THE CHEMICAL PRODUCTS OF WOOD.

Frank H. Mason, consul general at Berlin, Germany, has in response to a request from a resident of Michigan, transmitted through the state department, furnished an interesting and valuable paper upon the production of wood charcoal and recovery of the by-products, from which the American Lumberman has condensed such portions as are of most practical interest to lumbermen.

Coincident with the development of coke manufacture in Germany by the use of retort ovens, which recover the ammonia, gas, tar and its valuable derivaties that are wasted by the primitive "beehive" oven process, has been the improvement in methods and apparatus for wood distillation, through which the production of charcoal has been raised through thearchaic, wasteful, earth-kiln process that recovered only charcoal and tar, to an intelligent, scientific system by which every valuable element in the wood is saved and added to the wealth producing power of the forests. So far has this been carried that special patented processes have been devised for using even sawdust and the rough outer bark of trees as material for the manufacture of charcoal and other products.

The apparatus for wood distillation, which will be briefly described in a later section of this report, includes cast and plate iron retorts of various types, as well as ovens of masonry, together with pipes, coils, tanks and pans for condensation and rectification of the several distillates and ultilization of the gases. Retorts are either heated by direct firing from beneath or by superheated steam introduced in coils. Retorts with direct heating by fuel or gas flame are most in use, and they are of two general classes the horizontal and the vertical.

1—THE PRODUCTS OF WOOD DISTILLATION.

These form four primary groups, which, with their derivaties, may be synopsized as follows:

(1) Uncondensed gases, which may be burnt as fuel, or, after certain treatment, used for illuminating purposes.

(2) Tar, from which are derived benzol, naphthalene, paraffin, rosin and phenyl acid (creosote).

(3) Pyroligenous acid (wood vinegar), from which are derived acetic acid, acetone and methyl, or wood alcohol.

(4) Charcoal.

The quantities of these several products which can be obtained from the distillation of a certain quantity of wood vary considerably according to the species or kind of timber used, its dryness, and especially the time consumed by the process of distillation, it being a general principle that, within reasonable limits, slow distillation yields larger percentages of distillates than are recovered when the process is quickened. All this has been reduced to exactly demonstrated results by the German chemists, and these have been tabulated by Professor Fisher, in his "Chemical Technology," to show the comparative yield, by slow, and by quick distillation respectively, of the seven species of wood that are most employed for charcoal manufacture in Germany. The table shows for each kind of wood two lines of figures, the first of which (slow distillation) shows the products obtained when the wood was put into a cold retort and heated for a period of six hours; the second line (fast distillation) shows the results when similar wood was put into a glowing retort and exposed to a fierce heat for a period of three hours:

Wood, 100 Parts.	Total Distillates.	Tar	Hydrated Wood Vinegar (raw)...	Pure Acetic Acid.	Charcoal (dry)...	Uncondensed Gases ..
Hornbeam (Carpinus betulus)—						
Slow distillation	52.40	4.75	47.68	6.43	25.37	22.23
Fast distillation	48.52	5.55	42.97	5.23	20.47	31.01
Birch (Betula alba)—						
Slow distillation	51.05	5.46	45.59	5.63	29.64	19.71
Fast distillation	42.98	3.24	39.74	4.43	21.46	35.56
Beech (Fagus Silvatica)—						
Slow distillation	51.65	5.85	45.80	5.21	26.69	21.66
Fast distillation	44.35	4.90	39.45	3.86	21.90	33.75
Poplar (Populus tremulas)—						
Slow distillation	47.44	6.90	40.54	5.10	25.47	27.09
Fast distillation	46.36	6.91	39.45	4.36	21.33	32.31
Oak (Quercus robur)—						
Slow distillation	48.15	3.70	44.45	4.08	34.68	17.17
Fast distillation	45.24	3.20	42.04	3.44	27.73	27.03
Larch (Larix decidua)—						
Slow distillation	51.61	9.30	42.31	2.69	26.74	21.65
Fast distillation	43.77	5.58	38.19	2.06	24.06	32.17
Spruce (Picea excelsa)—						
Slow distillation	46.92	6.93	40.99	2.30	34.30	18.78
Fast distillation	46.35	6.20	40.15	1.78	24.24	29.41

