TABLE V

Variety of wood used in the distillation	Vol. of pyroligneous acid in liters	Per cent wood alcohol in pyro. acid	Per cent acetic acid in pyro. acid	Vol. of tar in liters	Per cent turpentine oil in tar	Per cent creosote oil in tar	Per cent mixed heavy oil in tar	Per cent pitch in tar	Per cent water in tar	Kilos of charcoal
Sugar pine.....	9.8	0.52	2.6	1.26	8.5	9.0	15.7	56.1	10.2	3.64
Yellow pine.....	12.4	0.55	2.2	2.09	10.6	6.2	20.2	46.9	6.5	4.32
Stump wood-pine....	10.9	0.57	2.4	3.50	18.1	9.0	20.4	50.4	2.4	4.09
Red fir.....	11.1	0.48	1.8	1.78	16.1	7.8	18.4	47.1	11.2	5.03
Silver fir.....	10.1	0.51	2.1	1.23	11.2	11.0	18.4	53.1	8.4	4.77
Mill states.....	9.6	0.61	2.7	1.81	9.2	8.1	20.7	48.8	11.8	4.53
Sage brush.....	9.4	3.54	11.53	1.94	...	16.2	14.7	15.6	48.0	7.8

wood turpentine, distilling below 170°. The results obtained from Experiments 3 and 4 are given in Table II.

Sample A is almost colorless and easily purified by distillation, but Sample B contains impurities, which can be removed only by alternately washing with caustic soda and sulfuric acid and redistilling.

Experiments 3 and 4 were repeated, using samples of other kinds of wood with results given in Table III.

From the above results it is evident that the yield of turpentine under diminished pressure is from 10 to 20 per cent higher than that obtained at ordinary pressure, using the same method of heat control, while it is double that obtained by the common destructive distillation method. In addition to this the quality of the product is much improved. If, however, as shown by a number of experiments in this laboratory, the wood used is green, and contains water in large excess of the volume of turpentine, then the process becomes one of steam distillation and the diminished pressure, while bringing the distillate over at a lower temperature, produces no decided increase in the total yield of turpentine.

The samples of purified wood turpentine, obtained from each of these varieties of wood, is water white and looks like ordinary spirits of turpentine, but they differ from it, and from each other, in odor and optical properties. They are under examination in this laboratory in an effort to identify the various terpenes present.

When the temperature of the retort reaches 250°, the volume of the gases given off is so great that the pump is no longer efficient in reducing the pressure, and distillation under diminished pressure becomes impossible. In order, however, to determine the total amount and the properties of the different products obtained at various temperatures from western yellow pine, 22 kilos of a sample of dry "light wood" were submitted to distillation in an oil-jacketed retort with results tabulated in Table IV.

After the distillation there remained 7.8 kilos of charcoal. The time for the distillation of each fraction was one and a half hours and the temperature was raised at almost uniform rate.

There are many varieties of wood indigenous to the Pacific coast, concerning the distillation products of which there is no published data. Samples of a number of these varieties, as they occur in the lumber districts of the Sierra Nevada Mountains, were submitted to destructive distillation. The results obtained are set down in Table V. The amount of wood used in each experiment was 25 kilos, and the methods

used in the examination of the distillate are those described in Allen's "Commercial Organic Analysis."

SUMMARY

The above experiments show that:

I. The western conifers contain wood turpentine in commercial quantities.

II. Under favorable conditions a cord (4,000 lbs.) of yellow pine will yield 25 gallons of wood turpentine.

III. The yield of turpentine from a given sample of dry wood can be increased by distilling under diminished pressure.

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THE NATURE OF BASIC LEAD CARBONATE

By EDWIN EUSTON

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In an article¹ "On the Composition of White Lead," reasons were presented for the assertion that white lead consists of a mixture of normal lead carbonate with a basic carbonate of lead of the composition $\text{PbCO}_3 \cdot \text{Pb}(\text{OH})_2$. The purpose of the present paper is to consider the nature of the combination of the components of this basic carbonate of lead. The existing assumption in text books on pigments is that, in basic carbonate of lead, the lead carbonate and the lead hydroxide are firmly united in actual chemical combination, but the results obtained in the experiments here to be mentioned indicate rather that the basic carbonate of lead should be considered as among those substances described by Zsigmondy² as mixtures of colloidal substances which can, under certain conditions, act as chemical compounds. "Not only³ have colloid compounds or colloidal mixtures, in which two colloids are united, been erroneously described as chemical compounds, but so also have mixtures or adsorption compounds of crystalloids with colloids."

The fact that the lead hydroxide portion of basic lead carbonate is soluble in ammonium chloride solution but not in cane sugar solution, indicates that the lead hydroxide is not present in mere mechanical mixture and yet is not so firmly held as to be properly considered in chemical combination. Direct evidence that the basic carbonate of lead is an "adsorption compound" is afforded by the fact that, in more than fifty trials, various samples of white lead and of lead carbonate, when treated with basic lead acetate solution at room temperature by stirring or agitation, invariably withdrew lead hydroxide from the solution and correspond-

¹ THIS JOURNAL, March, 1914.

² "Colloids and the Ultramicroscope," N. Y., 1909, p. 68.

