Integrated Geological and Engineering Studies in Support of Producing Light Oil from a Frozen Reservoir: A Case Study from Umiat Oil Field, Northern Alaska

Catherine Hanks [1], Joanna Mongrain [2], Abhijit Dandekar [2], Paul J. McCarthy [3], Vasil Godabrelidze[2], Chinmay Shukla [2], Kiran Venepalli [2], Obiama Levi-Johnson [2], Grant Shimer [3], and Raelene Wentz [3]

[1]Petroleum Engineering and Geophysical Institute, University of Alaska, Fairbanks, AK.
[2]Petroleum Engineering, University of Alaska, Fairbanks, AK.
[3]Geology and Geophysics, University of Alaska, Fairbanks, AK.

Shallow oil production in arctic regions must contend with a variety of unique production issues. Consolidated reservoirs in the permafrost may have production challenges even if the oil is light and not biodegraded. While deemed uneconomic in the past, horizontal drilling technology and higher oil prices may make these shallow accumulations economic if the reservoir character and rock and fluid behavior under these low temperature and pressure conditions are adequately understood and managed.

The Umiat field of the National Petroleum Reserve of Alaska (NPRA) is an example of a such a shallow, light oil accumulation. Umiat is a thrust-related anticline at the leading edge of the Brooks Range fold-and-thrust belt and consists of multiple reservoirs in shallow marine clastic rocks of the Cretaceous Nanushuk Formation. Most of the potential reservoir rocks are within permafrost. Natural fractures associated with the folding may impart a permeability anisotropy to the reservoir. If so, these fractures could be utilized to enhance production by selective well placement and orientation. Ongoing reservoir modeling attempts to capture both sedimentologic and structural reservoir heterogeneities and predict how the Umiat reservoir will flow using horizontal wells with pressure maintenance by cold gas injection.

Reservoir modeling also requires an understanding of how Umiat rock and fluids will behave in the presence of ice. Gas-oil relative permeability analysis on Umiat core plug samples indicate a clear reduction in the relative permeability of gas and oil in the presence of *in situ* ice. In order to more fully evaluate what part of the reservoir will experience this reduction, NMR analysis of water-saturated and frozen Umiat samples is underway in order clarify where ice forms and at what temperature at various reservoir depths.

No live Umiat oil samples exist. Recent density and viscosity analysis of a dead Umiat oil sample yielded an API gravity of ~30°, a value significantly lower than the 37° API gravity reported when the field was discovered in the 1940's. This suggests that the sample has been extensively weathered and its characteristics are not totally representative of the original oil. In order to determine a representative Umiat fluid for reservoir simulation, the recent analytical results will be used to calibrate an Equations of State (EOS) model that will then be used to predict the properties of a representative Umiat fluid.