The Chemical Formulary

Collection of Commercial Formulas
for Making Thousands of Products
in Many Fields

VOLUME XXXIV

Editor-in-Chief

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PREFACE

Chemistry, as taught in our schools and colleges, concerns chiefly synthesis, analysis and engineering—and properly so. It is part of the right foundation for the education of the chemist.

Many a chemist entering an industry soon finds that most of the products manufactured by his concern are not synthetic or definite chemical compounds, but are mixtures, blends, or highly complex compounds of which he knows little or nothing. The literature in this field, if any, may be meager, scattered, or obsolete.

Even chemists with years of experience in one or more industries spend considerable time and effort in acquainting themselves with any new field which they may enter. Consulting chemists similarly have to solve problems brought to them from industries foreign to them. There was a definite need for an up-to-date compilation of formulas for chemical compounding and treatment. Since the fields to be covered are many and varied, an editorial board of chemists and engineers engaged in many industries was formed.

Many publications, laboratories, manufacturing firms, and individuals have been consulted to obtain the latest and best information. It is felt that the formulas given in this volume will save chemists and allied workers much time and effort.

Manufacturers and sellers of chemicals will find, in these formulas, new uses for their products. Non-chemical executives, professional men, and interested laymen will make through this volume a "speaking acquaintance" with products which they may be using, trying, or selling.

It often happens that two individuals using the same ingredients in the same formula get different results. This may be due to slight deviations in the raw materials or unfamiliarity with the intricacies of a new technique. Accordingly, repeated experiments may be necessary to get the best results. Although many of the formulas given are being used commercially, many have been taken from the literature and may be subject to various errors and omissions. This should be taken into consideration. Wherever possible, it is advisable to consult with other chemists or technical workers regarding commercial production. This will save time and money and help avoid trouble.

A formula will seldom give exactly the results which one requires. Formulas are useful as starting points from which to work out one's ideas. Also, formulas very often give us ideas which may help us in our specific problems. In a compilation of this kind, errors of omission, commission, and printing may occur. I shall be glad to receive any constructive criticism.

H. BENNETT

PREFACE TO VOLUME XXXIV

In 1990 we lost our oldest and most prestigious author and friend, Harry Bennett at age 95. He is sorely missed.

It was his wish that the "FORMULARY" continue with or without him. Our editorial staff has put together this volume XXXIV, and shall continue to do so without making any changes in style or presentation.

This new volume of the CHEMICAL FORMULARY series is a collection of new, up-to-date formulas. All the formulas in Volume I through XXXIV (except in the Introduction) are different. Thus, if you do not find what you want in this volume, you may find it in one of the others. The only repetitious material is the introduction (Chapter I) which is used in every volume for the benefit of those who may have bought only one volume and who have no educational background or experience in chemical compounding. The simple basic formulas and compounding methods given in the introduction will serve as a guide for beginners and students. It is suggested that they read the introduction carefully and even make a few preparations described there before compounding the more intricate formulas included in the later chapters.

The list of chemicals and their suppliers has been enlarged with new trademark chemicals. All tradename chemicals appear in the formulas in boldface and these tradenames are listed alphabetically in the appendix followed by a list of corresponding manufacturers. The Trademark Chemical Suppliers Index includes address, telephone and fax numbers. Thus buying the required ingredients will present no problem.

Grateful acknowledgement is made to the Contributors for their valuable suggestions and contributions, which allows us to continue this series.

CHEMICAL PUBLISHING CO., INC.

BOOKS BY H. BENNETT

The Chemical Formulary Vols. I–XXXIV
The Cumulative Index Vols. I–XXV—The Chemical Formulary
Concise Chemical & Technical Dictionary
Bennett's Cosmetic Formulary
Industrial Waxes, Vols. I, II

