THE COLOR PRODUCTS OF COAL—MAUVE AND MAGENTA.

The following is a most interesting chemical lecture by A. W. Hofman, LL.D., F.R.S., lately delivered before the Royal Institution in London. This branch of chemical science has been cultivated with great assiduity and success by the lecturer, who is one of the most distinguished chemists of the age:—

The fact of the beautiful coloring matters known by these fanciful terms, mauve and magenta, being substances derived from coal, must, I presume, be familiar to every one of you. But there may be many unacquainted with the means by which this transformation is accomplished. It is to them that I address myself.

Coal to become color, has to pass through a series of stages of transition, each of which claims our attention for a moment. Briefly expressed, the aim of this address may be said to be, to show you the way from coal to color.

Color is intimately associated with light: without light there is no color. This remark applies in a double sense to the colors derived from coal; for it is to the introduction of gas light for illuminating our streets and houses, that we are indebted for the acquisition of these colors. This statement may appear strange, for nearly half a century has elapsed during which we have been in the possession of gas, whilst the transformation of coal into coloring matters has been achieved only recently under our own eyes. But you will immediately appreciate the truth of my assertion if I tell you that these substances are obtained from a secondary product, generated in the manufacture of gas, a product long used for a variety of purposes, but which, only within the last few years, the researches of chemists have proved to be an inaxhaustible mine of wealth and interest.

The starting point, then, for the production of mauve and magenta, is the manufacture of coal gas; but this is so well known as not to need any detailed description. Let me briefly remind you of the principal features of the distillation of coal, by directing your attention to the two large diagrams representing the retort house and the condensers of a gas works. You observe how the coal is heated in stupendous retorts, five or seven of which are generally associated in one furnace. The gas ascends from these retorts in vertical tubes, the bent ends of which dip into a large horizontal pipe, partly filled with water, called the hydraulic main, a considerable amount of the oily and tarry substances generated with the gas being separated by the water. The gas, so far purified, passes on through the condensers—immense vertical iron pipes constantly cooled by a current of cold water which surrounds their external surface. In these condensers an additional quantity of oily matter is separated, which, together with the oily substances deposited by the gas during its passag through the hydraulic main, is collected in appropriately-placed cisterns. The gas, having traversed the condensers, passes through a series of further purifications before it is delivered into the mains of our streets; but these, unconnected as they are with our subject, must no longer occupy our attention.

It is in the oily products, the so called coal-tar oil, that our interest is centered. To my mind this coal-tar oil is one of the most wonderful productions in the whole range of chemistry. That may be rather a one-sided view, but having in younger years spent much time in the investigation of this substance, I have acquired quite an affection for it. Nor can you fail to appreciate the interest which coal tar presents to the chemist when you look at the diagram in which I have endeavored to arrange synoptically the various substances which have been eliminated from it.

PRODUCTS OF THE DESTRUCTIVE DISTILLATION OF COAL.

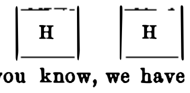
Name.	Formula.	Boiling Points. Degrees.
Hydrogen	$H\ H$	
Marsh gas, or hydride of methyl	$C\ H_3,\ H$	
Hydride of hexyl	$C_6\ H_{13},\ H$	
Hydride of octyl	$C_8\ H_{17},\ H$	
Hydride of decyl	$C_{10}\ H_{21},\ H$	
Olefiant gas, or ethylene	$C_2\ H_4$	
Propylene or tetrylene	$C_3\ H_6$	
Caproylene or hexylene	$C_6\ H_{12}$	55
Œnanthylene or heptylene	$C_7\ H_{14}$	
Paraffine	$C_n\ H_{2n}$ (?)	
Acetylene	$C_2\ H_2$	
Benzole	$C_6\ H_6$	84
Parabenzole	$C_6\ H_6$	
Toluol	$C_7\ H_8$	114
Xylol	$C_8\ H_{10}$	126
Cumol	$C_9\ H_{12}$	150
Cymol	$C_{10}\ H_{14}$	175
Naphthalin	$C_{10}\ H_8$	212
Paranaphthalin or anthracen	$C_{14}\ H_{10}$	
Chrysen	$C_{12}\ H_4$ (?)	
Pyren	$C_{30}\ H_4$	
Eupion	(?)	
Water	$\left.\begin{matrix}H\\H\end{matrix}\right\}O$	100
Hydrosulphuric acid	$\left.\begin{matrix}H\\H\end{matrix}\right\}S$	
Hydrosulpocyanic acid	$\left.\begin{matrix}H\\(C\ N)\end{matrix}\right\}S$	
Carbonic oxide	$C\ O$	
Carbonic anhydride	$C\ O_2$	
Disulphide of carbon	$C\ S$	
Sulphurous anhydride	$S\ O_2$	
Acetic acid	$\left.\begin{matrix}H\\(C_2H_3O)\end{matrix}\right\}O$	120
Phenylic acid or alcohol, *phenol.*	$\left.\begin{matrix}H\\(C_6\ H_5)\end{matrix}\right\}O$	188
Cresylic acid or alcohol, cresol	$\left.\begin{matrix}H\\(C_7H_7)\end{matrix}\right\}O$	203
Phlorylic acid or alcohol, phlorol	$\left.\begin{matrix}H\\(C_8\ H_9)\end{matrix}\right\}O$	
Rosolic acid		
Brunolic acid	(?)	
Ammonia	$\left.\begin{matrix}H\\H\\H\end{matrix}\right\}N$	
Aniline	$\left.\begin{matrix}C_6\ H_5\\H\\H\end{matrix}\right\}N$	182
Cespitine	$(C_5\ H_{13})'''N$	96
Pyridine	$(C_5\ H_5)'''N$	115
Picoline	$(C_6\ H_7)'''N$	134
Lutidine	$(C_7\ H_9)'''N$	154
Collidine	$(C_8\ H_{11})'''N$	170
Parvoline	$(C_9\ H_{13})'''N$	188
Corodine	$(C_{10}\ H_{15})'''N$	211
Rubidine	$(C_{11}\ H_{17})'''N$	230
Viridine	$(C_{12}\ H_{19})'''N$	251
Chinoline or leucoline	$C_9\ H_7\ N$	235
Lepidine	$C_{10}\ H_9\ N$	260
Crytidine	$C_{11}\ H_{11}N$	
Pyrroll	$C_4\ H_5\ N$(?)	
Hydrocyanic acid	$H\ C\ N$	

