cannot fail to recognize the great improvement which has been made in the general line of pharmaceutical products. The keeping qualities of many products have been thoroughly studied although only a few years ago very little was known in regard to the stability of medicines. Much remains to be done and progressive manufacturers are sparing no effort to improve the quality and raise the standards of their products.

Many of the older classes of pharmaceutical products, however, are rapidly giving way to new medicinal agents which are established on a scientific foundation. This necessitates research with the object of developing new products to take the place of those which are falling into disuse, for the manufacturer who neglects this will see his business gradually going to his competitor who is awake to this necessity. Extracts and tinctures made from vegetable drugs can hardly be considered scientific products even though standardized to a definite content of the active principles since they always contain many other substances which are either inert or possess undesirable physiological activity. Alkaloids and other definite principles isolated from vegetable drugs have already, to a large extent, taken the place of the various extracts and we may expect even greater progress in this direction during the next few years. The preparation of active extracts and definite principles from the ductless glands is one of the remarkable developments of the last fifteen years. Most of us have witnessed with interest the increase in synthetically prepared medicines from a very small beginning to a point where they are made to meet almost every therapeutic indication. The continued advance along the line of rational and exact medication has led the manufacturer to develop many of these new and improved therapeutic agents.

In one respect the position of the pharmaceutical manufacturer differs from that of manufacturers in other lines. The U. S. Pharmacopoeia, a book of standards published under the authority of a convention whose members are appointed by various medical and pharmaceutical bodies, and the National Formulary, published by the American Pharmaceutical Association, have been made the legal standards for all preparations and substances described by them. It is evident that such legal standards are necessary and that the manufacture of medicinal products should be very carefully controlled. This being granted it is very important that the standards be correct and the control judicious. The U. S. Pharmacopoeia is revised decennially by a revision committee chosen by the convention already referred to. In making this revision the committee draws upon the published or privately communicated work of chemists and pharmacists and to some extent upon work carried on under its own direction. Much of the work of chemists for the manufacturing houses has been utilized in the compilation of the Pharmacopoeia. Since the revision committee is a representative body in which all classes interested in the preparation and use of medicinal products have a voice, probably no better standards could be established, but it must be recognized that the progress which necessitates the revision of the book every ten years also renders many of the old standards obsolete long before the new edition appears. The National Formulary is a valuable book which was designed to serve as an unofficial guide in preparing commonly used preparations which were not described by the Pharmacopoeia and its elevation to the rank of a legal standard seems to have been due to a misconception of its function.

While these two standards have been legalized by the Federal Food and Drugs Act a very wise clause was inserted in the act which provides that preparations may differ from the standards so established if the standard be *plainly* stated on the label. This clause allows uninterrupted progress during the interval between revisions of the Pharmacopoeia and insures new material and improved standards for the use of each revision com-

mittee. It is this clause which now enables the chemist to contribute actively to the manufacture of medicinal products.

In some quarters the repeal of this provision of the law has been advocated and since it has such an important bearing upon the relation of the chemist to pharmaceutical manufacturing, it should receive our careful consideration. The repeal of this clause would make it unlawful to market any product which differed in any way from the product described by the Pharmacopoeia or National Formulary; manufacturers therefore could not profit by any improvement which they might make and all research tending toward the improvement of such products would be discontinued. When it is remembered that the most important medicines are described in the Pharmacopoeia, that many are included in the National Formulary which afterward find their way to the Pharmacopoeia, and that many of the articles dropped from the Pharmacopoeia are subsequently inserted in the National Formulary, it will be seen that no more effective bar to progress in the production of medicinal products, than the elimination of this clause from the law, could be devised. It may be pointed out that the standardization of extracts and tinctures as well as many other improvements could never have been introduced by manufacturers if no variation from pharmacopoeial standards had been allowed. Under such a law while manufacturers in every other line would be stimulated by competition to improve their products, the manufacturer of medicines would be legally prohibited from doing so. The contributions of the chemist to this industry would then be confined to routine analytical work and to the development of products which could be protected by patents; all improvements in medicinal substances now included in the National Formulary and Pharmacopoeia would have to be made by the committees of revision with limited time and facilities and without manufacturing experience. It seems doubtful if such a law could be enforced but if the matter is placed before our law makers in the proper light there can be no doubt that the federal law will remain unchanged and that the state laws will conform to it in this respect. If this course is followed the progress in this industry, which has never been as rapid as at the present time, will be uninterrupted.

