EQUIPMENT FOR BAKERS

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Equipment For Bakers

CONVERSION FACTORS

Units of measure found in this book are U.S. versions, unless otherwise designated. The following conversion factors will enable the reader to readily convert these measurements into metric or English units (and vice versa).

To convert	into	Multiply by
Length		
inches	cm	2.54
feet	cm	30.48
feet	meters	0.3048
yards	meters	0.9144
mm	in	0.03937
cm	in	0.3937
meter	in	39.37
meter	ft	3.281
meter	yd	1.094
Area		
sq in	sq cm	6.452
sq ft	sq meter	0.0929
sq yard	sq meter	0.8361
sq cm	sq in	0.155
sq meter	sq yard	1.196
sq meter	sq ft	10.764
Weight		
ounce	grams	28.50
pounds	grams	453.592
pounds	kilograms	0.4536
short T	metric T	0.907
long T	metric T	1.016
long T	kg	1016.05
gram	ounce	0.03527
kg	ounce	35.274
kg	lb	2.205
metric T	long T	1.016
metric T	short T	0.907
metric T	lb	2204.6

To convert	into	Multiply by
Capacity or volume		
cubic in	cu cm	16.387
cubic ft	cu meters	0.0283
cubic yd	cu meters	0.7646
fl oz (US)	ml	29.573
pt (US)	litre	0.4732
pt (US)	pt (Imp)	0.8327
qt (US)	litre	0.9463
gal (US)	litre	3.7853
gal (US)	gal (Imp)	0.8327
cu cm	cu in	0.0610
cu meter	cu ft	35.315
cu meter	cu yd	1.308
ml	fl oz (US)	0.0338
litre	fl oz (US)	33.81
litre	pt (US)	2.1134
litre	qt (US)	1.057
litre	gal (US)	0.2642
Pressure per unit area		
lb/sq in	kg/sq m	703.1
lb/sq in	kg/sq cm	0.0703
lb/sq in	g/sq cm	70.3
lb/sq ft	kg/sq m	4.88
lb/sq ft	g/sq cm	0.488
Miscellaneous		
Btu	gram-cal	252.
Btu	kg-cal	0.252
ft lb	kg meter	0.138

Temperature conversion formulas

To convert Celsius to Fahrenheit: (°C + 17.78) X 1.8 = °F

To convert Fahrenheit to Celsius: (°F − 32) X 5/9 = °C

Abbreviatons and definitions: Btu = British thermal units, cal = calories, cm = centimeters, fl oz (US) = U. S. fluid ounces, ft = feet, gal (Imp) = imperial gallons, gal (US) = U. S. gallons, in = inches, kg = kilograms, lb = pounds, m = meters, ml = milliliters, ounce = avoirdupois ounces, pt (Imp) = imperial pints, pt (US) = U. S. liquid pints, qt (US) = U. S. quarts, sq = square, T = tons, yd = yards.

PREFACE

The various pieces of equipment used for processing dough products are described in this book. Processing is followed from receipt of ingredients to the finished but unpackaged product. Specifications and functions of the equipment are considered. Variations in models commercially available (e.g., their hourly output) are pointed out. Interaction of ingredients with equipment and effects of changes in machine settings on finished products are discussed.

The emphasis is on equipment made in the U. S. A., as might be expected. Quite a few machines of foreign manufacture are discussed, however.

Only commercial equipment is considered in this volume. Although some space is given to machines suitable for use in the small retail bakery, more extended treatments are given of equipment used for wholesale baking.

I devoted much effort to avoiding duplication of material contained in the first two books of this series, but there were times when some repetition of previously published information on ingredients, formulas, and processes was absolutely necessary in order to make the discussions comprehensible to the reader. I estimate that less than 5% of the material in this book duplicates anything contained in "Ingredients for Bakers" and "Formulas and Processes for Bakers."

Packaging materials and equipment will be covered in the next volume of this series. Sanitation and maintenance procedures and special preservation methods will also be discussed in volume four, "Packaging, Protection, and Product Development for Bakers," which is expected to become available early in 1989.

Very many people have contributed material--text, drawings, photos, etc.—used in this book. The following list of contributors is thought to be complete, or nearly so. If omissions have occurred, please accept my apologies and rest assured that corrections will be made in the next edition.

Descriptions and evaluations of equipment and methods were not in any way biased by financial considerations. No company or person paid compensation of any kind for mention of their equipment and I have never been retained as a consultant for any of the companies mentioned.

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Edinburg, Texas
June 1, 1988

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CHAPTER ONE

BULK HANDLING SYSTEMS

INTRODUCTION

We can define bulk ingredients as those food components which are not packed in containers of a given size, such as 100 lb bags, 30 gal drums, or 50 lb cartons. Water was the first bakery ingredient to be received and handled in bulk. It is still the material received in greatest quantity by bakeries, although much of it is used for non-ingredient purposes, such as steam generation and sanitation. The bulk handling of other ingredients—flour, sugar, syrups, oils, etc.—had to await the development of technologies which made the practice economically justifiable. Implementation of bulk receiving by bakeries involved a collaboration of suppliers and purchasers which was relatively slow to evolve. In many cases, the final step was made when suppliers financed the installation of tanks and other necessary equipment, with payment being included as part of the ingredient cost.