This is rather a formidable list of compounds; their names, too, are not always remarkable for smoothness and melodious character, although I should not omit to state they are tame and domestic when compared with some of the terms which chemists of late have been under the painful necessity of inventing and inflicting. You need not be afraid, however, that I shall trouble you with many details about these substances. Most of them, though highly interesting for more than one reason, more especially when considered from a purely scientific point of view, are of no importance for our present subject, and need not therefore specially be noticed. In fact, the only coal derivatives which, in connection with mauve and magenta, claim our attention, are benzole, phenol and aniline; those certainly we must by-and-by examine somewhat more in detail.

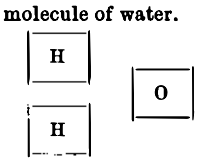
But before doing so, you legitimately expect that I should endeavor to give you some idea of the nature of the process in which this endless variety of compounds is generated from coal. Were I to tell you simply that coal consists of carbon, hydrogen, nitrogen, oxygen and sulphur, not to mention the ash which is left after combustion, and that you may therefore look upon coal as a sort of magazine of these several elements, capable, under the influence of heat, of associating in an infinity of forms and proportions, you would have learnt comparatively little. Let me attempt to convey to you a somewhat more precise idea of the processes involved in the distillation of coal. For this purpose you must allow me to remind you of some of the general results elaborated by the researches of chemists during the last ten years, which at the first glance appear but little connected with mauve and magenta.

The infinite number of substances, mineral, vegetable or animal, which form our planet, variously as they are composed, may be referred—chemists now pretty generally agree—to a comparatively small number of types of construction. Opinions are divided respecting the actual number of these types, and even the choice of typical bodies is still a subject of discussion among chemists. But whatever the special views of particular schools may be, the number of types is always small, and among them almost invariably figure hydrogen, water and ammonia. The comprehension of the meaning attached by chemists to the term "types" may perhaps be facilitated to you by a glance at three models which I have had constructed for this purpose, and which for the sake of convenience I may be allowed to designate as type molds.

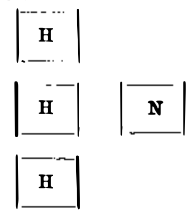
Chemists assume that the smallest particle of hydrogen which exists in the free state, or, to use the chemical phrase, the molecule of hydrogen, consists of two atoms of hydrogen. The first of our type molds, then, charged as it is with one atom (one volume) of hydrogen, associated with another atom (one volume) of hydrogen, represents the molecule of hydrogen.



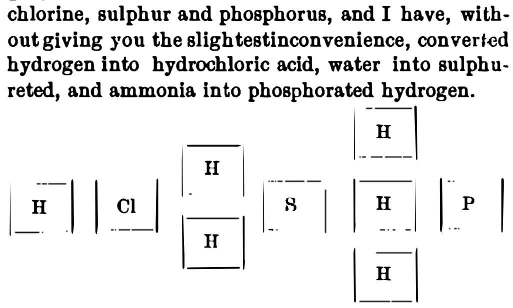
In water, as you know, we have two atoms (two volumes) of hydrogen, associated with one atom (one volume) of oxygen. (Equivalents used: H=1; O=16; S=32; C=12; N=14; Cl=33·5, &c.) You are reminded of this fact by our second type mold which represents the molecule of water.



In ammonia, lastly, you have three atoms (three volumes) of hydrogen united with one atom (one volume) of nitrogen, a form of construction which is recorded in our third type mold representing the molecule of ammonia.



Nothing is easier now than to trace the derivation of other substances from hydrogen, from water, from ammonia. Let me remove from our three type molds one atom respectively of hydrogen, oxygen and nitrogen, and fill the places thus vacated with atoms of chlorine, sulphur and phosphorus, and I have, without giving you the slightest inconvenience, converted hydrogen into hydrochloric acid, water into sulphureted, and ammonia into phosphorated hydrogen.



You observe the molecules of hydrochloric acid, of sulphureted and of phosphorated hydrogen respectively contain the same number of atoms which are present in the molecules of hydrogen, of water and of ammonia. We have thus indicated that hydrochloric acid is constructed upon the hydrogen type, sulphureted hydrogen upon the water type, phosphorated hydrogen, lastly, upon the type of ammonia. The three bodies just considered were formed by the insertion of elementary atoms; but our type molds receive compound atoms with the same facility.

(To be continued.)

IT has been calculated that the fibers of pure Sea Island cotton average one inch and three-quarters in length. If it were possible to place the fibers end to end, one pound would extend 4,777 miles.