Zero-thickness interface model with chemical degradation by acid attack

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ABSTRACT

Carbon dioxide (CO_2) storage in abandoned oil/gas reservoirs is considered a viable alternative to reduce greenhouse gas emissions to the atmosphere. An important element of the risk associated with long-term CO_2 storage effectiveness is the integrity of the cement seals of the abandoned wells in the reservoir. Any loss of seal integrity may become a potential leakage pathway, which may generate environmental impacts, cause economic losses, and reduction of CO_2 storage efficiency [1].

In carbon capture and storage (CCS), besides chemical attack, mechanical degradation is another factor that can lead to cement sheath loss of integrity [2]. However, previous studies of well cement degradation under CO_2 storage conditions have focused mainly on individual chemical attack, ignoring the coupled of CO_2 attack with mechanical stress. In this paper, an existing zero-thickness interface constitutive law based on the theory of elasto-plasticity with concepts of fracture mechanics [3-5] is modified to incorporate the effect of degradation in mechanical resistance parameters of cement by acid attack. Preliminary results of model are presented to illustrate the importance of combined mechanical-chemical degradation, since as it is observed in the diffusion-reaction model [6-7] the rate of chemical degradation front by itself seems not enough to initiate and/or propagate fractures that allow leakage of CO_2.

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