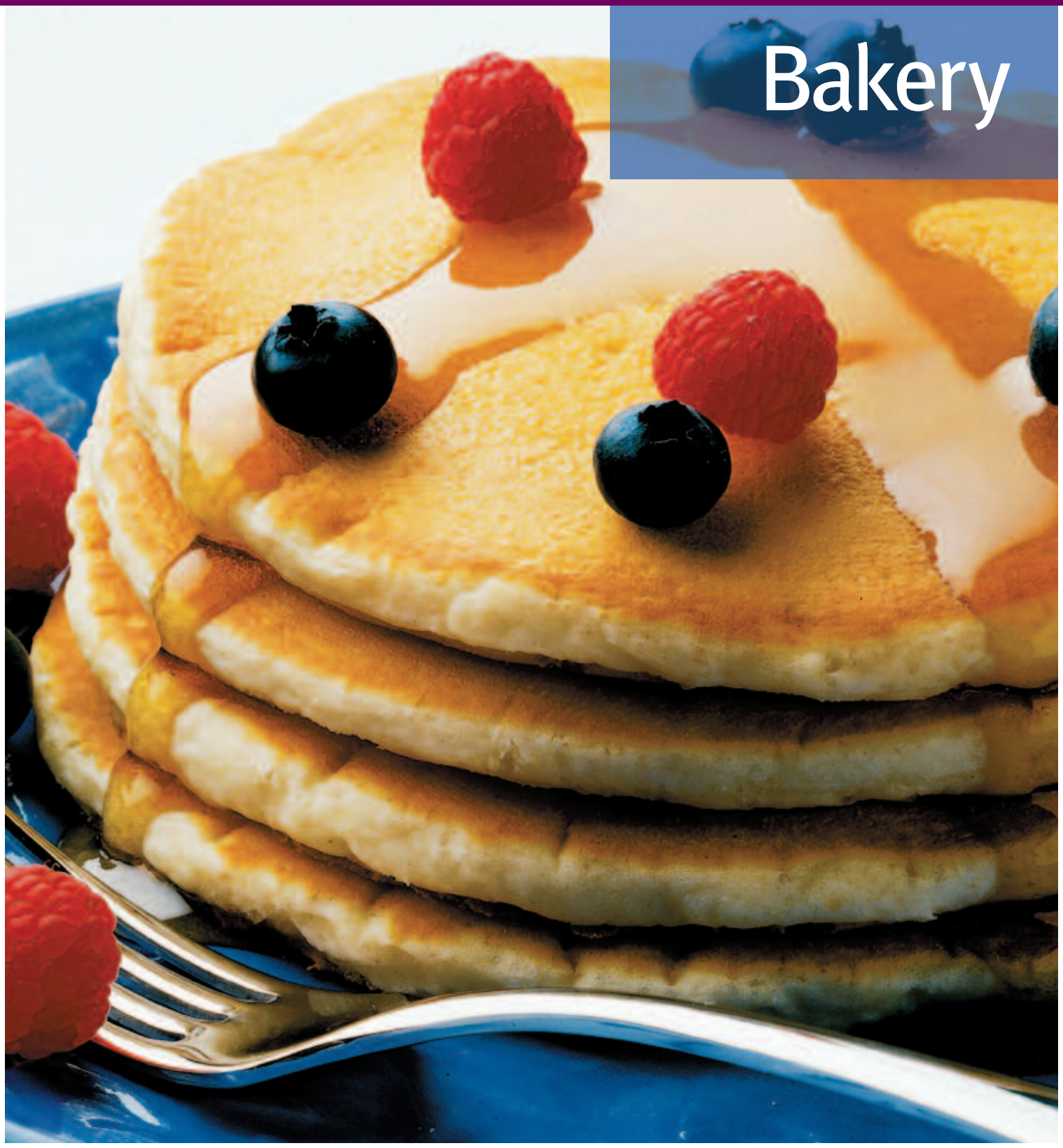
ICL Performance Products LP

APPLICATIONS AND PRODUCTS

FOR THE FOOD INDUSTRY

# Bakery



# Bakery

## APPLICATIONS OF FOOD PHOSPHATES

ICL PERFORMANCE PRODUCTS FOOD PHOSPHATES FIND MANY VERSATILE USES IN BAKING INCLUDING LEAVENING ACIDULANTS, DOUGH CONDITIONERS, MINERAL SUPPLEMENTS, pH AND BUFFERING AGENTS.

