven. Fast-acting types are less common but use a fast-acting acid such as cream of tartar to provide gas production at low temperatures immediately after addition.

**Double-acting baking powders** contain a mixture of a fast-acting leavening acid like MCP and a slow-acting leavening acid like SAPP. They react partially at low temperatures and partially at high temperatures.

### CHEMICAL LEAVENING INGREDIENTS

<table>
<thead>
<tr>
<th>INGREDIENT NAME</th>
<th>COMMON NAME</th>
<th>FUNCTION</th>
<th>CONSIDERATIONS</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sodium bicarbonate</td>
<td>Baking soda</td>
<td>CO₂ source</td>
<td>Most common CO₂ source, required in baking powder</td>
</tr>
<tr>
<td>Potassium bicarbonate</td>
<td></td>
<td>CO₂ source</td>
<td>Used in place of baking soda in low-sodium applications</td>
</tr>
<tr>
<td>Ammonium bicarbonate</td>
<td></td>
<td>CO₂ source</td>
<td>Ammonia taste limits use to low-moisture products</td>
</tr>
<tr>
<td>Tartaric acid</td>
<td></td>
<td>Leavening acid</td>
<td>Very rapid action</td>
</tr>
<tr>
<td>Monopotassium tartrate</td>
<td>Cream of tartar</td>
<td>Leavening acid</td>
<td>Rapid action</td>
</tr>
<tr>
<td>Monocalcium phosphate monohydrate</td>
<td>MCP</td>
<td>Leavening acid</td>
<td>Rapid action, used in double-acting baking powder</td>
</tr>
<tr>
<td>Anhydrous monocalcium phosphate</td>
<td>AMCP</td>
<td>Leavening acid</td>
<td>Coated for slower action than MCP</td>
</tr>
<tr>
<td>Sodium acid pyrophosphate</td>
<td>SAPP</td>
<td>Leavening acid</td>
<td>Slow to very slow action, slightly bitter aftertaste</td>
</tr>
<tr>
<td>Sodium aluminum phosphate</td>
<td>SALP</td>
<td>Leavening acid</td>
<td>Slow action, used in single-acting baking powder</td>
</tr>
<tr>
<td>Sodium aluminum sulfate</td>
<td>SAS</td>
<td>Leavening acid</td>
<td>Very slow action</td>
</tr>
<tr>
<td>Dicalcium phosphate dihydrate</td>
<td>DCPD</td>
<td>Leavening acid</td>
<td>Very slow action</td>
</tr>
<tr>
<td>Glucono-delta-lactone</td>
<td>GDL</td>
<td>Leavening acid</td>
<td>Slow action, slightly bitter aftertaste</td>
</tr>
<tr>
<td>Calcium sulfate</td>
<td></td>
<td>Filler</td>
<td>Inert</td>
</tr>
<tr>
<td>Calcium carbonate</td>
<td></td>
<td>Filler</td>
<td>Inert</td>
</tr>
<tr>
<td>Corn starch</td>
<td></td>
<td>Filler</td>
<td>Inert</td>
</tr>
</tbody>
</table>

Continued
Lallemand Products for the Baker

LALLEMAND Inc. is a leading producer of yeast and dough conditioners and supplies a full range of products to the baking industry through its subsidiaries Lallemand Distribution and American Yeast Sales.

Chemical Leaveners
- Single-acting and double-acting baking powder
- Bakers cream
- Single-strength and double-strength yeast food
- Bromate-free yeast food
- Bromate, L-cysteine, ADA, ascorbic acid

Yeast Foods and Oxidizers
- Vinegar and raisin juice
- Natural mold inhibitors
- Powdered, granular, and dust-free calcium propionate
- Sodium propionate
- Natural mold inhibitors
- Potassium sorbate and sorbic acid
- Vinegar and raisin juice

Preservatives
- Emulsifiers
  - Sodium stearoyl-2-lactylate (SSL)
  - Calcium stearoyl-2-lactylate (CSL)
  - Monoglycerides
  - Mono- and diglycerides
  - Ethoxylated mono- and diglycerides
- Sugars and Syrups
  - Granular and brown sugar
  - Liquid and dry malt syrup
  - Liquid and dry honey and molasses
  - Corn syrup, bakers syrup, and cerealose
- Shortening
  - Butters, margarines, and shortenings
  - Soy, cotton seed, canola, and olive oils
- Dairy and Egg Products
  - Whole, nonfat, dry, and buttermilk
  - Whey and dairy blends
  - Liquid, frozen, and dry eggs, yolks and whites

A Guide to Chemical Leaveners (Continued)

to provide uniform leavening throughout processing.

Potassium bicarbonate and ammonium bicarbonate are carbon dioxide sources that are sometimes used in place of baking soda. Potassium bicarbonate can be used for low-sodium applications. Ammonium bicarbonate can be used for low-moisture finished products (such as cookies) where its ammonia taste dissipates after baking.

Taste is influenced by the choice of leavening acid and ratio of leavening acid to baking soda. SAPP and GDL have a slightly bitter aftertaste in some applications, but the SAPP taste can be masked by using sufficient baking soda and by adding a source of calcium ions, sugar, or flavors.

Texture is also influenced by the choice of leavening acid. Calcium and aluminum-containing leavening acids allow good gluten development for volume and texture, while sulfates and phosphates interfere with gluten development and reduce gas retention. GDL also allows good gluten development and gives acceptable crumb texture in bread-like products which normally are leavened with yeast.

Crumb color is influenced by the pH of the finished product. A low pH from low baking soda levels gives whiter crumb color. A high pH from high baking soda levels gives a darker crumb color that is desirable in chocolate products.

APPLICATIONS
Cake donuts require little leavening during mixing, then some for buoyancy at the start of frying, and considerable fast leavening during frying. SAPP is commonly used as the leavening acid, sometimes with added MCP for initial activity or GDL for late activity.

Layer cakes require leavening during mixing to give good batter consistency for pan fill, and additional leavening during baking for optimum crumb texture and volume. Double-acting baking powder is commonly used with MCP as the fast-leavening acid and SAPP or SALP as the slow-leavening acid.

Refrigerated doughs for biscuits require a leavening system which produces some gas in the can after mixing, but which also retains the major part of the activity until the biscuit can is opened and the biscuits are baked. MCP is used to have some gas produced in the can, while SALP or DCPD are used to produce gas in the oven after a long period of refrigerated storage.

Biscuits and muffins require fast leavening in the oven because of their short bake times. Double-acting baking powder is commonly used with MCP or coated MCP as the fast-leavening acid and SALP as the slow-leavening acid.

Neutralizing Values

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</tr>
<tr>
<td>SAS</td>
</tr>
<tr>
<td>GDL</td>
</tr>
</tbody>
</table>

4% SAPP = \( \frac{2% \text{NaHCO}_3 \times 100}{50} \)

Baking Update

Lallemand Baking Update is produced by Lallemand Inc. to provide bakers with a source of practical technology for solving problems. If you would like to be on our mailing list to receive future copies, or if you have questions or comments, please contact us at:

LALLEMAND Inc.
1620 Préfontaine
Montréal, QC H1W 2N8 CANADA
tel: (800) 840-4047 (514) 522-2133
fax: (514) 255-6861

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