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Convective Stability of CO_2 Sequestration in a Porous Medium

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Abstract: We considered an incompressible fluid-saturated porous layer bounded by two infinite parallel plates. The Boussinesq approximation and Darcy's law are applied. The permeability is assumed to be a linear function of the depth z. The linear stability is investigated. The long wavelength expansion method is applied to conduct the weakly nonlinear stability analysis. The evolution equation is derived and analyzed. A uniformly valid periodic solution of the evolution equation is obtained by the application of the Poincaré-Lindstedt method. Some numerical simulations are presented.

Keywords: *stability analysis; long wavelength method; Poincaré-Lindstedt method; periodic solution; carbon sequestration.*

Mathematics Subject Classification (2010): 76E20, 76E15, 76S05, 76-10, 76E06.

1 Introduction

The greenhouse effect of carbon dioxide is one of the most urgent problems that face the humanity. The greenhouse gas emissions can be reduced through the geological carbon dioxide sequestration in deep rock formations. Geological carbon dioxide sequestration is the process of trapping CO_2 that is produced by burning fossil fuels or any other chemical or biological processes and placing it in a deep rock formation (thousands of feet deep) for a long-term storage so that it will not affect the atmosphere. This process is comprised of three stages: capturing, transporting, and injecting CO_2 into the geological formation such as gas reservoirs, unmineable coal seams, and basalt formations [1–4]. The capacity of such formations is estimated worldwide to be between 675-900 Gt of carbon in the gas reservoirs, between 1000-10000 Gt for saline aquifers, and for unmineable coal it

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