INDIANAPOLIS, INDIANA

CONTRIBUTIONS OF THE CHEMIST TO THE HARDWOOD DISTILLATION INDUSTRY

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The hardwood distillation industry has been brought to popular attention of late, on account of the rapid increase in value of one of its products, acetate of lime, which is being converted, in large amounts, into acetone for the manufacture of smokeless powder. This recent impetus has been a great boon to the industry for, with low prices for wood alcohol since the passage of the denatured alcohol act, overproduction and low prices for acetate of lime and a constantly decreasing premium for charcoal pig iron, the outlook for the industry has not been brilliant for the past few years.

It was the last named condition which made the advent of the chemist into the wood distillation industry imperative. Necessity called him in to show how efficiency of operation, with low prices, might replace obsolete processes, stimulated by high prices. He came into the industry as efficiency engineer.

It has been in the treatment of the crude pyroligneous acid resulting from the wood distillation and in the recovery and refining of the valuable products that the contribution of the chemist has been of greatest value. Although he has shown the importance of temperature control of carbonization; of the physical condition of the wood; of the proper condensation and scrubbing of the non-condensable gases; although he proved beyond question the necessity of the abandonment of the old

kiln process and the adoption of the more efficient oven or retort system; yet it has been in the treatment of the products of wood distillation that he has served the industry most usefully.

To outline this treatment of the pyroligneous acid, we have the following steps, after the settling of the crude liquor for the purpose of removing the insoluble wood tar:

1—Distillation of the crude acid liquor for the purpose of removing the tar in solution.

2—After neutralization of the crude acid liquor by means of milk of lime, separation of the volatile products, *viz.*, methyl alcohol and acetone, from the acetate of lime of the neutralized liquor.

3—Concentration and drying of the acetate of lime.

4—Concentration and refining of the wood alcohol.

The primary distillation of the crude liquor was usually a simple distillation under atmospheric pressure, carried out in copper stills, fitted with cylindrical steam coil, copper goose and vertical tubular condenser. The operation consisted of feeding the crude liquor into this still continuously, while the process of distillation was carried out by means of live steam in the coil. This was continued ordinarily for three days when the addition of crude liquor was stopped and the distillation continued until no further product was obtained. Then live steam was entered in the still and a further amount of distillate, containing a large percentage of acetic acid was obtained. The matter of keeping the coils of these stills free from tar and carbon deposit was a difficult one, especially where the liquor was obtained from the kiln process. For the retort plant, it was necessary only once a week to enter a charge of settled tar which, in this process, contains a large amount of oils.

The crude liquor generally entered these primary stills at the temperature at which it was obtained from the retort or kiln condenser. Seldom were preheaters, operated either by the use of the steam condensate from the coil or the heat in the distilling vapor used. When it is remembered that substantially 90 per cent of the crude liquor is distilled, it will be readily seen that the process was a very costly one, not only on account of the high steam consumption, but also on account of the large investment in copper stills, coils and necks, all of which required frequent renewal.

The separation of the volatile constituents, *viz.*, methyl alcohol, acetone and methyl acetate, from the acetate of lime of the neutralized liquor was carried out by a simple distillation in the so-called "Lime-Lees" stills—vertical iron tanks, fitted with copper coil on the bottom, with a vertical goose, consisting of an iron pipe of varying heights, leading to a surface condenser, similar in construction to that used in the primary stills. The operation of these stills consisted of alternately filling the still with the neutralized liquor and, by means of live steam in the coil, distilling the volatile constituents until the watery distillate showed, by hydrometer test, no further alcohol content. According to the nature of the liquor, that is, if from retort or kiln and also depending on the nature of the goose, the distillate obtained in this process would vary from 5 to as high as 50 per cent alcohol.

The weak acetate of lime solution remaining in the Lime-Lees stills was then pumped or drawn into storage tanks, settled and fed to open, double bottom graining pans. The solution was evaporated down and grained, with the necessary stirring or "spudding" to secure proper grain of the final product. The final drying of the acetate of lime was then carried out, either on the brick tops of the retort setting by means of the waste heat from the retort, or on an iron dry floor, set on brick flues and heated at one end by coal fire, or by means of waste boiler gases. This process required a large amount of labor in the graining and raking of the drying acetate on the floor.