³ *Ibid.*, p. 69.

ingly gained in weight. In composition the samples before treatment ranged from 12.0 to 16.3 per cent CO_2 , and after treatment contained as low as 10.1 and 10.3 per cent CO_2 in extreme cases. The extent of the reaction under uniform temperature conditions is dependent on the basicity of the lead acetate solution, on the relative amounts of the sample to be treated and of the available lead hydroxide in the solution, and on the duration of the treatment. Merely enough agitation is required to ensure uniform treatment. The process proceeds slowly, requiring, for example, six hours in one instance to enable a sample containing 14.7 per cent CO_2 to join with enough lead hydroxide from the solution to reduce to 10.1 per cent CO_2 in the final product. Excess of basic lead acetate in solution beyond the calculated amount is required for complete action, as the end point of the reaction is an equilibrium determined by the relative basicity of the solution and of the sample under treatment. With a sample containing both normal lead carbonate and basic lead carbonate this equilibrium can be disturbed in either direction at will by the addition of a further quantity of basic lead acetate solution or by the addition of neutral lead acetate solution. Samples prepared from lead carbonate in the manner described respond to the tests for basic lead carbonate to the extent that their analyses indicate.

To learn whether normal lead carbonate is unique in its ability to withdraw lead hydroxide from basic lead acetate solution, similar trials, using considerable excess of basic lead acetate solution, were then made with kaolin, commercial zinc oxide, basic zinc carbonate, whiting, precipitated calcium carbonate, precipitated barium sulfate and precipitated barium carbonate. The kaolin gained 10.6 per cent in weight by addition of lead hydroxide, and two different brands of zinc oxide gained only 0.6 per cent each. The other substances named formed compounds corresponding approximately to the following formulae:

Basic zinc carbonate became $\text{ZnCO}_3 \cdot \text{Zn(OH)}_2 \cdot 3\text{Pb(OH)}_2$.

Whiting became $2\text{CaCO}_3 \cdot \text{Pb(OH)}_2$.

Precipitated CaCO_3 became $2\text{CaCO}_3 \cdot \text{Pb(OH)}_2$.

Precipitated BaSO_4 became $3\text{BaSO}_4 \cdot \text{Pb(OH)}_2$.

Precipitated BaCO_3 became $3\text{BaCO}_3 \cdot 2\text{Pb(OH)}_2$.

The calcium compounds and the barium sulfate compound were so lacking in opacity as to be worthless as pigments. The barium carbonate compound and the basic zinc carbonate compound showed marked improvement in density, in opacity, in brushing quality, and in rapidity of drying with linseed oil, in these respects closely resembling white lead. In tinting and spreading power the basic zinc carbonate compound equalled white lead, and the barium carbonate compound considerably exceeded it. These results show that other substances than normal lead carbonate form compounds with lead hydroxide from basic lead acetate solution, and that the lead hydroxide so combined tends to give to such compounds, in varying degree, characteristics as pigments heretofore ascribed only to white lead. Further similarity is shown by the lead hydroxide portion of the compounds being soluble in

ammonium chloride solution but not in cane sugar solution.

The slow withdrawal of lead hydroxide from basic lead acetate solution by normal lead carbonate to form basic lead carbonate, the like action of some other substances in forming lead hydroxide compounds, the similarity in some properties conferred by the lead hydroxide on these different compounds, and the fact that the lead hydroxide is present neither in mechanical mixture nor in true chemical combination, indicate that basic lead carbonate is an adsorption compound.

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THERMAL REACTIONS IN CARBURETING WATER GAS PART I—THEORETICAL

By M. C. WHITAKER AND W. F. RITTMAN

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Much careful scientific work has been done on the equilibria involved in the manufacture of uncarbureted blue water gas. In the combined processes of manufacturing and carbureting blue water gas according to present practice, few experiments have been made on the equilibria of the constituents to find out the effect of varying pressure, temperature and concentration conditions. In the technical literature of gas manufacture, one rarely finds a reference to the relationship which may exist between the spheres of reaction in the process. The natural conclusion has been that the water gas and oil gas reactions are separate and influence each other but little.

It is proposed to consider some of the factors in which the H_2 , CO , CO_2 and H_2O of the blue water gas may affect the proportions of CH_4 , C_2H_6 , C_2H_4 , H_2 , etc., resulting from the cracking of the gas oil which is added. Likewise the influence of the gases coming from the oil on the percentage composition of the final gas mixture will be considered.

When the blue water gas or oil gas are manufactured in separate operations, hydrogen is the only gas which is found in the free state, in any quantity. But if the two gases, separately made, should be brought together at high temperature in a container such as a gas plant superheater, would there not be new equilibria to be satisfied? For example, might not the CO and H_2 of one become CH_4 and H_2O of the other, or *vice versa*? In case of these new equilibria there would, of course, be vital reactions between the gases of the two processes. In actual manufacturing practice, all the gases produced are in intimate contact at high temperature for the greater part of the manufacturing period, *i. e.*, while passing through the carbureter and superheater. Is it then correct to regard carbureted water gas as the result of two distinct reactions?

Equilibrium conditions tend to establish themselves both during the periods of initial cracking of the oil and the subsequent passage of the mixture through the carbureter and superheater. Gas oil itself can be "cracked" in a short distance, as has been shown in practically all laboratory experiments; in the laboratory the length of the cracking tube is usually a question of inches. It would seem on *a priori* grounds that the only important reason for the existence of the superheater is to enable the various