In baking applications, you will find ICL food phosphate ingredients to be uniform, predictable and reliable in quality and performance. Our food phosphates:

- Include ingredients tailored to meet the home and commercial baker's specific leavening acid requirements.
- Serve as the most commonly used acidulants for chemically leavened formulas.
- Contribute to bread production directly as dough enhancers and yeast foods, as well as indirectly as acidifiers and nutrients in the production of yeast.

YOU CAN COUNT ON ICL TO PROVIDE EXPERT ADVICE WHEN YOU ENCOUNTER A CHALLENGE IN FORMULATING OR PROCESSING YOUR BAKED GOODS.

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## Leavening

In baking, the phosphates function as leavening acids, which react with sodium bicarbonate or baking soda, to control the release of carbon dioxide gas. The amount of gas, the rate of gas production and the timing of the gas release determine the main effects of leavening. Table A below shows leavening uses of ICL food phosphates.

TABLE A

## Leavening Applications of ICL Food Phosphates

| PRODUCT | SODIUM BICARBONATE* (%) | LEAVENING ACIDS (TO NEUTRALIZE) |
|---|---|---|
| Baking powders | 30-40 | H.T.® MCP, Py-Ran,® SAPP 28, Levn-Lite,® Levona™, Adipic Acid, Leverage® |
| Biscuits | 1.5-2.0 | Stabil-9,® Levn-Lite, SAPP 28, Levona, H.T. MCP |
| Breading and batter | 0.0-2.0 | SAPP 40, Levn-Lite, Pan-O-Lite,® SAPP 28, Levona, H.T. MCP |
| Cake doughnuts | 0.5-1.0 | SAPP 40, SAPP 28, SAPP 26, SAPP 37, SAPP 43, Levona, Levn-Lite, Py-Ran, Leverage |
| Cake mixes – angel | 1.5-2.0 | H.T. MCP, Py-Ran, SAPP 40, Levn-Lite, Adipic Acid |
| Cake mixes – layer | 0.6-1.0 | Levn-Lite, Pan-O-Lite, SAPP, Levona, DCPD, Py-Ran, Leverage, H.T. MCP |
| Cookies | 0.0-0.7 | Stabil-9, SAPP RD-1, Levn-Lite, H.T. MCP, SAPP 28 |
| Crackers | 0.5-1.8 | H.T. MCP, Py-Ran, SAPP 28 |
| Flour tortillas | 0.5-1.5 | Levn-Lite, SAPP 28, Levona, H.T. MCP, Py-Ran |
| Frozen biscuit doughs | 1.5-2.0 | Levn-Lite, Levona, SAPP RD-1, SAPP 28, SAPP 26, Leverage |
| Frozen cake batter | 0.6-1.25 | Levn-Lite, Pan-O-Lite, Levona, SAPP 28, H.T. MCP, DCPD, Leverage |
| Frozen pancake batter | 1.7-2.2 | Pan-O-Lite, Levn-Lite, Levona, DCPD, Leverage, H.T. MCP |
| Hush puppy mixes | 1.5-2.0 | SAPP 28, SAPP 40, Py-Ran, Stabil-9, Levn-Lite, Levona |
| Muffins | 1.5-2.0 | Stabil-9, Pan-O-Lite, SAPP 28, DCPD, Leverage, Levn-Lite, H.T. MCP, Levona |
| Novel bread | 1.5-3.5 | Levn-Lite, SAPP, Py-Ran, Levona |
| Pancakes | 1.5-2.0 | Pan-O-Lite, Levn-Lite, H.T. MCP, Py-Ran, SAPP 40, SAPP 28, Levona, Stabil-9 |
| Pizza crusts | 0.3-1.2 | Levn-Lite, SAPP 28, DCPD, Leverage, Pan-O-Lite, Stabil-9, Levona |
| Refrigerated dough | 2.0-2.5 | SAPP RD-1, SAPP 26, Levn-Lite, Levona, Leverage |
| Self-rising corn meal | 1.5-2.0 | Py-Ran, Stabil-9, Levn-Lite, H.T. MCP |
| Self-rising flour | 1.2-1.5 | Stabil-9, Py-Ran, SAPP 28, Levn-Lite, H.T. MCP |
| Self-rising pizza crust | 0.5-1.0 | Levn-Lite, Pan-O-Lite, Levona, Stabil-9, SAPP 28, DCPD |
| Waffles | 1.5-2.0 | Pan-O-Lite, Levn-Lite, Levona, H.T. MCP, Py-Ran, SAPP 40, SAPP 28 |