ABBREVIATIONS

act . . . . . active, activity
AM . . . . . active matter
amp . . . . . ampere(s)
anhyd . . . . . anhydrous
approx . . . . . approximately
aq . . . . . aqueous
ASTM . . . . . American Society for Testing and Materials
avoir . . . . . avoirdupois
Bé . . . . . Baumé
B.P . . . . . boiling point
°C . . . . . degrees Centrigrade
cc . . . . . cubic centimeter(s)
cm . . . . . centimeter(s)
cm^3 . . . . . cubic centimer(s)
conc . . . . . concentrated/concentration
c.p . . . . . chemically pure
cp, cP, cps . . . . . centipoise(s)
cs . . . . . centistoke(s)
cu ft . . . . . cubic foot
cwt . . . . . hundredweight
dil . . . . . dilute
dm . . . . . decimeter(s)
dr . . . . . dram(s)
°F . . . . . degrees Fahrenheit
fl . . . . . fluid
fl dr . . . . . fluid dram(s)
fl oz . . . . . fluid ounce(s)
F.P. . . . . freezing point
ft . . . . . foot
ft^2 . . . . . square foot
ft^3 . . . . . cubic foot
g . . . . . gram(s)
gal . . . . . gallon(s)
gr . . . . . grain(s)
h . . . . . hour(s)
hl . . . . . hectoliter(s)
in . . . . . inch(es)
in^3 . . . . . cubic inch(es)

ABBREVIATIONS

K.U. . . . . Krebs units
kg . . . . . kilogram(s)
l. . . . . liter(s)
lb . . . . . pound(s)
liq . . . . . Liquid
m. . . . . milli or meter(s)
MIL. . . . . Military specifications
min. . . . . minimum or minute
ml . . . . . milliliter(s)
mm . . . . . millimeter(s)
M.P . . . . . melting point
MPa. . . . . mega pascal
N . . . . . Newton or Normal
N.F . . . . . National Formulary
NV. . . . . nonvolatiles
o/w . . . . . oil-in-water
oz . . . . . ounce(s)
P/B . . . . . pigment/binder
Pa. . . . . Pascal
pH . . . . . hydrogen-ion concentration
phr. . . . . parts per hundred rubber
pkg. . . . . package
ppm . . . . . parts per million
psi . . . . . pounds per square inch
psig . . . . . pounds per square inch gauge
pt . . . . . pint(s)
PVC. . . . . pigment volume concentration
pwt . . . . . pennyweight
q.s.. . . . . a quantity sufficient to make
qt . . . . . quart
® . . . . . registered trademark
R.T. . . . . room temperature
rpm . . . . . revolutions per minute
s . . . . . second(s)
sol'n. . . . . solution
Sp.Gr. . . . . specific gravity
T.P. . . . . triple pressed
tbsp. . . . . tablespoon(s)

tech. . . . . technical
tinc . . . . . tincture
™ . . . . . trademark

ABBREVIATIONS

tsp . . . . . teaspoon(s)
USP . . . . . United States Pharmacopeia
UV . . . . . ultraviolet
V . . . . . volt(s)
visc . . . . . viscosity
vol . . . . . volume
w/o . . . . . water-in-oil
wt . . . . . weight

Chapter I
INTRODUCTION

The following introductory matter has been included at the suggestion of teachers of Chemistry and Home Economics.

This section will enable anyone, with or without technical education or experience, to start making simple products without any complicated or expensive machinery. For commercial production, however, suitable equipment is necessary.

Chemical specialties are composed of pigments, gums, resins, solvents, oils, greases, fats, waxes, emulsifying agents, dyestuffs, perfumes, water, and chemicals of great diversity. To compound certain of these with some of the others requires definite and well studied procedures, any departure from which will inevitably result in failure. The steps for successful compounding are given with the formulas. Follow them rigorously. If the directions require that (*a*) is added to (*b*), carry this out literally, and do not reverse the order. The preparation of an emulsion is often quite as tricky as the making of mayonnaise. In making mayonnaise, you add the oil to the egg, slowly, with constant and even stirring. If you do it correctly, you get mayonnaise. If you depart from any of these details: if you add the egg to the oil, or pour the oil in too quickly, or fail to stir regularly, the result is a complete disappointment. The same disappointment may be expected if the prescribed procedure of any other formulation is violated.

The point next in importance is the scrupulous use of the proper ingredients. Substitutions are sure to result in inferior quality, if not in complete failure. Use what the formula calls for. If a cheaper product is desired, do not prepare it by substituting a cheaper ingredient for the one prescribed: use a different formula. Not infrequently, a formula will call for an ingredient which is difficult to obtain. In such cases, either reject the formula or substitute a similar substance only after a preliminary experiment demonstrates its usability. There is a limit to which this rule may reasonably be extended. In some cases, substitution of an equivalent ingredient may be made

legitimately. For example, when the formula calls for white wax (beeswax), yellow wax can be used, if the color of the finished product is a matter of secondary importance. Yellow beeswax can often replace white beeswax making due allowance for color, but paraffin wax will not replace beeswax, even though its light color seems to place it above yellow beeswax.

