



A Study on Gel Time of Colloidal Nano Silica Solutions

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Abstract

Colloidal silica is an aqueous suspension of nanoparticles of SiO₂. In dilute solutions, colloidal silica has a density and viscosity similar to water. Because of long controllable gel time and low viscosity, colloidal silica can flow into the liquefiable formations slowly over a long time, so it is a potential stabilizer for passive site remediation. The gel time of colloidal silica depends on several variables. In this study Ludox®-SM colloidal silica was used for testing program. A series of gel time testing were done on samples of dilute solutions of colloidal silica at concentrations 5, 7.5, 10, 12.5, 15 and 30% with different pH and ionic strengths. The Sydansk gel time description was used to develop gel time curves. On the other hand, the samples of solutions were tested by adding Firoozkooh sand and silt. The results show that gel time decreases as the concentration of silica and ionic strength is increased, minimum gel time occurs between pH 5 and 6 and adding sand and silt decreases solutions gel time, especially out of this pH range.

Keywords: Colloidal Silica, Gel Time, Stabilizer, Liquefiable Solis

1. Introduction

Colloidal silica is an aqueous suspension of microscopic silica (SiO₂) particles produced from saturated solutions of silicic acid [1]. The particles size can range in size from 2 to 100 nm, although the particle size is fairly constant in a given suspension. During manufacturing, colloidal silica solutions are stabilized against gelation so they can have long induction periods during which the viscosity remains fairly low up to a few months. Colloidal silica is also nontoxic, biologically, and chemically inert, and has excellent durability characteristics [2, 3]. Because of these features colloidal silica is a potential stabilizer for passive site stabilization.

Passive site stabilization is a new concept proposed for non-disruptive mitigation of liquefaction risk at developed sites susceptible to liquefaction during earthquakes. It involves slow injection of stabilizing materials at the edge of a site and delivery of the stabilizer to the target location using natural groundwater flow [4].

The factors controlling the gel time of colloidal silica include silica solids content, ionic strength, the pH, particle size and specific surface area [5]. One additional factor pertinent of the case of passive site remediation is the presence of ions in the soil to be stabilized and pore water. If there are exchangeable cations in the soil and water, there may be an effect on the gel time because of changing the ionic strength of the solution as it passes through soil.

The present study was undertaken to develop gel times curves of colloidal silica at various concentrations with different pH and ionic strengths and to examine the effect of additional Firoozkooh sand and silt on gel times of colloidal silica solutions.

Sydansk bottle test method was used to description of gel times. This method a highly cost-effective and straightforward technique to obtain a semi-quantitative measure of gel strength and gelation rate [6].