

THE SETTING OF CEMENTS.

A GENERAL discussion on the setting of cements and plasters was held by the Faraday Society on Monday, January 14, when several interesting papers were contributed. The subject is one of great technical importance, in view of the large and continually increasing application of calcareous cements, especially of the Portland class, in engineering and building work. Although this country leads in the manufacture of Portland cement, very little attention has been given to its chemical study by British chemists, and it is not surprising that the most important papers in the discussion came from France and the United States.

Whilst the setting of plaster of Paris is now agreed to be brought about by the crystallisation of a super-saturated solution, there still exists a difference of opinion as to the mechanism of the process in the case of Portland cement. The recent work of the U.S. Bureau of Standards, as described in a paper by Mr. A. A. Klein, supports the view, originally due to Michaëlis, that the products of hydrolysis are colloidal in nature, and that the desiccation and induration of gelatinous aluminates and silicates, and even of free alumina and silica, are responsible for the mechanical strength of the cement when set. On the other hand, the veteran cement chemist, Prof. Le Chatelier, to whom the first explanation of setting is due, reiterated his opinion that the process is essentially identical with the setting of plaster, the hardness being caused by crystallisation. Incidentally Prof. Le Chatelier offered some criticisms of the tendency, observable in much of the literature dealing with colloids, to use new technical terms as if they afforded an explanation in themselves, whereas they only express known facts in new language.

Dr. C. H. Desch, who opened the discussion, and Mr. Hatschek pointed out that the difference between the two schools is in great part one of terminology. It is agreed that the particles of the hydration products are usually too small to be distinguished, so that they fall within the region of ultramicroscopic dimensions, and surface forces become comparable with those which bring about the crystalline arrangement. Under such conditions it is almost immaterial whether the particles be described as crystalline or colloidal, especially in view of the work of von Weimarn, who has done much to show the continuity of the passage from one condition to the other with diminishing size of particles.

The contributions of Prof. Donnan, Dr. Lowry, and Mr. Hemming dealt with the agglomeration and disintegration of simple salts, and it was shown that these phenomena have a close connection with those of setting. In both cases the greater solubility of unstable as compared with stable solid phases plays a part. Dr. Rosenhain carried the discussion a step further by comparing the hardening of plasters and salts with the process of solidification of a metal. The solid formed in each case is a crystalline aggregate, which breaks more readily, under ordinary conditions, across the individual crystals than between their boundaries. This has been attributed to the formation of an amorphous intercrystalline layer, and it is possible that the strength of hydrated plaster may be due, not merely to friction between the interlocking radiating needles of adjacent spherulites, or to their simple adhesion, but to the presence of such amorphous material. Portland cement would presumably contain a much higher proportion of the amorphous products.

Another group of papers dealt with questions more closely allied to engineering practice, and the discussion rendered evident the fact, well known to those who have studied the somewhat complex subject of the

chemistry of cement, that there are numerous unsolved problems in connection with the setting and hardening processes, some of which bear in the most direct manner on the utility of cement and concrete as structural materials. Mr. Blount spoke of these difficulties from the point of view of the technical chemist, and Mr. Caröe from that of the architect. For the physical chemist some of the most interesting of these problems concern the spontaneous changes of setting time and their acceleration or inhibition in the presence of catalysts. The chemical constitution of Portland cement clinker is now established, thanks to the splendid work of the Geophysical Laboratory in Washington, a summary of which was given by Mr. Rankin, who was responsible for the investigation. The exact part played by impurities, such as magnesia, iron, and alkalis, still remains to be determined.

The addition of puzzolanic materials, containing soluble silica, has been practised since ancient times as a means of improving the qualities of lime mortar, and similar additions to Portland cement have been recommended. The work of the Bureau of Standards indicates that the strength after setting should be improved by such additions, and the practical question was directly raised in a paper by Messrs. Lewis and Deny, who showed a marked improvement in the strength of good brands of Portland cement, due to the addition of finely ground blast-furnace slag of suitable composition. The discussion brought out the fact that a difference of opinion exists on this question, although the evidence for improvement is very strong. Blast-furnace slag as a raw material for Portland cement manufacture has received little attention from chemists in this country, although the industry is now becoming an important one, and the utilisation of such a troublesome waste product deserves much closer study.

Discussions of this kind do a great service in reviewing the field for investigation in the branch of science or industry discussed, and also in bringing together work undertaken from quite independent viewpoints, the relations between which may have been quite unsuspected by the original investigators. Portland cement was an English invention, and this country has always led in its manufacture; it would be of advantage to the industry and to engineering if it were to receive more attention from British chemists than it has hitherto obtained.

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**SECONDARY-SCHOOL EXAMINATIONS
AND ADVANCED COURSES.**

THE Consultative Committee of the Board of Education some years ago prepared a report on examinations in secondary schools, and this was published by the Board in 1911. Following the Committee's recommendation, the Board of Education invited the English universities to confer with representatives of the Board on the whole subject. These conferences took place during 1913, and in the same year the Board explained the general nature of the proposals it was about to make to representatives of local education authorities and of associations of secondary-school teachers. In July, 1914, the Board issued the now well-known Circular 849, on "Examinations in Secondary Schools," and invited criticisms from responsible authorities upon the scheme proposed in it. The scheme provides for the annual examination of grant-earning schools in connection with the Board. Two examinations are proposed, and they are to be conducted by one of the recognised university examining bodies. The first examination is to be suitable for forms in which the average age of the pupils ranges from about sixteen