An Integrated Approach for Assessing Unconventional Petroleum Resources: a Case Study of the Devonian-Mississippian Lower Middle Bakken Member, Southeastern Saskatchewan

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Abstract

Recent advances in horizontal drilling coupled with multistage hydraulic fracturing enable commercial oil and gas production from low porosity-permeability fine grained reservoirs. The rapid development of unconventional oil and gas resources in North America has resulted in a fundamental shifting of global energy markets. In contrast, our tools for characterizing and assessing those unconventional resources are based largely on our understanding and experience from conventional reservoirs. The very nature of regional pervasive, but variable resource abundance, reservoir characteristics and rock mechanic properties of unconventional resource play often leads to great risk on their commercial productivity. New assessment methods based on the latest understanding and reservoir characteristics of unconventional reservoir are highly desirable.

In this paper we propose an integrated approach by considering all available data to constrain the resource estimation geologically and outline potential sweet spots objectively. This method consists of three components: a well-performance method that utilizes historical production records to derive estimated ultimate recovery (EUR) for each production well; a reservoir volumetric approach that constructs the in-place resource maps; and a geological risk analysis procedure to estimate the probability of commercial production at an untested spot if a production well is drilled. The recovery factor is estimated at each production well site by comparing well EUR and in-place resource, thus reflecting the spatial variation of recoverability of the in-place resource and eliminating the impacts of well completion specifics on the recovery estimation.

The Middle Bakken Unit A tight oil reservoir of the Devonian Bakken Formation in southeastern Saskatchewan is used as a case study for the method development. The application of the method to the Unit A reservoir resulted in a geological risk map outlining the likely locations of high productivity areas (sweet spots) as probability map and probability distributions of estimated recoverable oil and gas resources. The assessment indicates that the expected recoverable oil and associated gas are 0.22 $x10^9$ m^3 (1.38 billion barrels) and 34 $x10^9$ m^3 (1.21 TCF) respectively with large uncertainties.

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