The watery alcohol distillate from the Lime-Lees stills was generally concentrated in intermittent stills, consisting of an iron still, fitted with scroll coil, the vapors passing through copper columns, of various design, frequently built with perforated plates and return pipes, with tubular separator and condenser at the top for increasing the proof of the distillate by means of fractional condensation. Frequently, the refining distillations are carried out in columns built of plates, with a large number of boiling pipes and caps for the purpose of better separating the more volatile acetone from the methyl alcohol.

The process indicated above involved, in some plants, as many as seven separate distillations from the pyroligneous acid to the refined alcohol; and, where carried out with live steam under atmospheric pressure, it resulted, of course, in great fuel consumption and excessive amounts of water required for condensing and cooling purposes. To these may be added the constant loss of products, due to the rehandling of the volatile material, especially when it is remembered that, even in the northerly plants, the available water frequently rises in temperature in the summer months to a point at which losses of volatile material may be considerable. The improvements undertaken, therefore, in the last few years have had these objects in view:

1—Economy of steam in evaporation and distillation.

2—Economy of water for condensing and cooling.

3—Greater simplicity of operation involving the elimination of repeated condensations and consequent redistillations in the step-up process.

The greatest steam consumer was the first step in the process, the distillation of the acid for the removal of the tar in solution. The first departure, therefore, from the atmospheric evaporation, was the introduction of vacuum evaporators. With the recognized advantage of single- or multiple-effect evaporation, the introduction into this industry was long delayed for various reasons. In many plants which operated in connection with sawmills, refuse has been sold to the chemical plant at a round figure, generally quite favorable to the chemical plant. With the large excess of waste available, the necessity of steam economy was, therefore, not present at these plants and it was at the plants without this favorable connection or at which the utilization of lumber was closer, that the introduction was first made.

The nature of the problem involving the evaporation of a liquid containing volatile products (methyl alcohol and acetone) together with an acid (acetic) with a tarry residue, in solution and held colloiddally, presented many new conditions for the builder of evaporators. Generally, their work had involved the concentration of a dilute aqueous solution, in which case the removal of the distillate at a high temperature was permissible. With pyroligneous acid, however, the presence of methyl alcohol and acetone necessitates the use of very efficient condensing and cooling apparatus to prevent losses of these valuable products. Again, the tar in solution presents a substance which rapidly forms a coating on the evaporator tubes, quickly reducing the heat transference and decreasing the boiling and circulation in the evaporator. The following conditions were essential, therefore:

1—Complete accessibility of all evaporator tubes for cleaning, inside and out. The cleaning problem varies with the nature of the crude liquor: that is, if derived from retort or kiln process, and the matter of keeping the evaporator clean is the most serious problem met with in the use of the vacuum evaporator. It is at this point that the attention of the chemist is most necessary, for it is his duty to indicate, judging from temperature and pressure conditions, in the different vapor chambers of the several effects, just where the accumulation of tar has brought about the decrease in heat conductivity.

2—Efficient condensing and cooling apparatus is of vital

importance on account of the difficulty of complete condensation, while working under the high vacuum. The design of the condensing apparatus, therefore, in this case, should involve a considerable length of path for vapors and gases before the non-condensable gas is allowed to escape from the apparatus.

3—The prevention of entrainment is important on account of the possible contamination of the distillate by a small amount of tar which might be thrown over and which causes difficulty in the later drying of the acetate of lime solution. Hoods, built within the evaporator body, itself, where the evaporator tubes are vertical, have lately been found to be of great advantage in this regard and permit rapid circulation in the boiling chamber, without fear of entrainment.

Again, in the concentration of the dilute acetate of lime liquor, the introduction of the vacuum evaporator has brought about great savings in steam and consequent lowering of costs. Here, also, the possibility of losses by entrainment was present, but has been completely eliminated by the use of horizontal tubes in the construction of the evaporator. The particular type of evaporator introduced has depended upon the saving to be brought about, in other words, upon the availability of exhaust steam or sawmill refuse. Hence, the single- or double-effect evaporator would be introduced where considerable exhaust steam was available or where fuel was cheap, while the triple-effect would find its place where coal at a high price was used for fuel. Combination evaporators have been introduced with success in several plants. Thus, a common type is a double-effect evaporator, the first effect of which is an iron pan, equipped with horizontal tubes, serving to concentrate the acetate of lime solution, while the second effect, operated by the vapors from the acetate pan, is a copper pan with steam chest equipped with vertical tubes for the distillation of the pyroligneous acid. Further economy has been secured by the introduction of preheaters for the crude liquors, which use the various waste condensates as the heating medium.

