



Reactions of sugar solution on certain calcium aluminates and calcium aluminoferrite
by William W Niven Jr

A THESIS Submitted to the Graduate Committee In partial fulfillment of the requirements for the
degree of Master of Science In Industrial Chemistry
Montana State University
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Abstract:

The Mechanisms of the reaction of sugar solution with the calcium aluminates, $5\text{CaO} \cdot 3\text{Al}_2\text{O}_3$ and $3\text{CaO} \cdot \text{Al}_2\text{O}_3$ as related to the Merriman auger solubility test for Portland cement, here been studied. A similar study for $4\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot \text{Fe}_2\text{O}_3$ was also attempted but wee not completed. Both aluminates reacted with sugar solution to form metastable solutions from which solid phase precipitated on standing. The ultimate products of hydrolysis of $5\text{CaO} \cdot 3\text{Al}_2\text{O}_3$ by sugar solution under the conditions examined were dissolved and precipitated hydrated calcium aluminate of the apparent composition, $2\text{CaO} \cdot \text{Al}_2\text{O}_3 \cdot x\text{H}_2\text{O}$ and precipitated hydrated alumina, without the liberation of free calcium hydroxide at any stage of the reaction. The ultimate products of hydrolysis of $3\text{CaO} \cdot \text{Al}_2\text{O}_3$ by sugar solution were dissolved and precipitated hydrated alumina and calcium sucates, the sugar solution apparently completely hydrolysing the compound at the hydroxyl-ion concentrations obtaining in the tests and the calcium hydroxide thus liberated then combining with the sugar.

REACTIONS OF SUGAR SOLUTION ON CERTAIN
CALCIUM ALUMINATES AND CALCIUM ALUMINO-FERRITE

by

WM. W. HIVEN, Jr.

A THESIS

Submitted to the Graduate Committee

in

partial fulfillment of the requirements

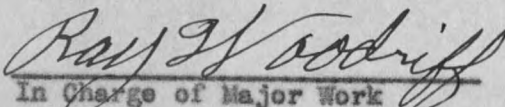
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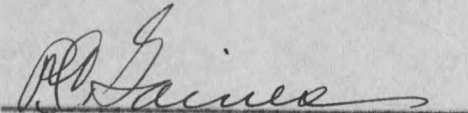
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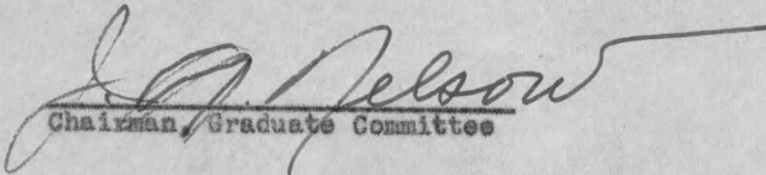
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I. ABSTRACT

The mechanisms of the reactions of sugar solution with the calcium aluminates, $5\text{CaO}\cdot 3\text{Al}_2\text{O}_3$ and $3\text{CaO}\cdot \text{Al}_2\text{O}_3$, as related to the Merriman sugar solubility test for Portland cement, have been studied. A similar study for $4\text{CaO}\cdot \text{Al}_2\text{O}_3\cdot \text{Fe}_2\text{O}_3$ was also attempted but was not completed. Both aluminates reacted with sugar solution to form metastable solutions from which solid phase precipitated on standing. The ultimate products of hydrolysis of $5\text{CaO}\cdot 3\text{Al}_2\text{O}_3$ by sugar solution under the conditions examined were dissolved and precipitated hydrated calcium aluminate of the apparent composition, $2\text{CaO}\cdot \text{Al}_2\text{O}_3\cdot x\text{H}_2\text{O}$, and precipitated hydrated alumina, without the liberation of free calcium hydroxide at any stage of the reaction. The ultimate products of hydrolysis of $3\text{CaO}\cdot \text{Al}_2\text{O}_3$ by sugar solution were dissolved and precipitated hydrated alumina and calcium suerates, the sugar solution apparently completely hydrolyzing the compound at the hydroxyl-ion concentrations obtaining in the tests and the calcium hydroxide thus liberated then combining with the sugar.

II. INTRODUCTION

The problem of readily determining the degree to which equilibrium conditions have been attained in the kiln in the manufacture of Portland cement has yet to be satisfactorily solved. Quantitative chemical analyses and the standard physical tests of Portland cement cannot alone indicate whether equilibrium conditions were adequately approached and, frequently, the theoretical compound composition of the cement, as computed from the chemical analysis, may be only a rough approximation of the actual conditions.

The fact that existing methods for exact determination of true cement composition are not readily adaptable for routine application to the problem of determining cement quality has led to the development of the so-called "sugar solubility test" as proposed by Merriman (8, 9, 10)*, which is in effect an adaptation of earlier test methods for the determination of free lime in cement. This test has been incorporated into at least one contract specification for the purchase of Portland cement (12) and consists briefly of the following:

Fifteen grams of prepared cement are shaken for two hours with 100 ml of a 15% sugar (sucrose) solution, after which the suspension is filtered. A 25 ml aliquot of the filtrate is titrated with 0.5N hydrochloric acid, first to a phenolphthalein end point and then to a clear point. Cements which require more than 8.0 ml of acid to the phenolphthalein end point and more than 10.0 ml of acid to the clear point are considered objectionable.

*Numbers in parentheses refer to references listed at the end of this paper.

