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Abstract. This fluids (oil, water takes into account concentration of oil description of oil tion in a porous water phase, the heat transfer equation aqueous phase, distance factor. Res domain are pressure, concentration determined. The comparing with the aim of this work is displacement by oil of the combined

Keywords: EOF

1 Introduction

The investigations show recovery, such as polymer methods. There are various fluids, such as adsorption used to reduce the intensity and increase the mobility method used for enhancing and increasing viscosity of enhancing oil recovery combination with water into the reservoir, then. When using this method

heat transfer. In contrast to the use of the phase pressure as the functions are eliminated from the temperature which lead to unres approach their residual values. e proves the boundedness of the coefficients in the equations. The problem reproduce the character- that allows the use of the proposed r problems.

methods as finite difference methods e flow in porous media. Journal of (2006)
eam injection in heavy oil reservoirs.

tive saturation approach for non- lations. Transport in Porous Media,

dy of the process of steam injection (87)

re formulation for three-phase com- 1464
ultiphase Flows in Porous Media. 1999)

roleum engineering finite volume ous media. SIAM Journal of Numer-

ls and finite elements for reservoir

ry by steam injection. Ph.D. thesis, California, 349 p. (1979)

Report: Physical Simulation of Non- in Porous Media, Sandia National

ion. Ph.D. thesis, Environment & ark (2003)

odeling of Multiphase Transport of Heat in the Subsurface. Numerical h 29(11), 3727-3740 (1993)

Self-Organization Phenomena in Underground Hydrogen Storages

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Abstract. The problem of underground hydrogen gas mixture storage is that unlike natural gas, hydrogen gas mixture undergoes chemical changes in underground storage and thus the concentration of hydrogen and carbon dioxide is reduced, and the concentration of methane increases. It has been found that these changes occur because of the activity of methanogenic bacteria populations inhabiting in a reservoir. This chemical activity, which caused by the bacterial activity, as well as gas and water flow in the reservoir causes the phenomenon of self-organization such as the occurrence of autowave spatial structures, the dynamics of which is characterized by a multiplicity of different scenarios, including the occurrence of chaos and the jump from one scenario to another. In this paper we developed a qualitative theory of self-organization scenarios in the underground hydrogen storage depending on the external and internal parameters. Development of the theory and computer models of transport in underground hydrogen storage will be based on the relating of models of multiphase composite flows in porous media with model of dynamics of bacterial populations which will be based on mechanism of chemotaxis (internal chemical mechanism by which bacteria are able to detect the presence of nutrients in the distance and move in that direction).

Keywords: Porous media · Hydrogen · Reactive transport · Bacteria · Methanogenic microorganisms · Population dynamics · Oscillations · Chemotaxis

1 Introduction

Increasing energy demand and anthropogenic greenhouse-gas emissions pose serious challenges for national and international energy economies. Low emissions and the increasing efficiency of fuel cells make the case for the use of hydrogen (H_2) as the fuel of the future [1]-[2]. At best, H_2 is generated, e.g. through electrolysis, from renewable energy sources. In such a scheme, storing H_2 comes down to storing electricity. However, it may also be produced from fossil fuels, making it easier to contain emissions at the power plants while distributing clean energy in form of H_2 , e.g. for transportation.

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