

### 3.4 **Control of in situ oil production in unconventional resources**

Jack Bridges, Armin Hassanzadeh, Richard Snow

*PyroPhase Inc., Chicago, Illinois, United States*

Radio frequency (RF) heating of oil shale by installing long conducting electrodes into a formation has been investigated as part of a study into alternative methods for in situ retorting. By controlling the frequency and other parameters, the power absorbed by the formation can be electronically controlled to vary heating in different portions of the shale. Thermal conduction can be superimposed, giving an added control tool by varying heating rate and time. The objective of relatively uniform heating can thus be achieved, so as to produce a high proportion of the in-place resource, resulting in a highly economic process. Further, the heating can be tailored to dynamically accommodate the varying physical properties of hydrocarbon formations. Other in situ production methods offer fewer means for controlling the location and severity of treatment. Results from several studies will be discussed. One example for oil shale shows how a 150% variation in temperature at the start of heating is smoothed to about 15% during the final stage. Another example illustrates control of RF heating to recover bitumen from a tar sand deposit. Simulation results for oil shale and tar sand are confirmed by data from previous pilot tests. We plan to use simulations to guide the design and control of future scale up efforts, and to calibrate simulations with pilot results. These techniques should advance the goal of commercializing unconventional domestic hydrocarbon resources in the US by RF heating.