March 1890, ½ Bushel Brewery Grains, 4 qts. Bran, 2 qts. Hominy Meal.
April, 1890, ½ Bushel Brewery Grains, 4 qts. Bran, 2 qts. Corn Meal.
May, 1890, Grass alone.
June, 1890, " "
July, 1890, " "
August, 1890, Grass and ½ Bushel Brewery Grains.
September, 1890, " " " " " "
October, 1890, " " " " " " 4 qts. Bran.
November, 1890, " " " " " " 8 qts. Bran.
December, 1890, " " " " " " 8 qts. Bran.

ON CONDENSATIONS.

By Wm. Bernhardt.

It was with deep interest I have read Dr. T. Sterry Hunt's paper on "mineral condensation," published in this journal and reprinted in the *Chemical News*, but, whilst accepting most of his views, it has seemed to me, that what is commonly called "condensation" is an expression comprising processes of very different kind, and of strongly distinguished characters. For instance, formaldehyde and the products of its condensation exhibit the distinctions between "condensation" in the strict sense of the word and identical with "polymerisation," and ordinary condensation, by which compounds result that cannot strictly be considered as polymeres of the original substance. Formaldehyde when kept for some time is partly transformed into solid paraformaldehyde, from which by applying heat formaldehyde may easily be regenerated. Not so from the sugars which result from treating the aldehyde with milk of lime, or with tin shavings. Although their aldehydic character can scarcely be denied and is manifested in the formation of alcohols under the influence of

nascent hydrogen, the reproduction of formaldehyde from them has not yet been performed, and it is doubtful if it ever can be performed. Condensation in the strict sense of the term should include the possibility of regenerating the original substance, a possibility which is lacking in the case of formose and similar sugars. Moreover, paraldehyde is a true product of condensation. I consider sulphur, phosphorus and arsenic, when solidified from their vapor, liquid chlorine obtained by cooling or compressing the gas, water, and, in short, all elements and compounds in the solid or liquid state directly convertible into their primary forms. The formula of common crystalline phosphorus in respect to the density of its vapor would be P_{333}, as becomes apparent from the following calculation, in which, however, neither the expansion by heat of the vapor nor that of the solid substance has been considered.

1 litre of hydrogen weighs 0.0897 grm.

1 " " phosphorus vapor (sp. gr. 62) $= 62 \times 0.0896$

1 " " " " contains 5.555 grms. of solid phosphorus

Sp. gr. of solid P. (water $= 1$) is 1.830

1.830 grm. solid P. therefore fills the volume of 1 c. c. of water.

Then by the proportion :

$1.830 : 1{,}000 :: 5.555 \cdot\cdot x$

We find $x = 3$ c. c. meaning that 3 c. c. of solid phosphorus, when converted into vapor, fills the volume of 1 litre. Condensation ensues in the proportion of $1{,}000 : 3 = 333 : 1$. 333 is the coefficient of condensation of phosphorus, its formula therefore P. 333.

The complex nature of both solid and liquid elements becomes evident by calculations of this kind. To crystallized elementary arsenic a formula of about As 425, and to mercury of Hg 1,515 should be given. 1,696 volumes of the vapor of water yield 1 vol. of liquid water ; water therefore (H_2 O) is 1696.

Condensation, as appears from the instance of water, does not always take place in the order of gas, liquid, solid, but the liquid state may be of greater density than the solid one. Solid cast iron also swims upon the surface of the molten metal. In chloral,

upon addition of a small quantity of water, solidification ensues, chloral hydrate resulting; it is questionable, however, whether this process may be classified as a "condensation," the product, although solid, being of less spec. gravity than chloral.

As to most of the metals, their oxides and salts, we are entirely at a loss to determine their real molecular weights, calculation of them from the density of their vapor being only possible in the comparatively few cases which permit of volatilization; there seems to be little doubt, however, that in their formation condensation is mostly combined with a chemical change excluding the possibility of restoring the original substance by simple physical means. Such changes generally occur in the formation of precipitates; they are especially evident in the decomposition of neutral bismuth and antimony salts by water. Still there are various exceptional cases, in which, by applying or withdrawing heat, a precipitate already formed is again dissolved. Most soluble salts are more readily dissolved by warm than by cold water; calcium citrate, on the contrary, readily dissolved by cold water, is precipitated by heating the solution. There can be little doubt that in such cases some chemical change occurs, a soluble combination of calcium citrate and water existing, which is decomposed by heat, but restored on cooling. A similar change occurs, when a solution containing calcium tartrate and potassium hydroxide is heated.

Heat is one of the mightest promoters of chemical combination on the one hand, of decomposition on the other, and is indeed the chief agent in most chemical processes; furthermore, the doctrine of thermo-chemistry is founded upon the appearance or disappearance of heat in every disturbance of chemical equilibrium. Still, heat has always been considered as a physical force, and the modern kinetic theory regards it as a kind of movement which, when transferred to the molecules of any substance, may induce chemical alterations, also consisting of particular kinds of motion. These reasons entitle us to distinguish the effects of heat from those of other chemical agents and to classify the products of condensation in the following way:

1. *Physical condensation* or *polymerisation* consists in an aggregation of atoms in a molecule, by which, the constituents and their

percentage remaining unaltered, a complex molecule is formed, from which, however, by the application of heat the original molecule can be restored. For example, sulphur, phosphorus, arsenic, mercury, chlorine, iodine, bromine, water, paraldehyde, metaldehyde, etc.

2. *Chemical condensation* consists in an aggregation of atoms in a molecule, which, together with changes of the atoms as to their relative position and of the molecular structure, produces a complex molecule, from which by means of heat the primary molecules cannot be restored. For example, many insoluble precipitates of metallic compounds, fixed solid elements and compounds in general.

It is hoped that these few suggestions may contribute to a more precise understanding by the expression "condensation," and may separate such natural processes into classes of different character.