** Percent of Solids*

*This chart will help you match a phosphate to a particular application and sodium bicarbonate level. If your application is not listed or you want to develop a new application, give us a call at (800) 244-6169.*

# Phosphates for the Bakery Industry

**SAPP** (sodium acid pyrophosphate) leavening acids are supplied in several grades which have different rates of reaction with baking soda. In general, the grades of ICL SAPP ingredients are designated by a number related to the Dough Rate of Reaction (DRR), which is expressed as the percentage of available carbon dioxide released in eight minutes under standardized test conditions. (For complete description see page 4.)

**SAPP RD-1 and SAPP 26** are the slowest reacting SAPPs. Their primary use is in products that require a long production cycle, long bench tolerance or long storage life. For refrigerated and frozen doughs and batters, the slow rates of carbon dioxide gas production provide tolerance to process variation, yet the carbon dioxide is released at the right time to ensure proper product characteristics.

**SAPP 28** is an all-purpose leavening phosphate. Its delayed gas release is especially suited to institutional and commercial baking of large batches, where extended mixing and forming times are necessary. The slow reaction rate is stabilized by a special ICL process. Doughnut applications employ SAPP 28 in combination with faster reacting SAPPs. SAPP 28 is also used in the manufacturing of baking powders, either alone or in combination with MCP.

**SAPP 37, SAPP 40 and SAPP 43** provide rapid, uniform rates of reaction over long periods, making them particularly useful in cake and doughnut mixes. These agents combine well with slower leavening acids to accommodate variation in other ingredients.

**SALP** (sodium aluminum phosphate) and blends offer consistency in leavening rate throughout dough or batter storage and use. These products also provide desired batter thickness, baking tolerance, and increased crumb whiteness and resiliency. SALP is an ideal leavening agent for prepared mixes. ICL has three SALP products: Levn-Lite, Stabil-9 and Pan-O-Lite.

**Levn-Lite®** is SALP. Its major leavening action takes place only when the product is heated. Levn-Lite is used in cake, pancake and waffle mixes, where it helps ensure good volume. In cake formulations, it is employed with high-aerating emulsifiers. Levn-Lite has application in frozen and refrigerated products and in some commercial baking powders.

**Stabil-9®** combines SALP with anhydrous monocalcium phosphate for “double action”: the early release of carbon dioxide by anhydrous monocalcium phosphate and the heat-triggered release by SALP in the oven. Available in regular and high-calcium grades, Stabil-9 is used primarily in self-rising flours and biscuit mixes, where its properties permit long storage life of the dry mix. Stabil-9 gives finer grain to cakes. Other uses include self-rising corn meal and muffin mixes.

**Pan-O-Lite®** a blend of SALP and monocalcium phosphate monohydrate, works well in pancake, waffle and cake mixes. It is used in cakes that do not contain high-aerating emulsifiers. Batter made with Pan-O-Lite resists thickening and loss of leavening power during storage under refrigerated or room temperature conditions. This leavening agent is particularly appropriate for refrigerated pancake, muffin or cake batters.

**H.T.® MCP** (monocalcium phosphate monohydrate) reacts rapidly with baking soda, so it is well suited for use in double-acting baking powders and in products requiring double action, such as cake and pancake mixes. MCP is a free-flowing powder that readily blends in dry mixes.