The final drying of the concentrated acetate of lime solution from the evaporators is now carried out very efficiently by means of mechanical driers which have eliminated the high labor costs of the old dry floor process. Rotary cylindrical driers, operated with steam within the cylinder, with the concentrated solution without, and fitted with scrapers to remove the acetate mud, have been eminently successful, the final drying taking place on horizontally moving canvas belts traveling over a series of pipes heated by exhaust steam or, better, the wet material is fed into a continuous wire belt moving vertically counter to a current of waste gases from blast furnace stoves, or boilers, reduced to the proper temperatures for drying. The latter arrangement produces a uniform product, especially free from dust, with one-quarter the labor previously used on dry floors and with a considerable saving of steam.

Returning to the second step of our process, the separation of the volatile components from the acetate of lime solution, we find that the introduction of continuous columns has halved the amount the steam formerly used in the old Lime-Lees and the distillate is brought to high proof in one operation, thereby eliminating the step-up process of intermittent distillation. These continuous columns are of various types, frequently of plates equipped with boiling pipes and caps, the preheated neutralized liquor entering at the middle part of the column, the lower half then serving to deprive the neutralized liquor of the volatile products, the upper half concentrating the volatile distillate continuously. An improved arrangement which has been put in successful operation during the last few weeks consists of two separate columns, the first one serving only to remove the alcohol from the neutralized liquor and discharging a low-proof vapor into the middle of the second column, which, operating on this vapor, produces a high-proof distillate, miscible with water, while discharging waste oils and watery

condensate from its base. This latter arrangement is a considerable improvement over previous columns in that this latter discharge will not dilute and contaminate the acetate solution, as has been the case heretofore.

In refining the crude wood alcohol, continuous columns have, in some plants, replaced the intermittent stills to a considerable extent. Columns are now in successful operation which separate the acetone from the methyl alcohol, so that a 50 per cent solution of acetone and, simultaneously, methyl alcohol containing under 0.1 per cent of acetone, are obtained continuously. The chemist's ingenuity in the production of various special solvents and mixtures has been of great value in the creation of new uses for methyl alcohol, which to-day are of great importance in disposing of the product, when the market for the regular grades is poor.

It is not within the scope of this paper to mention the work that has been done in the further development of wood distillation products, namely the manufacture of acetone and acetic acid from acetate of lime; of formaldehyde from methyl alcohol and of wood creosote from wood tar. We need only mention that these are purely chemical developments and their increasing importance to-day is a tribute to the American chemist.

Thus, the work of the chemist is apparent at every important step of the hardwood distillation industry and it may safely be said that the introduction of the improved apparatus described and its successful operation would never have been accomplished without the guidance of the chemist.

MANCELONA, MICHIGAN

CONTRIBUTIONS OF THE CHEMIST TO THE PACKING HOUSE PRODUCTS INDUSTRY

By ARTHUR LOWENSTEIN

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The modern large packing house is composed of a group of industries. The packing phase itself consists usually of the slaughter of animals, resolving the carcasses into various commercial cuts, curing, smoking, canning, assorting the various by-products and their conversion into finished products, the manufacture of sausage and other meat food products, etc., etc. In addition to this phase, however, many of the large packers are engaged in a number of specialized industries on a good-sized commercial scale, which are distinctive in themselves. Some of these are: the cottonseed oil industry; the poultry industry; manufacture of "compound" (a substitute for lard), oleomargarine, fertilizers—both animal and mineral (acid phosphate), sulfuric acid, glue, hair felt, curled hair, anhydrous ammonia (from ammoniacal liquor from coal), creamery butter, canned specialties, soda-fountain products, soap and toilet specialties, pharmaceuticals—from animal products, glycerine refining, etc., etc.

The contributions of chemists to some of these specialized industries referred to have already been ably discussed in papers presented earlier in this symposium and others are to be discussed at this meeting. That which follows in this paper will therefore deal largely with the contributions of the chemist to essentially the packing house phase of the subject rather than its allied industries in which the packing house chemist and chemical engineer today actively participate.

It may be interesting to quote from a book entitled the "Modern Packing House" by F. W. Wilder under the caption "Chemical Department:" "This is a department which in all of the large well-regulated packing houses is considered very essential and the information obtained therefrom in the saving and the turning into commercial value of the by-products, as well as in determining the value of the products already produced is turned to good account. Laboratories in the larger plants are fitted up for making exhaustive tests as to the value