present by forcing the product through porous stone cylinders and which produces an absolutely sterile beer, capable of keeping perfectly unchanged for an almost unlimited period of time. The object of the latter process is really to do away with pasteurization which checks the development of microorganisms in the finished beer in the bottle by heating. The conditions yielding the most satisfactory results in preserving beer by pasteurization have likewise been studied and the methods greatly improved.

The large quantities of spent or waste material derived from brewing operations have, for a long time, attracted the interest of the chemist. The question of the disposal of spent grains was most easily solved and for a long number of years these spent grains have formed a valuable cattle feed. Their value for this purpose has been considerably increased since drying of the wet grains is resorted to, thus resulting in a stable article which can be kept in perfect condition for a long time and which is even suitable and actually used for export.

The enormous quantities of carbonic acid gas escaping during fermentation, which amount to several hundred thousand tons per year in all of the breweries of the United States combined, were next given attention. Part of this gas is now, after suitable washing, compressed and sold in liquid form, while another part is utilized on the brewery premises for charging the fermented beer with the gas required to impart to it the necessary life and to insure a sufficient head of foam. The latter process, the carbonating of beer, has been largely introduced and has resulted in a very great saving to the breweries in which the system is installed.

The third waste product which has attracted the attention of the chemist is the yeast, of which very large quantities are discarded and run to waste after each fermentation. Analysis showed that yeast is extremely rich in valuable proteids and phosphates, and many chemists have endeavored and quite a number have succeeded in manufacturing from the waste yeast an extract which in taste and nutritive qualities is at least equal to meat extract. By others highly valuable cattle feed has been prepared from yeast and it is to be expected that in a relatively short time almost all of the yeast now going to waste will be diverted into useful channels.

In the above paragraphs the achievements of the chemist in his relation to brewery operations could merely be touched upon. As in all sanely conducted manufacturing enterprises, it has been and is the chemist's ideal to get at the bottom of, and explain in a strictly scientific way, the principles underlying all phases of the entire operation and to evolve means of cheapening the manufacture of the final product. At the same time I wish to emphasize that it is the aim of the brewery chemist to assist in producing a sound and healthful article in which the factors of purity and quality are of paramount importance and rank first before all other considerations.

CONTRIBUTIONS OF THE CHEMIST TO THE PRESERVED FOODS INDUSTRY

By R. I. BENTLEY

Vice-President and General Manager California Fruit Cannery Association

A little over a century ago Appert, a French chemist, was awarded a prize by his government for discovering a process for preserving foods without the use of preservatives. Appert's process of hermetical sealing is the same in principle as that in use today by food preservers the world over.

The industry has grown to such wonderful proportions that the annual output runs into billions of packages and nearly every known variety of meat, fish, vegetable and fruit—to say nothing of various sundries—is preserved in tin or glass. Statistics show that New York City expends \$150,000,000 annually for preserved foods—as much as that city spends for milk, bread

and eggs combined for the same period. This gives some conception of the volume of the business and the extent and variety of the field that it covers.

A chemist having made the industry possible, it would be presumed that chemists would have more or less to do with the preserving of foods from that time on—but in the early days of the industry, in our country at any rate, preservers of foods had little or no scientific knowledge. Their business for the most part was done in a very small way. There was an air of mystery about the processes and each preserver very jealously guarded the methods which he had acquired by experience, or by purchase from some one who had the experience. Under such conditions the keeping quality was the primary consideration in the mind of the preserver—if the flavor or appearance received any consideration, it was merely secondary.

It is a question whether, up to 20 years ago, it ever occurred to a preserver of foods that he could make use of a chemist or bacteriologist in his business. It is a question also, if it had occurred to him, whether he could have found a man, excepting at very large centers, who could have assisted him to any material extent. It is also a question whether, without special knowledge of the industry, a chemist could accomplish much until some insight and knowledge of the business was acquired. If the chemist and bacteriologist gave any attention to manufacturers prior to 20 years ago, they confined their attention to industries other than that of the food preserver. The food preserver, however, having now started to avail himself of their services, is making up for lost time.

Reference will be made to the application of bacteriology to the industry as well as to that of chemistry. The two sciences are so closely related and interwoven in the preservation of foods that it is difficult to discuss the one without referring to the other. If an apology is necessary, your attention is called to the fact that the presentation of this subject is not by one of your profession.

