CO2 Storage in Sediments by Hydrate Formation and Self-Preservation in the Presence of Promoters

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Carbon storage in the geological setting is seen as a useful technique to mitigate the impact of climate change. When CO$_2$ is injected into sediments, at a specific pressure and temperature range, CO$_2$ hydrate can be formed as a by-product, which could act as a seal against the possible leaking of CO$_2$ over an extended period. CO$_2$ hydrate formation can be accelerated in the presence of certain chemicals known as hydrate promoters. Effect of these promoters on hydrate self-preservation tendency is also noteworthy for studies.

This study discusses the formation behavior of CO$_2$ hydrate in sediment and quantifies the kinetics of hydrate formation, and self-preservation in the form of induction time, gas uptake. Critical parameters studied include the change in sediment particle size, type of hydrate promoter, volume of hydrate promoter, is studied, and comparative analysis of selected promoters are carried out about the water. Experiments are carried out in high pressure, low-pressure environment using high-pressure apparatus.

Additionally, self-preservation effect of CO$_2$ hydrate is also studied at a temperature between 269K - 272K. Hydrate promoter selected in this study includes surfactant sodium dodecyl sulfate (SDS) and amino acids, L-valine, L-methionine, L-histidine, and concentration equal to 3000 ppm for all. Amino acids are seen as a potential replacement for toxic surfactant such as SDS for CO$_2$ capture & storage application due to their environment-friendly nature.

Results indicate that at starting pressure 60-62 bars, and initial temperature between 274-275K, CO$_2$ hydrate forms instantaneously in sediments within 1 min. Nucleation time for hydrate formation is found to be highest for SDS, L-valine and L methionine whereas slowest for L histidine. As sediment particle size increases, hydrate formation time decreases. Presence of hydrate promoter within sediments found to have minimal effect on self-preservation except in case of L-methionine, which showed weakest self-preservation effect. Obtained results are expected to provide an enhanced understanding of industrial-scale CO$_2$ capture and storage in geological formation in the presence of hydrate promoter.