UNIVERSITI TEKNOLOGI MARA

REINFORCING EFFECTS OF GRAPHENE OXIDE IN OIL WELL CEMENT USED FOR CO2 STORAGE

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ABSTRACT

CCS or Carbon Capture and Storage is one of the method to conserve environment by reducing the CO_2 gas emission to the atmosphere by the process of separation and capture of carbon dioxide and safely store the CO_2 into deep geologic formations. Wellbore and cement integrity need to be maximized for safely and permanently storing of carbon dioxide (CO_2) in the subsurface for a very long term of duration. The chemical interactions between CO_2 in carbonic acid and cements will form calcium carbonate that easily leachable or susceptible to further reaction that could potentially diminish the strength of the cement and increase the cement degradation rate that can lead to leakage. The reinforcing effects of graphene oxide (GO) in oil well cement used for CO_2 storage was investigated in this experimental study. GO was prepared by oxidization and ultrasonic dispersion. Effects of GO on mechanical properties of cement cubes after been exposed to carbonic acid for 10 days were investigated by determining the compressive strength and mass losses of the cement cubes and the results were compared with neat cement without GO. It is discovered that when 0.10 wt.% by weight of GO was added into the cement paste, compressive strength was increased by more than 24% and it due to the refinement of the porosity of the cement matrix caused by strong covalent bond that form flower-like crystal regulated by GO and can reduce the degradation rate of the cement by more than 32% because GO have various oxygen-containing functional groups that make GO highly attractive for cement hydration that needed in order to get strong and lower degradable compound of cement. The overall results show that GO is an effective nanomaterial for reinforcing the mechanical properties of oil well cement used for CO_2 storage.

Keywords: graphene oxide, oil well cement, CO_2 storage, compressive strength, degradation rate, agglomeration

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CHAPTER ONE
INTRODUCTION

1.1 Research Background

CCS or Carbon Capture and Storage was recognized as a method to conserve environment and reduce the CO_2 gas emission to the atmosphere by the process of separation and capture of carbon dioxide gas from the emissions of industrial activities which then transport and safely store the CO_2 into deep geologic formations that defined as subsurface formation to avoid it from escaped, thus it will remain permanently stored. There are five types of subsurface formations which are saline formations, oil and gas reservoirs, unmoveable coal areas, organic-rich shale and basalt formations in wellbore which used for CO_2 storage that will give challenges and bad impact to the cement used in carbon capture and storage process as sealant. Cements act as sealant in wellbore used for carbon storage and used in the construction (primary cement) and abandonment (plug cement) of old wells (Sauki and Irawan 2010).

Wellbore integrity and effectiveness of cementing need to be maximized in order to ensure permanent and safe storing of carbon dioxide (CO_2) in the subsurface for long term of duration. The most likely location for the disposal of CO_2 is "depleted oil and gas bearing formations" because it has been proven that it is capable to trap fluids over geologic times. When CO_2 was captured and stored in depleted oil or gas reservoirs, one of the major issue that need to be considered is leakage through wells or cement to avoid CO_2 escaped. CO_2-injection wells can be new wells, or old wells that are active, closed or abandoned. In all situations, it is very important and significant to ensure that storage well's integrity is not compromised because cement's integrity reduction will result in formation damage around the wellbore, poor completion or abandonment, oil well cements degradation, mechanical stresses and casing corrosion that will induce great failure. The loss of "well integrity" may often cause by the geochemical alteration of hydrated cement that is used to isolate or improve the stability of the wellbore and to prevent fluid or gas migration between subsurface formations across the producing or injection intervals in CO_2-related wells (Humez, Audigane et al. 2011).