**Py-Ran®** (anhydrous monocalcium phosphate) is stabilized by a coating that protects against premature leavening action by slowing dissolution and the subsequent reaction with baking soda. Therefore, Py-Ran has excellent leavening characteristics in self-rising and phosphated flours, self-rising corn meal, cake and pancake mixes, and household baking powder.

**DCPD** (dicalcium phosphate dihydrate) is useful in bakery products with a high set temperature, such as high-ratio sugar cakes. It begins to react with baking soda when the batter or dough temperature rises to about 135-140°F.

**Levona™** (calcium pyrophosphate) provides controlled release. It is a source of calcium and does not contribute sodium. It provides consistent leavening rate and delivers finished products which are tender and have uniform cell structure.

**Leverage®** (dimagnesium phosphate) is a heat-triggered leavening agent that provides no leavening action before baking. It provides a consistent leavening rate for greater control in batters and dough. Leverage produces finished products which are moist and tender and have uniform cell structure.

**Adipic Acid** is a white crystalline powder that's ideal for multiple food applications. In many food applications, adipic acid is preferred because of its non-hygroscopicity, which means dry products containing adipic acid have a longer storage life under humid conditions. Adipic acid is an organic acid that allows the formulator to achieve lower pH products aiding in shelf life extension. Adipic acid has a neutral flavor profile, making it ideal for subtle flavor systems.

## Tools for Bakery Formulation

### NEUTRALIZING VALUE

The concept of neutralizing value (NV) was developed to both compare the available acidity of various leaveners and, more importantly, to calculate the correct level of usage. The leavener and soda are generally used in such proportions so that after baking there remains little, if any, unreacted soda or acidic salt in the finished product. There are some exceptions to this balancing of leavener and soda when particular effects related to the pH of the final product are desired (i.e., color, flavor).

The neutralizing value has been defined as the parts by weight of sodium bicarbonate that 100 parts by weight of leavening acid will neutralize, i.e., release all the carbon dioxide. Leavening acids are sold based on a specified minimum neutralizing value. The neutralizing values numbers are listed in Table B.

To determine the amount of ICL leavening acid you need

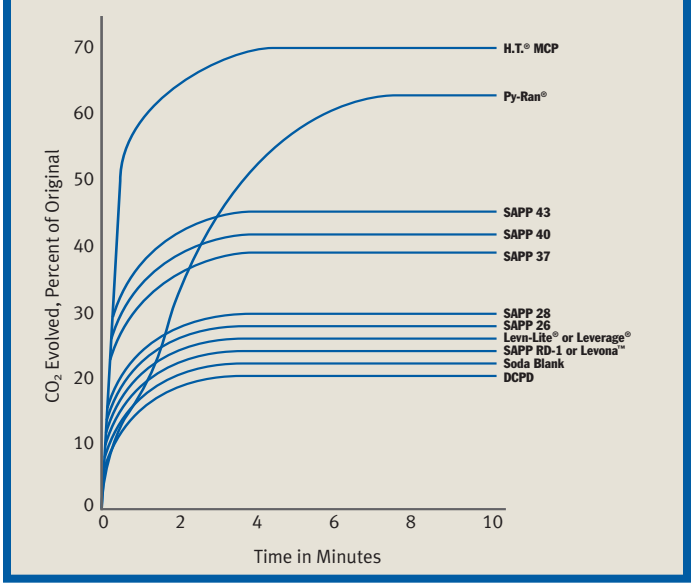
### TABLE B

## Neutralizing Values of ICL Leaveners

| LEAVENER | CHEMICAL NAME | SODIUM BICARBONATE NV | POTASSIUM BICARBONATE NV | AMMONIUM BICARBONATE NV |
|---|---|---|---|---|
| Adipic Acid | Adipic Acid | 115 | 137 | 108 |
| DCPD | Dicalcium Phosphate Dihydrate | 33 | 39 | 31 |
| H.T.® MCP | Monocalcium Phosphate Monohydrate | 80 | 95 | 75 |
| Leverage® | Magnesium Phosphate Dibasic | 40 | 48 | 38 |
| Levn-Lite® | Sodium Aluminum Phosphate | 100 | 119 | 94 |
| Levona™ | Calcium Pyrophosphate | 55 | 66 | 52 |
| Pan-O-Lite® | Sodium Aluminum Phosphate Blend | 100 | 119 | 94 |
| Py-Ran® | Anhydrous Monocalcium Phosphate | 80 | 95 | 75 |
| SAPP* | Sodium Acid Pyrophosphate | 72 | 86 | 68 |
| Stabil-9® | Sodium Aluminum Phosphate Blend | 93 | 111 | 87 |