This leads to the third point: the use of good-quality ingredients, and ingredients of the correct quality. Ordinary lanolin is not the same thing as anhydrous lanolin. The replacement of one with the other, weight for weight, will give discouragingly different results. Use exactly what the formula calls for: if you are not acquainted with the substance and you are in doubt as to just what is meant, discard the formula and use one you understand. Buy your chemicals from reliable sources. Many ingredients are obtainable in a number of different grades: if the formula does not designate the grade, it is understood that the best grade is to be used. Remember that a formula and the directions can tell you only part of the story. Some skill is often required to attain success. Practice with a small batch in such cases until you are sure of your technique. Many examples can be cited. If the formula calls for steeping quince seed for 30 min. in cold water, steeping for 1 h may yield a mucilage of too thin a consistency. The originator of the formula may have used a fresher grade of seed, or her/his conception of what "cold" water means may be different from yours. You should have a feeling for the right degree of mucilaginousness, and if steeping the seed for 30 min. fails to produce it, steep them longer until you get the right kind of mucilage. If you do not know what the right kind is, you will have to experiment until you find out. This is the reason for the recommendation to make small experimental batches until successful results are obtained. Another case is the use of dyestuffs for coloring lotions and the like. Dyes vary in strength; they are all very powerful in tinting value; it is not always easy to state in quantitative terms how much to use. You must establish the quantity by carefully adding minute quantities until you have the desired tint. Gum tragacanth is one of those products which can give much trouble. It varies widely in solubility and bodying power; the quantity listed in the formula may be entirely unsuitable for your grade of tragacanth. Therefore, correction is necessary, which can be made only after experiments with the available gum.

In short, if you are completely inexperienced, you can profit greatly by experimenting. Such products as mouthwashes, hair tonics, and astringent lotions need little or no experience, because they are, as a rule, merely mixtures of simple liquid and solid ingredients, which dissolve without diffi-

culty and the end product is a clear solution that is ready for use when mixed. However, face creams, toothpastes, lubricating greases, wax polishes, etc., whose formulation requires relatively elaborate procedures and which must have a definite final viscosity, need some skill and not infrequently some experience.

FIGURING

Some prefer proportions expressed by weight or volume, others use percentages. In different industries and foreign countries different systems of weights and measures are used. For this reason, no one set of units could be satisfactory for everyone. Thus diverse formulas appear with different units, in accordance with their sources of origin. In some cases, parts are given instead of percentage or weight or volume. On the pages preceding the index, conversion tables of weights and measures are listed. These are used for changing from one system to another. The following examples illustrate typical units.

Example No. 1

Ink for Marking Glass

Glycerin	40	Ammonium Sulfate	10
Barium Sulfate	15	Oxalic Acid	8
Ammonium Bifluoride	15	Water	12

Here no units are mentioned. In this case, it is standard practice to use parts by weight throughout. Thus here we may use ounces, grams, pounds, or kilograms as desired. But if ounces are used for one item, the ounce must be the unit for all the other items in the formula.

Example No. 2

Flexible Glue

Powdered Glue	30.90%	Glycerin	5.15%
Sorbitol (85%)	15.45%	Water	48.50%

Where no units of weight or volume, but percentages are given, forget the percentages and use the same method as given in Example No. 1.

Example No. 3

Antiseptic Ointment

Petrolatum	16 parts	Benzoic Acid	1 part
Coconut Oil	12 parts	Chlorothymol	1 part
Salicylic Acid	1 part		

The instructions given for Example No. 1 also apply to Example No. 3. In many cases, it is not wise to make up too large a quantity of a product before making a number of small batches to first master the necessary technique and also to see whether the product is suitable for the particular purpose for which it is intended. Since, in many cases, a formula may be given in proportions as made up on a factory scale, it is advisable to reduce the quantities proportionately.

