Pengaruh Aditif Kalsium Oksida dan Magnesium Oksida pada Semen Kelas-G sebagai Bahan Penyekat pada Sumur Injeksi Karbon Dioksida = The Effect of Calcium Oxide and Magnesium Oxide Additives on G-Class Cement as Insulation Materials in Carbon Dioxide Injection Wells

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Abstrak

Saat ini ada kendala dalam pengadaan semen khusus yang sesuai untuk dijadikan bahan penyekat sumur injeksi CO2 pada Carbon Capture and Storage (CCS). Semen Kelas-G merupakan bahan dasar yang dapat dimodifikasi sehingga sesuai untuk penggunaan pada sumur injeksi CO2 di mana dalam bentuk suspensi semen dan air banyak digunakan untuk penyekat ruang anulus pada sumur minyak dan gas bumi. Suspensi semen berbahan semen Kelas-G mengalami penyusutan volume selama proses pengerasan. Hal ini merupakan salah satu kekurangan semen Kelas-G jika diaplikasikan tanpa modifikasi. Selain itu semen Kelas-G cenderung terdegradasi apabila berada di lingkungan air dengan kandungan CO2 tinggi. Pada penelitian ini, semen Kelas-G dimodifikasi dengan menambahkan aditif mengembang (swelling) CaO dan MgO untuk mengatasi penyusutan volume dan degradasi tersebut. Selain itu, silica flour sebagai supplementary cementitious material dipergunakan juga dengan komposisi 35% by weight of cement (BWOC) sebelum ditambahkannya aditif tersebut. Penelitian ini bertujuan untuk meneliti dampak penambahan aditif tersebut di atas terhadap perubahan ketahanan korosi dan kekuatan mekanik suspensi semen di lingkungan air dengan kandungan CO2 tinggi. Pembuatan sampel dilakukan di laboratorium dengan variasi komposisi aditif (5%, 10%, 15%, dan 20% BWOC) temperatur cure (26°C dan 50°C) dan waktu cure sebelum uji korosi (1 hari dan 7 hari). Untuk mensimulasikan kondisi air dengan kandungan CO2 tinggi, sampel dibenamkan di dalam air tersaturasi CO2 di dalam autoclave bertekanan 2,0684 MPa dan temperatur 50°C selama 14 hari. Selain uji korosi, dilakukan juga pengujian X-Ray Diffraction, Scanning Electron Microscopy/Energy-Disperse X-ray Spectroscopy, Scanning Electron Microscopy, Laser Particle Size Analyzer, Uniaxial Expansive/Shrinkage, Ultrasonic Cement Analyser, Three Point Bending Test, dan Macro Photo Imaging. Hasil percobaan menunjukkan bahwa penambahan aditif CaO (komposisi 5%, 10%, 15%, dan 20% BWOC) dan MgO 20% BWOC dapat mencegah penyusutan volume pada suspensi semen Kelas-G. Peningkatan ketahanan korosi tertinggi terjadi pada sampel SC15(1d-26C) yakni sebesar 70,50%. Peningkatan kekuatan mekanik tertinggi terjadi pada sampel SC5(1d-50C) yakni sebesar 43,82%. Peningkatan ketahanan korosi tertinggi akibat penambahan aditif MgO terjadi pada SM20(7d-50C) sebesar 61,93% dan peningkatan kekuatan mekanik tertinggi pada SM10(7d-50C) sebesar 10,58%.
.....Currently there are obstacles in the procurement of special cement that is suitable to be used as an insulating material for CO2 injection wells in Carbon Capture and Storage (CCS). Class-G cement is a base material that can be modified so that it is suitable for use in CO2 injection wells where in the form of a cement and water suspension it is widely used to insulate the annulus spaces in oil and gas wells. Cement suspensions made from Class-G cement experience volume shrinkage during the hardening process. This is one of the disadvantages of Class-G cement when applied without modification. In addition, Class-G cement tends to degrade when exposed to water with high CO2 content. In this study, Class-G cement was modified by adding swelling additives (swelling) CaO and MgO to overcome the volume shrinkage and degradation.

In addition, silica flour as a supplementary cementitious material is also used with a composition of 35% by weight of cement (BWOC) before adding the additive. This study aims to examine the impact of the addition of the above additives on changes in corrosion resistance and mechanical strength of cement suspensions in water environments with high CO2 content. Sampling was carried out in the laboratory with various additive compositions (5%, 10%, 15%, and 20% BWOC), cure temperature (26°C and 50°C) and cure time before corrosion test (1 day and 7 days). To simulate water conditions with high CO2 content, the sample was immersed in CO2-saturated water in an autoclave at a pressure of 2.0684 MPa and a temperature of 50°C for 14 days. In addition to the corrosion test, X-Ray Diffraction, Scanning Electron Microscopy/Energy-Disperse X-ray Spectroscopy, Scanning Electron Microscopy, Laser Particle Size Analyzer, Uniaxial Expansive/Shrinkage, Ultrasonic Cement Analyser, Three Point Bending Test, and Macro Photo tests were also conducted. Imaging. The experimental results showed that the addition of CaO additives (composition of 5%, 10%, 15%, and 20% BWOC) and MgO 20% BWOC could prevent volume shrinkage in Class-G cement suspensions. The highest increase in corrosion resistance occurred in the SC15 (1d-26C) sample, which was 70.50%. The highest increase in mechanical strength occurred in the SC5 (1d-50C) sample, which was 43.82%. The highest increase in corrosion resistance due to the addition of MgO additives occurred at SM20(7d-50C) by 61.93% and the highest increase in mechanical strength at SM10(7d-50C) by 10.58%.