sodium ions in the clusters are polarized by the applied field and are subjected to the chain movement mechanism, which brings about more charge transports than expected from the diffusion data.

As far as the formation of alkali-rich cluster concerns, his idea will be acceptable. However, it seems to be difficult to believe that the charge current increases by the applied field in the range where the Ohm's law holds good.

Therefore, it should be considered that the deviation from Nernst-Einstein relation may be due to a peculiar diffusion mechanism in which sodium ions do not jump evenly to all the direction of the structure, but jump through the preferential paths^{3), 4)}.

Cesium ions have less tendency toward the formation of the clusters than sodium ions have⁶⁾. Nevertheless, the fact that the correlation factors in cesium-silicate glasses are smaller than unity may be due to either that the cesium-rich clusters also form in the cesium-silicate glasses, or that the tendency of $f < 1$ in both glass systems is independent of the cluster formation.

Brosset⁷⁾ investigated the electronic distribution curves for the cesium-silicate glasses by X-ray

method, and showed that cesium atoms in the glasses are present in the form of defined groups incorporated in the anionic framework. It seems that his results support the possibility of the jump of cesium ions through the preferential paths. The preferential paths for the ions are supposed to arise from the inherent sub-microscopic heterogeneity of the glass. However, further investigation is necessary to confirm the entity of these preferential paths.

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Influences of Curing Conditions on Micro-structure of Set Alumina Cement Mortar*

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Changes in micro-structure of set alumina cement mortar were studied under various conditions by electron microscope in comparison with mineralogical changes. The soft mortar specimens made with a W/C=0.6 were cured at three different temperatures of 20, 35 and 50°C. The electron microscopic examinations and the mineralogical analysis by the X-ray powder diffraction were carried out for the specimens of 1.5 hrs'. to 3 year' curing. The specimens cured under the accelerated converting condition proposed by Tsukayama¹⁾ were also examined. The carbon replica of each specimen for the electron microscopic examinations was prepared with a new

method developed by Murakami²⁾.

At 20°C, the specimen showed mainly the interlocking structure of a large number of prismatic needles of CAH_{10} (Fig. 1). The prismatic needles of CAH_{10} did not grow up with the aging time. After 1 year, polyhedral grains of C_3AH_6 were partly observed among the interlocking structure (Fig. 2).

On the 35°C hydration, the main hydrate consisted of hexagonal plates of C_2AH_8 in the early stages which turned into rounded grains of C_3AH_6 in the later stages. Fig. 3, a micrograph of the 1-day specimen cured at 35°C, shows the lamellate structure of hexagonal plates on which tiny pimple-like materials (probably AH_3 gel) are distributed. Figs. 4 and 5 are micrographs of the

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Fig. 1. Electron micrograph of set mortar after 3 months at 20°C

Fig. 2. Electron micrograph of set mortar after 1 year at 20°C.

Fig. 3. Electron micrograph of set mortar after 1 day at 35°C.

Fig. 4. Electron micrograph of set mortar after 7 days at 35°C.

Fig. 5. Electron micrograph of set mortar after 7 days at 35°C.

Fig. 6. Electron micrograph of set mortar after 1.5 hrs. at 50°C.

Fig. 7. Electron micrograph of set mortar after 1 day at 50°C.

Fig. 8. Electron micrograph of set mortar after 1 day at 20°C.

Fig. 9. Electron micrograph of set mortar after 2 days under accelerated converting condition.

Fig. 10. Electron micrograph of set mortar after 3 days under accelerated converting condition.

Fig. 11. Electron micrograph of set mortar after 7 days under accelerated converting Condition.

Fig. 12. Electron micrograph of set mortar after 8 days under accelerated converting condition.

7-day specimen. Fig. 4 shows that the hexagonal plates of C_2AH_8 have grown bigger and that the fine needles (gibbsite) have begun to develop from the pimple-like materials. Fig. 5 shows the many rounded grains of C_3AH_6 formed on the lamellate structure. The 3-year specimen showed the mosaic structure of polyhedral grains sur-

rounded by prismatic needles of gibbsite.

On the hydration at 50°C, the hexagonal plates of C_2AH_8 were observed in the first stage, then they converted to rounded grains of C_3AH_6 immediately. Fig. 6, a micrograph of the 1.5-hr. specimen cured at 50°C, shows the hexagonal plates (C_2AH_8), a large number of fine needles

(AH_3 gel or gibbsite) and polyhedra (C_3AH_6). The 1-day specimen showed the grown-up polyhedra and fine prisms, corresponding to C_3AH_6 and gibbsite, respectively (Fig. 7). Individual grains of each crystal had significantly grown up several times as large in their sizes as the initial grains during 1 day curing. These polyhedra gathered each other forming a mosaic structure of sizable, rounded grains.

From these micro-structures, it is revealed that the rate of crystal growth of C_3AH_6 is greatly influenced by the curing temperature.

On the basis of the accelerated conversion test method, the set mortar formed at 20°C was demoulded 4 hrs. after the casting, and cured in water at 20°C up to 24 hrs., then the specimen was removed into the water at 50°C .

The 1-day specimen cured at 20°C showed the fine pleat structure (Fig. 8). The structure of the 2-day specimen cured under the accelerated converting condition was similar to that of the 1-day specimen except that the crystals had grown (Fig. 9). The 3-day specimen showed that rounded grains of C_3AH_6 began to crystallize from muddy materials surrounded by fine structure of pimple-like materials (Fig. 10). Figs. 11 and 12 are micrographs of the 7-day and the 8-day specimens, respectively. Fig. 11 shows that the rounded grains have grown in size as well as in amount, containing some large polyhedra with indistinct edges. These grains were piled up each other forming the mosaic structure. During 8 days' curing gibbsite has grown up to many large prismatic crystals covering the mosaic structure of

C_3AH_6 (Fig. 12).

Comparison of the micrographs of both specimens cured at 20°C and under the accelerated converting condition shows the distinct difference between the microstructures of them. X-ray diffraction showed, however, that the crystalline hydrates produced under both normal and accelerating conditions are exactly the same if the hydrates are compared with each other at the curing time of 2 or 3 years and 1 or 2 days, respectively. The detailed observations lead that the texture of the set mortars becomes a little less compact under the accelerating condition than the case of the normal curing. Therefore, it is concluded that the curing conditions don't influence on the species of crystalline hydrates but on their microstructures formed in the conversion process of the set mortar. As the mechanical properties of the set mortar depend largely on the texture of crystalline hydrates, the predicted mechanical strength of the long aged mortar by the accelerating method is supposed to be somewhat different from the true strength. This trend agreed well with the results of the strength measurements. Although the accelerated conversion test method is practically of good use, it gives the microstructure different from that produced in the mortar cured under the normal condition for a long age.

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