Example No. 4

Neutral Cleansing Cream

Mineral Oil	80 lb	Water	90 lb
Spermaceti	30 lb	Glycerin	10 lb
Glyceryl Monostearate	24 lb	Perfume	To suit

Here, instead of pounds, ounces or even grams may be used. This formula would then read:

Mineral Oil	80 g	Water	90 g
Spermaceti	30 g	Glycerin	10 g
Glyceryl Monostearate	24 g	Perfume	To suit

Reduction in bulk may also be obtained by taking the same fractional part of portion of each ingredient in a formula. Thus in the following formula:

Example No. 5

Vinegar Face Lotion

Acetic Acid (80%)	20	Alcohol	440
Glycerin	20	Water	500
Perfume	20		

We can divide each amount by ten and then the finished bulk will be only one tenth of the original formula. Thus it becomes:

Acetic Acid (80%)	2	Alcohol	44
Glycerin	2	Water	50
Perfume	2		

APPARATUS

For most preparations, pots, pans, china, and glassware, which are used in every household, will be satisfactory. For making fine mixtures and emulsions, a malted-milk mixer or egg beater is necessary. For weighing, a small, low-priced scale should be purchased from a laboratory-supply house. For measuring fluids, glass graduates or measuring glasses may be purchased from your local druggist. Where a thermometer is necessary, a chemical thermometer should be obtained from a druggist or chemical-supply firm.

METHODS

To understand better the products which you intend to make, it is advisable that you read the complete section covering such products. You may learn different methods that may be used and also to avoid errors which many beginners are prone to make.

CONTAINERS FOR COMPOUNDING

Where discoloration or contamination is to be avoided, as in light-colored, or food and drug products, it is best to use enameled or earthenware vessels. Aluminum is also highly desirable in such cases, but it should not be used with alkalis as these dissolve and corrode aluminum.

HEATING

To avoid overheating, it is advisable to use a double boiler when temperatures below 212°F (temperature of boiling water) will suffice. If a double boiler is not at hand, any pot may be filled with water and the vessel containing-the ingredients to be heated placed in the water. The pot may then be heated by any flame without fear of overheating. The water in the post, however, should be replenished from time to time; it must not be allowed to "go dry." To get uniform higher temperatures, oil, grease, or wax is used in the outer container in place of water. Here, of course, care must be taken to stop heating when thick fumes are given off as these are inflammable. When higher uniform temperatures are necessary, molten lead may be used as a heating medium. Of course, with chemicals which melt uniformly and are non-exclusive, direct heating over an open flame is permissible, with stirring, if necessary.

When instructions indicate working at a certain temperature, it is important to attain the proper temperature not by guesswork, but by the use of a thermometer. Deviations from indicated temperatures will usually result in spoiled preparations.

TEMPERATURE MEASUREMENT

In the United States and Great Britain, the Fahrenheit scale of temperature is used. The temperature of boiling water is 212° Fahrenheit (212°F); the temperature of melting ice is 32° Fahrenheit (32°F).

In scientific work, and in most foreign countries, the Centigrade scale is used, on which the temperature of boiling water is 100° Centigrade (100°C) and the temperature of melting ice is 0 Centigrade (0°C).

The temperature of liquids is measured by a glass thermometer. This is inserted as deeply as possible in the liquid and is moved about until the temperature reading remains steady. It takes a short time for the glass of the thermometer to reach the temperature of the liquid. The thermometer should not be placed against the bottom or side of the container, but near the center of the liquid in the vessel. Since the glass of the thermometer bulb is very thin, it breaks easily when striking it against any hard surface. A cold thermometer should be warmed gradually (by holding it over the surface of a hot liquid) before immersion. Similarly the hot thermometer when taken out

of the liquid should not be put into cold water suddenly. A sharp change in temperature will often crack the glass.

MIXING AND DISSOLVING

Ordinary dissolution (e.g., that of sugar in water) is hastened by stirring, and warming. Where the ingredients are not corrosive, a clean stick, a fork, or spoon may be used as a stirring rod. These may also be used for mixing thick creams or pastes. In cases where very thorough stirring is necessary (e.g., in making mayonnaise, milky polishes, etc.), an egg beater or a malted-milk mixer is necessary.

