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ROBUST OPTIMIZATION FORMULATIONS FOR WATERFLOODING MANAGEMENT IN RESERVOIR ENGINEERING

Silvana Maria Afonso[(1)], Jefferson Pinto[(2)], Ramiro Willmersdorf[(3)]

[(1)]Federal University of Pernambuco - UFPE, Brazil
silvanabastos7@gmail.com

[(2)]UFPE, Brazil
wellano@gmail.com

[(3)]Federal University of Pernambuco, Brazil
ramiro@willmersdorf.net

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Abstract: In oil reservoir management, one of the major challenges is the search for the best solution for oil production. In this scenario, the geological characteristics of fields contain uncertainties. One way to conduct optimal management of reservoirs under uncertainty is through robust optimization, which uses a set of realizations to honor the statistics of geological properties. The statistics considered are the mean and the expected value. In this work, such statistics are considered in three different formulations for the optimal robust management in the reservoirs. The first one is a classical uniobjetive problem in which the mean of the NPV (Net Present Liquid) is the objective function and its standard deviation is included in the set of constraints. The second employs also a uniobjective problem formulation, combining in a unique function the expected function and standard deviation of the NPV using a risk factor that considers the trade-off between the expected value and the standard deviation. Finally a classical Multiobjective formulation based on Pareto front technique is employed. Here, the mean and the standard deviation are coupled together to obtain Pareto solutions from which any design can be chosen. The required statistics of the formulations will be computed Monte Carlo (MC) simulations and In order to reduce the procedure processing time, the simulations will be performed into a subset of existing field realizations as the consideration of all reservoir realizations is cost prohibitive. A small subset of realizations is select aiming time processing reduction for the statistics calculations. Two approaches of selecting a representative subset of realizations are done, one ranks the realizations according to the performance of each realization in terms of NPV (Net Present Value), the other is based on clustering the uncertain field, e.g. in terms of permeability field, using a K-means procedure. In order to reduce simulation costs due to several function calls required in the optimization process, data fitting based surrogate models are applied in the Sequential Approximated Optimization strategy. The optimization results based on the realizations subset is then applied to all existing realizations. Finally, the technical applicability of the investigated formulations will be checked against a benchmark example reported in literature.