

Structured versus Unstructured (PEBI) Grids in Reservoir Modeling and Simulation

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Abstract

Application of unstructured/irregular grids in reservoir simulation is one of the most important concepts that have been developed in the past decade [1]. Though this concept was introduced to the petroleum industry as early as 1989 [2], little has happened since then in terms of application of this type of grids to "real life" situations. Searching the SPE e-library one finds only one brief paper in which a full-field simulation using an unstructured grid is reported [3]. However, this is not the case when looking at the theoretical developments of this topic, for which the bibliographical sources are abundant. This situation implies that despite the theoretical advantages claimed for this relatively new technology there is some resistance to, or latency in, practical application of it within the industry.

In this presentation the terminology and some of the practical aspects of reservoir modeling and simulation using unstructured grids will be introduced, without going into the sophisticated mathematics of gridding algorithms. There are several types of unstructured grids discussed in the literature: CVFE (Control Volume Finite Element) based grids [2]; PEBI (Perpendicular BIsector) or Voronoi grids [4]; Composite Tetrahedral grids [5]; Mixed grids [5]; etc. This presentation will focus on PEBI grids.

The main differences between unstructured (PEBI) and structured (Cartesian, Corner Point) grids will be emphasized, outlining their advantages and disadvantages from the point of view of both reservoir modeling (geometric representation) and reservoir simulation (dynamic behavior). Several cases where complex reservoir geometry or complex flow problems could be better modeled or simulated with unstructured grids

than with structured grids will also be discussed.

A thorough quantitative, comparative study of structured and unstructured grids when applied to full-field simulation has not yet been found in the published literature. The only quantitative comparison, but only for very small scale, black oil simulation models can be found in [5]. In that paper, Gunasekera *et al.* have used a cost function calculated as the CPU simulation time per grid cell per time step, which is definitely just one possible criterion for comparison. Before a relevant study can be done, a set of representative comparison criteria has to be defined.

Last but not least, an important question one must ask is: are the currently available reservoir simulators up to the challenges posed by unstructured grids? We shall look briefly at what those challenges are and what is required of the simulators so that they can handle unstructured grids efficiently.

Bibliography

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