FILTERING AND CLARIFICATION

When dirt or undissolved particles are present in a liquid, they are removed by settling or filtering. In the first procedure, the solution is allowed to stand and if the particles are heavier than the liquid, they will gradually sink to the bottom. The liquid may be poured or siphoned off carefully and, in some cases, it is then sufficiently clear for use. If, however, the particles do not settle out, then they must be filtered off. If the particles are coarse they may be filtered or strained through muslin or other cloth. If they are very small, filter paper is used. Filter papers may be obtained in various degrees of fineness. Coarse filter paper filters rapidly but will not retain extremely fine particles. For fine particles, a very fine grade of filter paper should be used. In extreme cases, even this paper may not be fine enough. Then it will be necessary to add to the liquid 1–3% infusorial earth or magnesium carbonate. These are filter aids that clog up the pores of the filter paper and thus reduce their size and hold back undissolved material of extreme fineness. In all such filtering, it is advisable to take the first portion of the filtered liquid and pour them through the filter again as they may develop cloudiness on standing.

DECOLORIZING

The most commonly used decolorizer is decolorizing carbon. This is added to the liquid to the extent of 1–5% and the liquid is heated, with stirring, for $^1/_2$ hour to as high a temperature as is feasible. The mixture is then allowed to stand for a while and filtered. In some cases, bleaching must be resorted to.

PULVERIZING AND GRINDING

Large masses or lumps are first broken up by wrapping in a clean cloth. placing between two boards, and pounding with a hammer. The smaller pieces are then pounded again to reduce their size. Finer grinding is done in a mortar with a pestle.

SPOILAGE AND LOSS

All containers should be closed when not in use to prevent evaporation or contamination by dust; also because, in some cases, air affects the product adversely. Many chemicals attack or corrode the metal containers in which they are kept. This is particularly true of liquids. Therefore, liquids should be transferred into glass bottles which should be as full as possible. Corks should be covered with aluminum foil (or dipped in melted paraffin wax when alkalies are present).

Glue, gums, olive oil, or other vegetable or animal products may ferment or become rancid. This produces discoloration or unpleasant odors. To avoid this, suitable antiseptics or preservatives must be used. Cleanliness is of utmost importance. All containers must be cleaned thoroughly before use to avoid complications.

WEIGHING AND MEASURING

Since, in most cases, small quantities are to be weighed, it is necessary to get a light scale. Heavy scales should not be used for weighing small amounts as they are not accurate enough for this type of weighing.

For measuring volumes of liquids, measuring glasses or cylinders (graduates) should be used. Since this glassware cracks when heated or cooled suddenly it should not be subjected to sudden changes of temperature.

CAUTION

Some chemicals are corrosive and poisonous. In many they are labeled as such. As a precautionary measure, it is advised not to inhale them, and, if smelling is absolutely necessary, only to sniff a few inches from the cork or stopper. Always work in a well-ventilated room when handling poisonous or unknown chemicals. If anything is spilled, it should be wiped off and washed away at once.

WHERE TO BUY CHEMICALS AND APPARATUS

Many chemicals and most glassware can be purchased from your drugstore. A list of supplies of all products is at the end of this book.

ADVICE

This book is the result of cooperation of many chemists and engineers who have given freely of their time and knowledge. It is their business to act as consultants and to give advice on technical matters for a fee. As publishers, we do not maintain a laboratory or consulting service to compete with them.

Please, therefore, do not ask us for advice or opinions, but confer with a chemist in your vicinity.

EXTRA READING

Keep up with new developments of materials and methods by reading technical magazines. Many technical publications are listed under references in the back of this book.

CALCULATING COSTS

Raw materials, purchased in small quantities, are naturally higher in price than when bought in large quantities. Commercial prices, as given in the trade papers and catalogs of manufacturers, are for large quantities such as barrels, drums, or sacks. For example, the bulk price per pound of Epson salts will be lower than the retail price per pound of the same.

Typical Costing Calculation Formula for Beer- or Milk-Pipe Cleaner

Soda Ash	25 lb	@ \$0.02$^1/_2$ per lb =	\$ 0.63
Sodium Perborate	75 lb	@ 0.16 per lb =	12.00
	Total 100 lb		\$12.63

If 100 lb cost \$12.63, 1 lb will cost \$12.63 divided by 100 or about \$0.126, assuming no loss.

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