Mathematical modelling and development of a computer tool for laboratory methane gas production from hydrates by depressurization method

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A mathematical model developed for laboratory methane gas production from hydrates by depressurization method is presented. This model, solved through numerical analysis and programmed in programming language, becomes in a software tool whose results are compared to previously published laboratory tests. The proposed mathematical model is based on mass balance equations where liquid and gas are considered as mobile phases and the hydrate as an immobile phase. It is also assumed that there are not dramatic changes in temperature, so energy balance is overlooked. The proposed equations were discretized in cells by the method of finite differences and solved through Newton-Rhapson numerical method. Constitutive equations were also used to gas/water flow or production, gas hydrate dissociation and permeability changes due to the above-mentioned phenomenon. Numerical solution was programmed in m language from MATLAB, and a graphical user interface was designed to generate a software. Simulation results were compared with two previously published laboratory tests to validate the mathematical model proposed. The data analyzed was the cumulative production of gas against time, obtaining differences under the 7% between the calculated and the reported results in the two cases. In addition, the developed software also gives dissociated gas/water volumes, saturation changes and permeability changes in the rock. The novelty of this research is in the report of the changes in the saturations of the three phases due to hydrate dissociation in the rock, which can be supportive to a better gas reserves calculation of these structures non-produced commercially yet.

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