

Paper Number 59044  
Title **Implementing Convection in a Reservoir Simulator: A Key Feature in Adequately Modeling the Exploitation of the Cantarell Complex**  
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Source SPE International Petroleum Conference and Exhibition in Mexico, 1-3 February, Villahermosa, Mexico

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### **Abstract**

As for some thick and highly fractured Iranian fields, the Cantarell complex located offshore Mexico presents features (decrease in the production GOR and bubble point pressure with time) that reveal the effect of convection. This effect on the past homogenization of the fluid properties is discussed and is supported by a thorough characterization of the thermodynamic properties of the actual reservoir fluids.

In order to model convection, the reservoir simulator used for this study was adapted on purpose. Sensitivity runs were performed to demonstrate the necessity of accounting for convection for matching the past history of the Akal field, part of the Cantarell complex.

### **Introduction**

#### **Presentation of Cantarell Complex.**

The Cantarell complex is the most important oil field in Mexico, and the sixth largest in the world. In order to economically optimize its value, it has been decided to initiate a major recovery process by injecting nitrogen for pressure maintenance purposes. Cantarell field is a thick, highly fractured reservoir, therefore it is the kind of reservoir where convection phenomenon may occur. Convection is a complex process which is characterized by a vertical homogenization of fluid properties in the fractures. This may have an essential impact on production and injection profiles, in particular on the quantity of nitrogen in the effluents as well as nitrogen breakthrough times, thereby on the overall nitrogen injection efficiency.

The Cantarell complex is located offshore approximately 85 km from Ciudad del Carmen. It includes four adjacent oil fields known as Akal, Chac, Kutz and Nohoch. Akal is the largest oil accumulation with more than 90% of the 35 billion bbl oil (Bbo) in place. The reservoir is an anticline producing from the fractured carbonates of the Cretaceous and upper Jurassic formations, which contains also many vugs and caves. The Upper Cretaceous is the most fractured and brecciated. Fracturing decreases with depth in the Middle and Lower Cretaceous. The average thickness of the whole reservoir is about 775 m and the depth of the top Cretaceous ranges between 1100 and 3600 mTVDSS. Below the Cretaceous sequence, the Upper Jurassic (Oxfordian, Kimmeridgian, Tithonian) is a stratigraphic reservoir with poor reservoir characteristics.

Field production started in June 1979, reaching a peak of 1.157 MMbopd in April 1981, with 40 producing wells. A total of 184 wells were drilled in Cantarell, among which 173 wells in Akal. Cantarell crude is a 19 to 22° API Maya type, with an initial bubble point pressure close to 150 bar. Initially the reservoir pressure was above the bubble point pressure and was equal

to 266 bar at 2300 mSS. Therefore there was no initial gas cap. The reservoir pressure rapidly reached the bubble point pressure and a secondary gas cap appeared in 1981. The Gas-Oil Contact was located at 1800 mSS in 1997. The corresponding cumulative production was around 5.5 billion stb.