Optimum well placement

Mathematical models

Optimum well placement (determining optimum number, type and siting of wells) is a crucial step in field development

Automatic well placement optimization is an iterative procedure that can be divided into following procedures:

1. Using engineering judgment, guess initial well(s) location
2. Use an optimization engine based on user-defined decision variables to suggest possible improved well location(s).
3. Apply a reservoir response model to report to the optimization engine the performance of the proposed well locations.
4. Include the effect of uncertainty in reservoir properties, economic factors, etc, which can be an optional step.
5. Calculate the objective function (e.g. Net Present Value or NPV).
6. Repeat steps 2 to 5 until stopping criteria (set by user) are met.

The approaches to problems 1 to 5, may differ in the optimization algorithm, reservoir response modeling technique, and available decision variables and constraints. We now turn our focues to the modelling aspect of the problem

Modeling and algorithmic considerations:

Concentrating our attention to the optimization problem after the initial guess (problem n. 2), the well placement problem is translated into optimization of an objective function (NPV or cumulative hydrocarbon production). Applying MILP models one can for instance, solves this problem through finding locations of a given number of wells (out of total possible well locations) that minimizes the difference between the production and scheduled demand. Hence, the drilling decision can only be made at particular locations i which have to be identified beforehand (guess problem n. 1). The most complex constraints come from the interaction between withdrawal rates and pressures at all the wells, that must be defined by the nonlinear gas flow equation. However this nonlinear constraint has a very good linearization substitute, called influence equations. In these equations, the pressure drop at well i is a linear function of withdrawal flow rates from all drilled wells. This is defined by influence function matrices. After this proper linearization, the resulting problem is a mixed integer programming problem, which can be solved by well known techniques.

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