** Leavening: SAPP RD-1, 26, 28, 37, 40, 43*

**FIGURE 1 – TYPICAL DOUGH RATES OF REACTION, 27°C, THREE MIN. MIXING**




for your bakery product, you must first ascertain the baking soda level (see recommended levels in Table A). Once this is known, an easy equation calculates the use level of the leavening acid that is proper for most products. Here's how it's done:

1. Decide upon the amount of baking soda in your bakery product.
2. Determine the leavening acid's NV from Table B Neutralizing Value.
3. Calculate the use level of the leavening acid using the following equation:

$$\text{Amount of leavener} = \frac{\text{Amount of baking soda} \times 100}{\text{Neutralizing Value}}$$

*Note: When using more than one leavening acid, decide on the amount of soda to be neutralized by each acid. Then use that portion of the soda in the equation with the appropriate NV. You will have to go through one calculation for each acid.*

*Note: Some adjustment of the calculated amount may be required to optimize the baked product's characteristics. Neutralizing values are determined by a simple titration method. The methods for determining the neutralizing value are in: Approved Methods of the American Association of Cereal Chemists, AACC International, 3340 Pilot Knob Road, St. Paul, Minnesota 55121, USA, 651-454-7250. Method number 2-32A.*

## DOUGH RATE OF REACTION

The selection of the leavening acid is based upon the rate of release of carbon dioxide required in the dough or batter mixture. The rate of leavening action is the key to a successful application. ICL manufactures and markets a diverse line of leavening acids with varying reaction rates. The baker or formulator can select the right product for their particular "critical zone," the point in the preparation process where it is desired to have the carbon dioxide released. The Dough Rate of Reaction (DRR) test is used as a guide because it shows typical reaction curves for leavening acids.

Figure 1 demonstrates the leavening rates of various leaveners as characterized by the DRR test. The soda blank curve includes all the ingredients minus the leavening acid. These tests were conducted at 27°C with three minutes of mixing. Note that increase in temperature or stir time, and other ingredients will impact the final rate of reaction. In general, higher temperatures accelerate the rate of reaction.

## BATTER RATE OF REACTION

Batter reaction rates are determined at various temperatures using a batter formulation, whereas the DRR is determined at a single temperature using a simple biscuit dough formulation. The data is gathered to provide batter reaction rates of individual leavening acids as shown in Figure 2. This type of data can be used to understand how the leavening system is reacting at various temperatures and times during baking. The temperature versus time profile for a product can be determined by experimentation. Observe from Figure 2 the time at a select temperature until 60% of the leavening reaction has occurred. Note that this figure provides a snapshot of what is occurring in the baked product system, as the batter temperature is constantly changing during baking. This figure also can be used to help select a leavening system for a particular application where the release of carbon dioxide needs to occur after a certain temperature is reached.

An example would be a cake formulation which uses H.T. MCP and Levn-Lite as the leavening acids. If the cake is baked at 177°C, after about 12 minutes of baking (half the bake time), the batter temperature would be around 40°C. Only the Levn-Lite heat-activated leavener would still be present in the cake to release additional carbon dioxide.

### HEAT-ACTIVATED LEAVENING

For frozen and refrigerated products used in food service and sold as convenience foods for consumers, heat-activated leavening is critical to deliver consistent performance. ICL heat-activated leavening provides the bench tolerance needed in processing. Additionally, the final product has consistent volume and textural characteristics.

Figure 3 demonstrates the outstanding bench tolerance offered by Leverage and Levn-Lite at room temperature. Since they are heat-triggered, there is little or no expansion of batters and dough prior to baking. This allows the formulator greater flexibility in timing and handling.

