New One-Dimensional Model for Miscible Fluid Injection in Fractured Porous Media

Mohammad Jamshidnezhad, Mohammad Mehdi Montazerrahmati
Chemical Engineering Department, Faculty of Engineering, University of Tehran
Email: jamshidnezhad.m@nisoc.com

Abstract

A new mathematical model for miscible displacement in fractured porous media is developed. In this model, in addition to normalized fracture capacity, productivity capacity ratio, viscosity ratio and gravity number, for characterizing the miscible displacement process, the fifth parameter, advection mass transfer between matrix and fracture is introduced. The model takes into account advective, gravitational and crossflow mechanisms of mass exchange between fracture and matrix. The analytical solutions of the problem are provided by utilizing the method of characteristics. The model developed has been compared with experimental results and with previous model, which includes only crossflow between fracture and matrix. There is very good agreement between experiments and this model prediction.

Keywords: Fractured Porous Media, Crossflow, Advection mass transfer, Laboratory Miscible Displacement, Mathematical Modeling

Introduction

Fractured reservoirs (e.g. Asmari reservoirs in Iran) provide over 20 % of the world oil reserves in our nation. Iran is one of the world's leading energy producing countries with an estimated 9 percent of the world's remaining recoverable oil reserves and 17 percent of its natural gas reserves. Almost 90 percent of Iranian petroleum reservoirs are carbonated and these carbonated reservoirs are generally tight, and flow condition for oil in the matrix are poor. Therefore, the time needed to produce the oil will be longer than for high permeable sandstone reservoirs. Iranian carbonate reservoirs are fractured and consist of tight matrix blocks with fractures in between. The recovery factor for the Iranian fractured reservoirs is estimated to be in the range of 20 to 30 percent [1].In these reservoirs, the block heights are of the order of 3 to 15 m .

The declining oil production from Iranian fractured reservoirs after several decades of exploitation and the significant amount of oil still remaining in place are of great concern to the Iranian oil company and fully justify its interest in EOR processes. One of the important mechanisms in EOR from fractured reservoirs is miscible fluid injection. Miscible fluid injection allows to recover substantial quantities of that oil trapped in the matrix.

Miscible displacement within fractured porous media till recent time has not been sufficiently investigated. There are known only separate studies devoting to the interpretation of the field research data on intersoluble fluid displacement from heterogeneous porous media [2,3]. Theoretical work on miscible displacement in fractured porous media is limited to a few paper published in the Russian literature.