These figures show the yield in pure, hard charcoal, which, on exposure to the air, absorbs moisture to an extent of from 4 to 10 per cent. of its weight, according to the kind of wood from which the charcoal was made. Of the above varieties, the English hornbeam is practically similar to the "blue beech" (Carpinus Americana) of the United States; and the beech, birch and spruce are nearly so identical with American woods of the same name that the foregoing table of distillates will be found substantially correct for the woods mostly employed for charcoal manufacture in our country. It will be seen that the charcoal yield is about one-fourth of the entire weight of wood, the total distillates one-half, and the greater portions of these is hydrated wood vinegar, which in its crude form contains about 12 per cent. of crystalized acetic acid.

2—NATURES AND USES OF THE SEVERAL DISTILLATES.

This section of the report abounds with chemical technicalities and terms, and only a portion of it is reproduced.

Taking up these several by-products in their order, the second in commercial importance is probably the wood tar, which is found more or less in all kinds of timber, but most plentifully in the larches and other conifers.

A—THE TAR PRODUCTS.

Wood tar is composed mainly of several hydrocarburets, some of which have only a scientific interest. The tar which contains them is expelled from the wood at a temperature exceeding 360° Celsius. The higher the temperature and the more rapid the process of distillation, the greater the percentage of tar and gas produced and the smaller the yield of acetic acid. The tar obtained as a by-product of charcoal manufacture from hardwoods is mainly used for the production of creosote and applied to the antiseptic treatment of wood, such as posts, railway ties, paving blocks, etc., to protect the fiber against decay. When used as a raw material for producing any of the hydrocarburets, that forms a separate chemical industry. The best known of them are:

Benzol; boils at 82° Celsius; specific gravity, 0.85.

Tulol; boils at 111° Celsius; specific gravity, 0.87.

Xymol; boils at 139° Celsius; specific gravity, 0.875.

Cumol; boils at 166° Celsius; specific gravity, 0.887.

Cymol; boils at 175° Celsius; specific gravity, 0.85.

By reason of these sharply defined characteristics they can be rather easily separated, and when treated with ammonia produce bases which, being oxidized, yield aniline colors. Industrially, however, anilines are mainly produced from the cheaper benzol and other derivatives from coal tar. The principal value of these elements when derived from wood tar is that they serve for a vast range of interesting researches for new and valuable shades of colors. Naphthalene and paraffin are hydrocarbons occurring in small proportions in wood tar. The paraffin is characterized by a remarkably high melting point—300 to 400° Celsius—but is of small industrial importance for the reason that it can be obtained so much more abundantly and cheaply from coal tar. Of the oxidized, and therefore acid, combinations in coal tar two have been isolated and have some scientific interest, containing carbolic acid; but are usually left in the liquid creosote and add to its antiseptic properties for the treatment of wood.

B—THE ACID PRODUCTS.

By far the most important by-product of wood distillation in charcoal manufacture is the pyroligenous acid, or wood vinegar, which in its raw state, as it comes from the still, is an impure hydrated solution, a colorless, inflammable liquid, with a sour, pungent smell and, as already stated, 12 per cent. of pure acetic acid. It boils at 117.3 Celsius and at 4° the acid solidifies in laminated crystals which fuse at 16° C. From the table previously given it will be seen that the yield of pure acetic acid is highest in the hardwoods. Pure acetic acid is derived from raw wood vinegar by several processes, the simplest of which is as follows:

The raw distillate is first left standing for a certain time to permit the tarry elements which it contains to separate by settling. The clarified liquid is then put into a retort, with rectifying apparatus attached, and heated until the methyl alcohol and other light and volatile elements are expelled and pass over into a distillate, which is reduced by subsequent processes to alcohol and acetone, as will be elsewhere described in this report. The heating is continued until the areometer shows a specific gravity of 1,000 (same as water), indicating that the lighter elements have been eliminated. The acid solution is then drawn off and neutralized with a base usually lime or soda. This takes up the acid, forming an acetate, which on being decomposed yields acetic acid. The cheapest base for this process is limestone, but it should be pure, or as nearly as possible freed from organic impu-