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Application of the Method of Directly Defining the Inverse Mapping to Fingering Phenomenon in the Oil Industry

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Most of the real-world problems can be represented as systems of nonlinear partial differential equations. Perturbation method, Homotopy Analysis Method (HAM), Optimal Homotopy Analysis Method (OHAM), and Method of Directly Defining the inverse Mapping (MDDiM) are some methods that can solve nonlinear differential equations analytically. In this study, we picked MDDiM, which was first introduced by Sujin Liao in 2016. He used this technique to solve a single ordinary differential equation, and after that, Dewasurendra et al. extended this method to solve a system of coupled ordinary differential equations. In this work, we further extended this so-called method to solve nonlinear partial differential equations with two boundary conditions in the fingering phenomenon, which is an oil industry application. The fingering phenomenon occurs during the water injection in the secondary oil recovery process. When a fluid contained in a porous medium is displaced by another of lesser viscosity, instead of regular displacement of the whole front, protuberances may occur, which shoot through the porous medium at relatively speed. This phenomenon is known as the fingering phenomenon, and the protuberances are called fingers. We obtained a six-term solution to the water saturation of injected water by solving the governing equation of the above-mentioned application using MDDiM. In addition, we obtained approximate solutions to the saturation of water at the fixed values of time and represented solutions using graphs. These solutions are accurate enough with the averaged squared residual error 1.8381614×10^{-5} and all the solutions and graphs were obtained using Maple 16.

Key words: *Method of Directly Diffing the inverse Mapping, Fingering Phenomenon, Squared residual error*

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