Modern technology makes it possible to store and handle in bulk virtually all of the ingredients normally used in bakeries, but it is usually not considered to be economically advantageous, even in the largest plants, to construct such facilities for more than 7 or 8 of the raw materials. Since bulk transfer is essential for computerized batching, however, a few factories have automated the handling of nearly all the ingredients, including such minor components as ammonium bicarbonate and spices. Some lack of flexibility, in terms of the number of ingredients which can be introduced into the system, is inevitable in these plants.

Receiving, storage, and in-plant conveying of bulk ingredients can often be justified on the basis of economic advantages such as eliminating the cost of disposable containers, reducing waste, and lowering labor costs for material handling. Additional benefits are frequently obtained in the form of improved sanitation, better control over measuring, and reduction in size of storage areas.

The author is a firm believer in the advantages of bulk handling. It must be admitted, however, that hope tends to outrun reality in the designing of some installations. Careful planning, with close attention to all present and future changes in costs, is essential when a proposal is being considered to install a bulk handling line.

GENERAL CONSIDERATIONS

Bulk storage facilities logically fall into two categories based on the physical state of the product—whether it is in liquid or solid (i.e., granular) form. In some cases, the baker has a choice of obtaining the product in either form. Flour is, of course, always handled as a powder and it is more common to transfer sucrose, dextrose, and salt in this form rather than as solutions. Shortenings, corn syrups, and invert sugar are almost always handled as liquids in bulk systems. When milk is received in bulk, the liquid form is often preferred, in spite of such negative factors as increased cost and greater potential for spoilage. Dry milk can be handled successfully, however. Dried eggs are not often handled in bulk systems, but liquid egg products are often treated in this way.

There are general principles applicable to the design of all bulk handling facilities. Sanitation should be a primary consideration in the design. Surfaces which contact ingredients should be nonporous and resistant to corrosion and abrasion; they should be nontoxic and should not transfer odor, taste, color, or particles to the ingredients. They must not accelerate deteriorative changes in the food materials. Physical changes (as in particle size) during transfer or storage should be held to a minimum consistent with necessary design limitations. Tubes carrying powders should be grounded to prevent the buildup of static electricity. Changes in moisture content are to be avoided.

Certain physical characteristics of ingredients control the type of equipment required for transferring and storing these materials. Chief among these physical qualities are the rheological properties (viscosity or apparent viscosity) of liquid or semi-liquid ingredients and the flow properties of powdered and granular ingredients.

Factors Affecting Design of Bins for Powders

Difficulties in handling bulk solids are generally caused by a lack of flowability or a strong tendency to floodability. These two properties are sometimes described as being at two ends of a spectrum with good flowability somewhere between them. A flowable material tends to move smoothly and evenly under the influence of gravity without requiring assisting means. Floodable materials move in a series of separate, irregular avalanches. These properties are manifestations on the macroscopic scale of microscopic factors such as the dimensions of the particle, uniformity of particle size, conformation of the particle (whether spheroidal or cubic or with protuberances, etc.), smoothness or roughness of the particles' surfaces, elasticity of the particles, tendency to entrap air, adhesiveness of the surfaces (whether due to "sticky" layers or to accumulation of static electricity), and actual density.

Established procedures can be used to determine the relative position of an ingredient within the "spectrum" mentioned above, thereby furnishing a basis for predicting handling properties relative to other materials. The following descriptions of tests which can be performed omit many of the procedural details, but give an overall idea of the factors which are important in establishing ingredient flowability. First, the bulk density of the material is estimated by filling a container of known volume, without applying pressure or vibration, and weighing the contents. Second, the "compressibility" of the ingredient is determined by comparing the packed or tapped density of the material in the container used for measuring the bulk density. Compressibility is expressed as the percentage increase in density; if it is high, say above 20%, the material will probably not flow smoothly and will tend to bridge in hoppers. If the compressibility exceeds 40%, there will very likely be problems in discharging the material from the hopper after storage.

Third, the particle size and shape is determined, partially by visual means. Powder and pellets are characterized by particle size, and fibrous or matting or interlocking strands by shape. Powders such as sugar and flour can be roughly characterized by finding the finest mesh sieve that most of the powder will pass through with shaking. Shredded or flaked material such as bran, wheat germ, or coarse rye meal present somewhat more difficult evaluation problems. The fourth test is the measurement of angle of slide. This test consists of pouring a small amount of the ingredient on a polished metal plate and tilting the plate slowly until the powder begins to run downhill under its own weight. The number recorded is the angle formed by the underside of the plate and the table surface. A high angle of slide indicates that the material is probably somewhat sticky and could bridge in bins and hoppers.

The final parameter to be determined in the usual series of preliminary tests is the moisture content, which is measurable by well known methods. Hygroscopicity is also a factor which may have to be considered.

Other tests which can be conducted to give additional information relative to handling properties are the angle of repose, the angle of fall, the angle of difference, the angle of spatula, cohesion, uniformity, and dispersibility. A brief description of these tests is given in the following paragraphs.

The angle of repose is the acute angle formed between the side of a cone-shaped pile of the material and the surface on which it lies. The