It is impossible within the limits of this paper to go very much into detail, or to present any statistics for your consideration. In this general discussion, therefore, the application of chemistry and bacteriology for the benefit of the industry will be mentioned, and illustrations of such application will be given.

Chemistry has enabled the food preserver to get the best materials suited to his use. A very simple illustration is that of salt—used to a large extent in the preservation of vegetables. Formerly, the preserver considered it a matter of economy to use the cheapest grade of salt that could be purchased. The chemist has shown him that some salt on the market contains injurious materials and that its use affects both the quality and appearance of products. Chemistry having already determined what grade of salt is best suited to his use, on its delivery the chemist determines whether the preserver has received what was selected. In the item of solder also, chemistry has enabled the preserver to get those proportions of metals which are best suited to his use, and on delivery the chemist tells him whether he has received what he ordered.

The application of bacteriology has enabled the preserver to scientifically determine the best methods of processing. The bacteriologist has ascertained the forms of organisms which cause trouble and by means of cultures of the same and inoculation experiments he has determined definitely what times and what temperatures are necessary for sterilization in order to preserve the different products.

The preservers of corn probably had the first experience with bacteriology as applied to the industry, for they had more or less trouble with what was termed "sour corn." Ordinarily corn that was not properly processed would develop what the trade terms "swells," *i. e.*, gases would be formed to such an extent that the heads of the tin cans would swell out—hence the name "swell,"—and ultimately burst; but in the "sours"

no gases were formed and the preserver was completely at sea. While the corn men had experienced this in a limited way, it had not been of sufficient importance to warrant them going to any great expense in the matter of research—but one season it developed in such large proportions in the case of one packer that investigation was started. About the same time some of the California preservers experienced the same difficulty with their asparagus. The California people were fortunate in getting hold of the same bacteriologist who was investigating the matter for the corn people and at the same time the matter was put in the hands of a bacteriologist in California. What seemed almost uncanny to the California asparagus packers at that time was the fact that two bacteriologists working entirely independently of each other arrived at the same conclusions as to the methods of processing the goods in order to obviate the difficulty.

Application of the laws of chemistry and bacteriology has also enabled the preserver to improve the quality of his product. The preserver, before he was shown a scientific method of processing, whenever he had any trouble with his goods—no matter from what cause—subjected the same to heat for a longer period of time, with the result that the quality suffered. The bacteriologist having informed him of the time beyond which it was unnecessary to go, he now knows that if he has trouble he must look elsewhere for it. This has greatly improved the quality and flavor of his products.

Among the applications of chemistry that have given the food preserver an improvement in the quality of his products may be mentioned improvement in the color of some varieties of fruit, such as berries, by the enameling of the inside of the can; also the examination of the water supply of the food preserver and the elimination of the objectionable elements in the water or the securing of a new supply. The almost complete elimination of iron in the machinery which comes in contact with the canner's products is due to the chemist pointing out the fact that the source of darkening or discoloration of the products was caused by the affinity of iron for tannin.

The application of bacteriology has enabled the preserver to detect promptly possible spoilage and remedy it before any material damage is done. It is a common practice with most preservers to have their products examined frequently; for instance, in the manufacture of catsup, tomato pulp is examined daily; the bacteriologist determines whether this product is right or not before it has gone beyond the initial stage of manufacture.

Chemistry has enabled the preserver to arrive at more economical methods of manufacture, particularly in the saving of labor and eliminating or reducing waste. Many fruits and vegetables are made ready for canning by immersing them for a few seconds in a solution of caustic soda, after which the fruits or vegetables are subjected to the action of fresh water sprays. In this manner the peeling is removed at a great saving in waste and labor without affecting the flavor of the fruit and vegetables so treated. By this method riper, and consequently better-flavored fruit can be handled than by the hand method of peeling. This method is now used almost exclusively on some varieties and is far more cleanly and sanitary than the old.

The application of chemistry has enabled the preserver to improve the conditions under which he operates. The supervision of the boiler water supply of the cannery has resulted in the reduction of costs of generating steam by lessening the amount of fuel, and has lessened depreciation of plant by the elimination of boiler scale and consequent shortening of the life of the boiler. The modern canner does not attempt to feed his boiler with water that has not been declared fit by a chemist.

Chemistry has enabled the preserver of food products to utilize some of his waste materials. There are some fruits, for instance, that have to be treated to a preliminary manufacturing process. Much waste results from this method of manufacture, but the chemist has enabled the food preserver to utilize some

of this waste, and what was previously a source of expense has now become a source of revenue.

