

Reports on Special Departments of Chemical Science.

ON THE DENSITY OF CHLORINE AT HIGH TEMPERATURES.

Note by AD. LIEBEN (Comptes Rendus, No. 6, August 11, 1879.)

Translated by A. BOURGOGNON.

Messrs. Victor and Carl Meyer, in following up the very important researches of Victor Meyer, on the densities of vapors, have recently (Berl. Ber., 1879, p. 1,426) attained a result of extraordinary importance. They have found that at temperatures ranging from $1,240^{\circ}$ to $1,567^{\circ}$ C., the density of chlorine (air being unity) is not 2.45, as is the case from 0° to about 600° C., but only 1.63. Their conclusion is that the molecular weight of chlorine at such high temperatures is not 71, but 47.3. This number not being a multiple of the generally accepted atomic weight, $\text{Cl} = 35.5$, the authors have inferred that chlorine may, perhaps, not be an element, but a compound of oxygen, such as has been assumed in the old murium hypothesis, or that, if chlorine be an elementary substance, the atom, $\text{Cl} = 35.5$, is, itself, composed of smaller atoms, *i. e.*, $\text{Cl} = \frac{1}{3} \text{Cl} = 11.83$. The change of density from 2.45 to 1.63, and of molecular weight from 71 to 47.3, which takes place at high temperatures, will then be, to a certain extent, similar to the well known change undergone by the vapor of sulphur under similar conditions. Nevertheless, the very essential difference is noted, that the change in the density of sulphur vapor may be explained as the result of a new arrangement of the atoms, while, in the case of chlorine, it would be necessary to halve the atom, and even to admit the existence of new, and smaller, atoms, a proceeding which is not warranted by any known facts.

Even if we admit, with V. and C. Meyer, that all errors have been avoided in their experiments, and especially, that the porcelain of the vessels, and the platinum, did not evolve any trace of gas under the conditions obtaining therein, the facts observed by them are nevertheless susceptible of another interpretation than the one they have given. This note has, indeed, no other object than to direct attention to this point, and to provoke more decisive experiments. A considerable number of volatile compounds of chlorine are known, and there has never been found in their molecules, as determined by the vapor density, a smaller quantity of chlorine than that which is to-day considered as an atom, and which weighs 35.5 times as much as one atom of hydrogen. There has never been found in the mole-

cules of chlorine compounds any quantity of chlorine which was not a multiple of 35.5. The greater the number of chlorine compounds studied, the less becomes the probability that the value that we call one atom ($\text{Cl} = 35.5$) can be divided into smaller atoms.

The interesting fact, observed by V. and C. Meyer, that the density of chlorine, compared with air, decreases with the elevation of temperature until it becomes two-thirds of the ordinary density, may, however, be brought into accord with the generally accepted atomic weight, and even the molecular weight of chlorine. It is, for this purpose, simply necessary to assume that chlorine, after reaching a temperature of 700°C ., follows a different law of dilation from other gases, *i. e.*, that its coefficient of expansion is somewhat greater than those of oxygen, nitrogen, gaseous sulphur and gaseous mercury, the densities of which have been determined by the Messrs. Meyer at high temperatures.

We know that gases under high pressure do not follow Mariotte's law, and that the compressibility varies according to the nature of the gas. Thus, under a pressure of 2,790 atm., it is not possible, according to Natterer, to compress 2,790 vols. of hydrogen, but only 1,008 vols., into the space filled by 1 vol. under the pressure of 1 atm. In the case of nitrogen, the same space cannot contain, under a pressure of 2,790 atm., 2,790 vols., nor even 1,008 vols., but only 705 vols. The two gases evidently did not follow Mariotte's law, and hence, show a different degree of compressibility.

We do not know exactly what the coefficients of expansion of the different gases are, at temperatures of from $1,200^{\circ}$ to $1,600^{\circ}$; it may be that they diminish, but it is not irrational to assume that the coefficient of dilation of chlorine may be greater than that of nitrogen and oxygen, and that, at temperatures below 600°C ., the coefficients of dilation of the three gases may appear sensibly the same. The consequence would be, that the density of chlorine, compared with nitrogen or air, would be smaller at from $1,200^{\circ}$ to $1,600^{\circ}\text{C}$., than at from 0° to 630°C .

There is yet another explanation for the decreased density of chlorine. We may imagine that the molecules of chlorine (Cl_2) undergo, at high temperatures, a veritable dissociation into isolated atoms. If that dissociation be complete, the density of chlorine would become one-half (1.23) of the ordinary density. Now it is possible that, within a certain interval of temperature, the dissociation is left incomplete, that the molecules are decomposed into atoms, and that these isolated atoms combine again to regenerate the molecules

Cl_2 . There might thus result a kind of equilibrium of such nature that half of the molecules are decomposed into isolated atoms, and, consequently, that the density of the gas becomes two-thirds of the normal density of the non-dissociated molecules Cl_2 .

I very willingly admit that the two explanations I have given of the facts observed by the Messrs. Meyer, are not demonstrated, and may give rise to objections, but it seems to me that they are more easy to admit than a new atomic weight for chlorine which would be in contradiction with the definition of the atom, *i. e.*, the smallest quantity of an element contained in the molecules of its compounds.

Report on Foreign and American Patents relating to Chemistry.

Foreign Patents.

Condensed from R. BIEDERMANN'S Report to the German Chemical Society, by H. ENDEMANN.

CHARLES NORRINGTON, Plymouth : (Engl. P., No. 4139, Oct. 17, 1878.)—*Prevents loss of sulphurous acid from pyrites furnaces* during the process of recharging, by having the ash-pits closed with air-tight fitting sliding doors, which close automatically when the furnace is opened above to be recharged.

JAMES COCHRAN STEVENSON, South Shields : *Apparatus for the manufacture of soda*. (Engl. P., No. 4148, Oct. 18, 1878.)—Relates to an improvement in the construction of evaporating pans.

EDW. W. PARNELL, Liverpool : *Improvements in the manufacture of alkali*. (Engl. P., No. 4188, Oct. 21, 1878.)—The improvement consists in the use of zinc for the removal of sulphides, sulphites and hyposulphites, all furnishing zinc sulphide. Any zinc which might have gone into solution, is removed by untreated lye. Instead of using zinc, a solution of oxide of zinc in caustic alkali may be used; this, however, removes only the sulphides. The zinc sulphide is, for the purpose of regenerating zinc oxide, mixed with zinc sulphate and calcined.

FRANKE CLARKE HILLS, Deptford : *Improvement in the manufacture of ammonium sulphate*. (Engl. P., No. 3257, Aug. 17, 1878.)—Relates to an arrangement of communicating saturating tanks.

JEROME NARCISSE JOUVEAU DUBREUIL, Paris : *Method for the manufacture of iodine and bromine and other valuable substances, from varek*. (Germ. P., No. 6896, Jan. 9th, 1879.)—The plants are first reduced in machines similar to those used for the manufacture of wood paper pulp. The mass thus obtained, is then mixed with four or more per cent. of lime, and left standing for 12 hours. The sap is then separated from the insoluble part by means of an hydraulic press. Thus 1000 kgs of plants yield 800 pounds solution and about 200 kgs of yet moist pulp. This is washed with water, which is used for the slacking of new portions of quick lime. The quantity of iodine which may be obtained depends