

trict in the United States great mounds and embankments of discarded slack and coal dust which, under a better system, might be utilized as fuel; and fortunes are lost every year in the clouds of gas and smoke that rise from the coke ovens of Virginia, Pennsylvania, Ohio, and Alabama. With soda, salt, and phosphate beds in a dozen states, we import the heavy chemicals for soap and paper making and annually purchase from Europe sulphuric acids and chemical fertilizers which ought to be made at home. There is a lesson in the coke ovens and chemical laboratories of France and Germany which the economists and manufacturers of America can not study too thoroughly nor too soon.

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### NEW BOOKS.

RESEARCHES UPON THE PHENOMENA OF OXIDATION AND CHEMICAL PROPERTIES OF GASES. BY FRANCIS C. PHILLIPS.<sup>1</sup>

The dissertation, which is reprinted from the *Transactions of the American Philosophical Society*, 17, May 26, 1893, is published in two parts, the first of which deals with:

(a) Phenomena of Oxidation of Hydrogen, Carbonic Oxide, Gaseous Paraffins, Olefines, and Acetylene.

(b) Qualitative Reactions of Gases.

(c) Substitution Products of the Action of Chlorine Upon Methane.

(d) Preparation of Halogen Compounds of Alkyls and Olefines.

In (a) the author has directed his experiments chiefly towards ascertaining the temperatures at which combustible gases, when mixed with air and passed over asbestos impregnated with various metals, will unite with oxygen. Asbestos fiber was coated with the different metals by moistening the asbestos with a solution of the chloride of the metal and then dropping alcohol on the fiber and igniting it: The metals employed were palladium, gold, platinum, iridium, osmium, rhodium, and palladium-platinum. About 0.3 gram of the asbestos thus prepared

<sup>1</sup> Dissertation for the degree of Doctor of Philosophy, University of Pennsylvania.

was placed in a glass tube of one-eighth inch bore, and this tube was heated in an iron oven, the lower portion of which was filled to the level of the glass tube with iron turnings. A thermometer inserted into the turnings gave the temperature. Above 300° the temperature was approximately determined by inserting into the iron turnings glass tubes containing small amounts of different salts of known melting points.

In the experiments upon the oxidation temperatures of the hydrocarbons, air containing a small measured percentage of the hydrocarbon was freed from carbon dioxide by shaking with caustic soda solution, then dried by sulphuric acid, and the gas mixture was then passed through the glass tube. The formation of water was detected by inserting in the farther end of the glass tube a mixture of crystallized ferrous sulphate and potassium ferricyanide, the salts being ground separately and mixed just before using. Carbon dioxide was detected by passing the escaping gases through lime water.

The gases whose behavior under the above conditions was investigated were hydrogen, methane, ethane, propane, isobutane, pentane, heptane, ethylene, propylene, trimethylene, isobutylene, acetylene, benzene, alcohol vapor, and carbon monoxide. The gases were carefully prepared and purified, but it does not appear that the author assured himself of their purity by quantitative analyses.

The author states the results of this group of experiments as follows:

“1. The temperature of oxidation is mainly dependent upon the solid bodies with which the gas is in contact.

“2. Two phases are often, but not always, to be observed in the process of oxidation. As the temperature rises a point is reached at which a minute and scarcely recognizable trace of carbon dioxide appears. After the slow oxidation has continued for some time and gradually increased during a rise of temperature of twenty, thirty, or even more degrees, a sudden intense reaction occurs in the lime water. \* \* \* Very often this slow oxidation is not observed and the carbon dioxide reaction occurs in the lime water suddenly and with full intensity. \* \* \*

"3. The oxidation of a hydrocarbon by air, under conditions similar in all respects, does not occur always at the same temperature. \* \* \* A variation in the proportion of hydrocarbon and air does not seem to materially influence the oxidation temperature.

"4. The paraffins are the most stable towards heated air in presence of palladium. Acetylene and carbonic oxide stand next in order. The olefines are the most easily oxidized.

"5. Of the members of the same homologous series of hydrocarbons, the lower are the more stable towards oxidizing influences.

"6. Hydrogen stands alone among combustible gases in undergoing oxidation under the influence of palladium-coated asbestos in the cold.

"7. Oxidation of gaseous hydrocarbon in excess of air involves the simultaneous formation of carbon dioxide and water.

"8. In all cases where air is in excess, oxidation is complete (*i. e.*, yielding only carbon dioxide and water), even though a considerable portion of the hydrocarbon may escape unchanged. With insufficient air supply, carbon dioxide may be partly replaced by carbon monoxide among the products of oxidation.

"9. As regards oxidizing power, the metals which I have studied might be arranged in the following order, beginning with the most active: (1) osmium, (2) palladium, (3) platinum, ruthenium, (4) iridium, (5) rhodium, (6) gold.

"10. At a bright red heat and in excess of air, palladium asbestos causes oxidation of all hydrocarbons as efficiently as does ignited oxide of copper.

"11. Glowing of the palladium is by no means essential to slow oxidation. \* \* \*

"12. The proportion of finely divided metal used upon asbestos seems to be immaterial. Palladium asbestos containing two per cent. of palladium is nearly as efficient as that containing thirty per cent."

In (*b*), part 1, are given the qualitative reactions of a number of gases upon various reagents in solution, and upon reagents used in solid form and heated to any desired temperature. The gases investigated are hydrogen, methane, ethane, propane,

isobutane, heptane, ethylene, propylene, isobutylene, trimethylene, carbon monoxide, acetylene, allylene, carbon oxysulphide, methyl hydrosulphide, methyl sulphide, nitrogen, and oxygen, and the action of carbon monoxide upon methane at high temperatures is tested. As the experiments do not admit of being given in condensed form, the reader must be referred to the original for details. Mention may, however, be made of a delicate reaction for hydrogen, which, according to the author, will detect one-twentieth of one per cent. of hydrogen in a neutral gas. It consists in passing the dry gas mixture over dry, cold, palladious chloride. The salt is decomposed with the evolution of hydrochloric acid, which is detected by passing it into dilute silver nitrate solution.

(*c*), part 1, contains a brief description of results obtained by passing a mixture of chlorine and methane through a heated combustion tube filled with bone black. The chief products seemed to be methyl chloride and tetrachlormethane, only small amounts of dichlormethane and chloroform being formed.

In (*d*), part 1, the preparation of halogen compounds of alkyls and olefines, and the literature of the subject are briefly discussed.

Part 2 is divided into :

(*a*) The Composition of Natural Gas as Found in Western Pennsylvania and Other Regions.

(*b*) A Method for the Quantitative Analysis of Natural Gas.

(*c*) The Origin of Natural Gas and Petroleum.

In this last the different theories are considered in considerable detail, the author differing from Engler and Mendelejeff, and upholding the theory of vegetable decomposition.

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