The most notable application of chemistry in the matter of utilizing the by-products of a food preserver is that of the pineapple waste in the Hawaiian factories. More than 50 per cent of the pineapples received by the preserver were waste, the disposition of which was a heavy item in his expense account. A firm of chemists has worked out processes and methods for the recovery of the sugar values in this waste and proposes to furnish a syrup to the preserver, thereby almost entirely eliminating the use of cane sugar. These chemists have produced the syrup in the laboratory for the preserver on a small commercial scale. The syrup produced experimentally has been satisfactory both from a chemical standpoint and to the preserver as well. They have now about completed the erection of a small plant of a capacity of 50 tons of waste per day. Aside from the sugar value of the waste, it is expected that other products which will have considerable commercial value will also be recovered. If the larger commercial plant proves as successful as the experiment justifies the promoters in expecting, it will be very profitable both to the preservers and the chemists originating the process. It may be of interest to you to know some of the details of the business transaction between the chemists and the preservers. The chemists secured optional contracts from some of the largest producers of the waste in the Hawaiian Islands before even conducting their preliminary experiments, thus safeguarding the interests of the firm during the experimental period. If the small plant referred to is successful then it becomes binding upon this firm to erect a plant of sufficient capacity to take all of the waste of the preservers with whom contracts have been made, process the same and sell the sugar syrup back to the preserver at the equivalent of the market price for cane sugar. Each preserver shares in 50 per cent of the net profits as represented by his proportion of the waste furnished. The Hawaiian pineapple preservers will undoubtedly require the equivalent of \$500,000 worth of cane sugar in 1915. It is expected that the recovery plant will return to each preserver syrup recovered from his waste equal to 90 per cent of his requirements.

It is said that the preserver of meats has the utilization of waste and by-products down to such a fine point that he turns everything but the squeal of the slaughtered animal into profit. The preserver of fruit and vegetable products does not even approach such a position, for there are thousands upon thousands of tons of waste that are a source of expense which by the application of chemistry will be made ultimately to bring in a revenue.

While there has been something of accomplishment in this direction, it is not entirely the fault of the food preserver that it has not been more extensive. Many a good idea has been partially developed by chemists and submitted to manufacturers, and owing to the chemist's lack of practical knowledge of the food preserver's business, and owing to the manufacturer's lack of technical knowledge of chemistry, failure has resulted. When a manufacturer has one or more failures which have been a source of considerable expense to him in the way of equipment, etc., he is not inclined to continue experimenting. On the other hand, no class of manufacturers is more progressive and more likely to put money into research work than food preservers—but they must have a few successes along with the failures.

Every new idea should be worked out first in the laboratory and then on a small commercial scale, so that the expense in case of failure will not be large—and even if the experiment is ultimately a success it is best to hold down the expense and perfect the process before trying it out on a large scale. If chemists would work on these lines with manufacturers, we are satisfied that the application of chemistry would accomplish great things,

both for the chemist and the manufacturer. Under such conditions the preserver of fruit and vegetable products will, by the application of chemistry, be able to utilize all waste and even retain and preserve the bloom on the fruit and the spicy odor of it as well—and thus beat out the meat packer, who admits losing the squeal.

SAN FRANCISCO, CALIFORNIA

CONTRIBUTIONS OF THE CHEMIST TO THE POTABLE WATER INDUSTRY

By WM. P. MASON

Professor of Chemistry Rensselaer Polytechnic Institute

Less than a generation ago, the chemist approached the question of "Potable Water" with a confidence born of his ignorance, and he issued his pronouncements after an examination less thorough than that required to determine the fitness of a water for boiler uses.

E. Frankland and J. A. Wanklyn in England, and W. R. Nichols in America recognized that something more was needed than a knowledge of "total solids," "mineral matter" and "loss on ignition" before an opinion could be formulated as to the potability of the sample, and to them are largely due the beginnings of that advance in the technique of water examination which has taken such strides in our day.

It was perhaps to have been expected that, in their enthusiasm over their improved analytical processes, the water chemists should make the blunder, into which the bacteriologists fell at a later day, of demanding more from their recent discoveries than could with reason be asked. Thus we find Wanklyn dogmatizing upon the infallibility of the "albuminoid ammonia" process and insisting upon the reliability of a fixed standard for all waters, which measure should divide the good from the bad with accuracy.