## Other Bakery Applications

**Breakfast cereals and pasta** have shorter cooking times and richer, creamier color with the addition of DSP. Use of DSP also decreases processing time for hot cereals. The use of DSP in pastas is permitted by the FDA Standards of Identities found in the CFR Title 21 Parts 137 and 139. Fortification of cereals with calcium, magnesium, phosphorus and potassium can be achieved using phosphates. For extruded ready-to-eat cereal, phosphates aid in expansion. Phosphates also contribute to the color of cereal products by buffering pH.

**Dough conditioners,** also known as dough improvers, enhancers or yeast foods, can include phosphates such as MCP to optimize dough pH and to provide calcium in yeast-raised products.

**Fillings** rely on phosphoric acid and adipic acid to furnish acidity for optimum gel strength and shelf life enhancement. In addition, polyphosphates and calcium phosphates are used to interact with algins and starch. To preserve the texture and appearance of fruit pieces, Snow Fresh® and other phosphates, along with accidulants, can be used when processing.

**Frosting and icing** rely upon phosphates for pH adjustment and stabilization. Calcium phosphates are also used in gum-based systems for proper thickening and gelation.

**Mineral fortification** in the form of calcium, magnesium, phosphorus and potassium salts is used to enhance the nutritional value of baked products.

**FIGURE 2 – BATTER RATES OF REACTION**

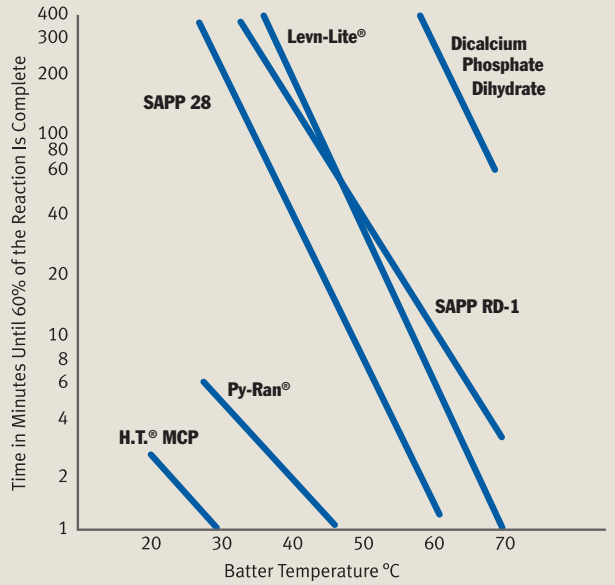
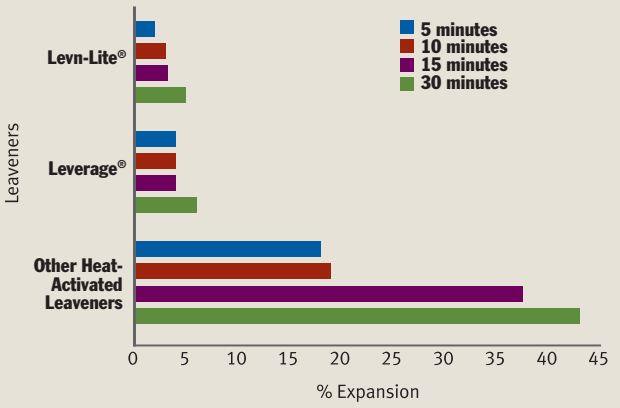



**FIGURE 3 – HEAT-ACTIVATED LEAVENING EXPANSION IN PANCAKE BATTER**




**Starches** may be modified by the addition of phosphate groups. They exhibit several desirable properties, including resistance to freeze-thaw breakdown, greater clarity, higher water-binding capacity and high viscosity without gel formation.

**Yeast production** sometimes utilizes phosphoric acid to adjust pH of the growth media. Monopotassium phosphate and dipotassium phosphate can be used to provide nourishment to the yeast.

**ICL Performance Products LP**

For order assistance or technical service, please call toll free: (800) 244-6169 or (314) 983-7500.

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