Use of Modeling in Petroleum Reservoir Development and Production Enhancement

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Developing new petroleum resources is becoming more and more challenging as most "easy" to produce petroleum assets have already been developed. To bring on new production, the oil industry must move into increasingly harsh environments or apply more complex recovery techniques. Reservoir modeling, which has been used in by the petroleum industry since the early days of computing, is becoming an increasingly important tool for meeting these challenges.

In harsh environments, such as deepwater or the arctic, development costs are extremely high -- individual wells can cost tens of millions of dollars. Because of this, large investment decisions must often be made based on the information available from early appraisal wells and remote sensing information (seismic data). There are often minimal data available at this point, and those data that do exist are from a variety of different sources and represent a variety of scales. Reservoir characterization research is focused on techniques to integrate all available data and geologic interpretation to provide the most accurate description of the subsurface environment as input to the reservoir simulation model. As assets mature, production data become available to further constrain reservoir simulation models. Models are calibrated or "history matched" to past production performance to increase confidence in future predictions. History matching has historically been an expensive and time-consuming process. Tools to assist or automate this process are being developed to reduce significantly the time required to achieve an adequate match to production history and to reduce uncertainty in future predictions.

In addition to moving into harsher operating environments, the industry is meeting the challenge of supplying energy through increased focus on maximizing recovery from known resources. Enhanced oil recovery (EOR) techniques such as miscible gas injection or chemical processes have been researched for decades, but have often been difficult to implement economically. With increasing oil prices, these processes are seeing renewed interest. EOR processes are challenging to model as complex phase behavior and rock/fluid interactions must be represented in order to predict performance accurately. Furthermore, the scale on which these physical processes occur is often much smaller that that which can be explicitly modeled by reservoir simulation and therefore special techniques are required to capture fine-scale phenomena.

This presentation will focus on the key challenges and opportunities for improving oil recovery and on some of the research directions being pursued to increase modeling accuracy and facilitate economic development of new production. An example demonstrating the value of reservoir simulation will be presented. This example shows how data from a variety of scales are coalesced into a reservoir simulation model that employs advanced techniques to capture important fine-scale physical processes.