Slowly, however, there crept into the minds of chemists the conviction that general standards could not be maintained, as waters were too various for their application; and therefrom developed the tendency towards that breadth of view in the matter of interpretation of analytical results which has led to a recognition of the great importance of what is now termed the "Sanitary Survey."

Considering that any one of the sundry items reported in an ordinary water analysis, is in itself harmless, and, therefore, is scrutinized only because of the possible bad company it might keep, it was soon admitted that an unusually high reading might be accounted for through some perfectly innocent cause in water from one locality and, therefore, justify a favorable report, while the same data from water derived elsewhere might determine condemnation of the sample.

The dictum is not new but it is as true as when first uttered that "no opinion should be risked as to the quality of a water from an unknown source."

It is even possible to add this further word, that, although we need all the light that chemistry, bacteriology and microscopy can throw upon the question as to the suitability of a water supply, nevertheless if but a single branch of inquiry be available the "Sanitary Survey" is the one to be chosen.

While declining to be bound by the hard and fast "standards of purity" advocated in the past, chemists have nevertheless done faithful work towards the establishment of suitable "comparates" where such records can be of service.

For instance, those chemists who undertook a determination of the "normal chlorine" of Massachusetts and Connecticut, and who gathered the data for plotting the "iso-chlors" of those states, certainly added much towards making an interpretation of analytical results more reliable.

Analytical averages for ground waters are now separated from those of surface supplies; the measure of "hardness" is so defined that the non-chemical laundry-man or boiler-user can

easily secure the information he needs; and, further, the public is informed as to how much iron would likely be objected to by the average community.

"Turbidity" and "color" are no longer described in words but are reported in definite "parts per million," as are the other items of the analysis, to the great advantage of the manager of the city filter, whose duty it is to watch the work done by the purification plant for which he is responsible.

The day is passed when a municipal filter is expected to run itself, except during its period of occasional cleaning. A chemist and bacteriologist will now be found continually on duty, ready to detect faulty operation on the part of the plant and prepared to apply those remedies which experience has shown to be proper under the circumstances.

"Pin-point coagulation" and its relation to water temperature is one of the disturbances of a mechanical filter that the chemist in charge must watch, for as the late autumn approaches, and the thermometer reads forty or less, the flocks of aluminum hydroxide decrease in size and tend more and more to pass through the sand bed.

Without a trained man in charge, aluminum compounds are likely to pass the filter at any time, for it is an easy matter to carelessly allow an overdose of alum to reach the filtered water; but the detection of too great an addition of coagulant is one of the simplest jobs the attending chemist has to do and it requires small effort on his part to keep down the alum bill.

When "bleach" is needed, as so often is the case, its strength in "available chlorine" must be determined, not only that the management may know the quality of the goods for which payment is made but also that a proper "dose" may be added to the water. Enough must be turned into the supply to do the work demanded, but an overdose should be avoided lest its disagreeable taste be complained of by the consumers. Who but the chemist in charge is to fix the proper value for the dose of "bleach" and who else can suggest a remedy if the right quantity should accidentally be exceeded?

It would not seem a very complex matter to supply properly purified water to a few people, but when this procedure is to be undertaken upon a large scale, the duties of the chemist in charge of the work become most varied. He has to examine and report not only upon the water product itself but also upon all the odds and ends of supplies and equipments that enter the establishment. Such a chemist must of necessity be a bacteriologist, and it would be of advantage to him should he be an electrician, mechanical engineer, biologist and general sanitarian as well.

So it is seen that the old rivalries between the chemist and the bacteriologist in the field of water supply have been outgrown and extinguished in that fusion of activities which produced the present water purveyor. There is yet much of the chemist in his makeup because there is much that is chemical in the detail of his daily work. Without bacteriology, he admittedly could not go far, because with that branch of his mental equipment he detects the present danger lurking in the water under investigation, but it is to chemistry he must turn in order to inquire as to the future and to estimate the probability of a yet distant danger following upon present safety. No better example of what is meant could be given than to cite a very recent instance falling within the writer's experience.

Two wells, each fifty feet in diameter, were sunk eighteen feet deep in a sandy soil, within a half mile of each other.

They were intended for use "in tandem" upon the same water service. One of these was, by bacteriological examination, shown to be grossly contaminated, a showing which was confirmed by both chemical analysis and the sanitary survey; the water from the other well appeared to be singularly good from the bacteriological standpoint but the chemical analysis indicated very material "past pollution" and the sanitary survey