

THE OCCLUSION OF GASES IN METALS.

ON Tuesday, November 12, the Faraday Society held a discussion on the above subject, attended by a very representative gathering of the various aspects of it, theoretical and experimental. After a foreword by the president, Sir R. Hadfield, on the great war, the discussion was opened by Prof. Alfred W. Porter, who emphasised that the term "occlusion" includes, in reality, a number of phenomena: chemical combination, simple or compound solid solution, surface adsorption accompanying solution, surface condensation unaccompanied by solution, and inclusion of gas forming blowholes visible to the naked eye or microscope. The difficulty of distinguishing between these several types was illustrated by the case of the occlusion of hydrogen by palladium, the nature of which, even at the present day, is still an unsettled problem. Amongst phenomena due to occlusion are the passivity of iron and the associated fact of the embrittling of iron by caustic soda. But there are other phenomena of more theoretical interest, such as the Volta effect, which has often been attributed to condensed layers of gases. By the experiments of O. W. Richardson and of Langmuir on thermionic emissivity, the question of the origin of the Volta effect has been completely reopened.

In connection with the brittleness associated with occlusion in iron and other metals, the opener endeavoured to elicit an expression of opinion as to the nature of brittleness, illustrating his remarks with the well-known behaviour of cobbler's wax, which is exceedingly plastic under the action of small forces of long duration, but is as brittle as glass when struck a sharp blow. He laid stress on the necessity for paying attention to the time element in specifying brittleness.

Mr. Cosmo Johns followed on the technical side with a paper on the properties of metals as affected by their occluded gases. He distinguished between gases which are absorbed as such and those which are formed as a result of reactions between non-gaseous constituents during the cooling of the metals in question. It is known that molten copper and iron dissolve more hydrogen than when those metals are solid. A molten mass saturated with hydrogen at a particular partial pressure will, during freezing, become supersaturated with the gas. Some of this must be entrapped between the growing crystals and exist as macroscopic or microscopic gas enclosures, though this is probably not the only method by which occlusion occurs. Probably it is the inter-crystalline, amorphous matter that is chiefly concerned, and brittleness will be due to the change in this produced by the gas. He attributed the CO_2 and CO occluded to reactions between dissolved oxide of iron and the carbon in the steel at the particular temperature when iron oxide, being thrown out of solution as freezing progresses, becomes concentrated in the mother-liquor between the growing crystals and reacts with the carbon which has not suffered the same concentration. He urged that all our knowledge of the properties of metals merely relates to metals containing occluded gases, and not to pure metals themselves.

Dr. Thomas Baker gave a description of experiments made to discover the relation, if any, between the temperature of evolution of gas and the critical points of steel. He finds that with hard steels the evolution of hydrogen reaches a maximum rate at 600°C ., and below this temperature constitutes the greater part of the gas given off. Carbon monoxide is slowly evolved from the beginning, and reaches its maximum rate at 688°C . With soft steel there is a further point of maximum evolution of hydrogen and carbon monoxide at 786°C .

NO. 2560, VOL. 102]

Dr. McCance spoke on the balanced reactions in steel manufacture, particularly with reference to the open-hearth process. Dr. Hatfield pointed out the large influence which silicon has upon occlusion.

Dr. Rosenhain emphasised that all liquids are brittle, but, as the opener afterwards pointed out, it would be better to say all bodies. Mr. C. V. Boys, referring to the spitting of silver on solidification, stated that he had found that to avoid loss of silver through spitting in cupellation it was necessary to cool it very slowly; and he asked if this was due to the evolution taking place over a range of temperature, and not all precisely at the solidification point. It could not be due to differences of temperature in the solidifying mass, because a considerable amount of undercooling takes place, and the solidification, when it occurs, is a very rapid process, the whole mass rising practically instantaneously to the melting-point.

Sir T. K. Rose dealt with the bearing of Le Chatelier's principle upon the change of the concentration of dissolved gases with temperature. Prof. N. T. M. Wilsmore pointed out that he had recently observed that the diminution of solubility of gases with rise of temperature, so far as data go, is peculiar to water as solvent, and that, even in the case of water, there seems to be a minimum at a moderate temperature (see the data in the last edition of Landolt-Börnstein). This important observation is quite contrary to the belief usually held. The exceptional character of water may be attributed to the variation in its degree of association.

Prof. H. E. Armstrong laid stress on the artificiality of distinguishing dissolution from combination; dissolution is combination.

Dr. R. E. Slade directed attention to the bearing of the eutectic point of $\text{Ag}-\text{Ag}_2\text{O}$ at about 6° below the melting-point of silver; and Drs. Harker and Rayner described interesting experiments with very large masses of molten silver.

Dr. Gwyer was in doubt as to the reason for the proportionality of solubility in some cases to the square root of the pressure, apparently omitting to notice the bearing of the Nernst-van't Hoff law of distribution when the molecular association is different in the free and dissolved states.

Many other interesting points were made by various speakers. The openers reserved their detailed replies to the printed discussion, where these points will be dealt with.

GEOLOGY OF THE PERSIAN OILFIELDS.

AN interesting paper on the geology of the Persian oilfields by Messrs. H. G. Busk and H. T. Mayo was read at the meeting of the Institution of Petroleum Technologists on October 15. Three areas are treated: the Bakhtiari country, in which the only oilfield worked as yet is situated; the Ahwaz-Pusht-i-Kuh country; and the Qishm Island and Persian Gulf region. The first of these is described in most detail. The rocks are divided into three series: The Asmari, Eo-cretaceous, at the base consists of massive limestones 2000 ft. or more in thickness. It is succeeded by the Miocene Fars series, more than 7000 ft. thick, divided into three groups: the lower, formed of some 3500 ft. of massive gypsum, shales, clays, and intercalated beds of detrital limestone; the middle, 1000 ft. of clays, shales, intercalated gypsum, limestone, and sandstone; and the upper, 2700 ft. of clays, shales, and intercalated red and brown sandstones. The Fars series is overlaid by the Bakhtiari series of Pliocene age, of which the lower group,