

Reservoir Modeling and Simulation: Assessing the Viability of an RF Heating System in Your Reservoir

Harris Corporation offers a proven solution to evaluate the use of radio frequency (RF) heating technology as an effective recovery technique for heavy oil and oil sands-based reservoirs.

The approach uses both technical and economic assessments to evaluate the suitability of deploying RF heating systems in a specific reservoir. Technical performance of the RF process is assessed through RF characterization and modeling of the reservoir using our Coupled Electromagnetic Reservoir Simulator (CEMRS™). These technical results are used to develop a preliminary business case for a full-field of RF heating systems producing an entire reservoir. Harris works collaboratively with each client to create the most accurate representation of the recovery process. Typical areas of collaboration are:

Client Provides:	Harris Supplies:
<ul style="list-style-type: none"> • Core samples • Reservoir data and analyst support • Economic assessment data and analyst support 	<ul style="list-style-type: none"> • Core sample characterization • Initial system architecture assessment • Reservoir analysis • Initial process development • Economic assessment

METHODOLOGY

Core Sample Characterization

Harris measures the dielectric properties of the reservoir (i.e., conductivity/resistivity and permittivity) for accurate reservoir response in the electromagnetic (EM) models.



System Architecture Assessment

Harris performs an initial architecture assessment to determine the appropriate RF system configuration for reservoir and economic analysis. This assessment evaluates the reservoir and the RF process to identify the antenna length, transmission line length, required support equipment, and basic requirements for the RF heating system. The assessment culminates in a recommended RF system configuration.

Reservoir Analysis and Process Development

Through a collaborative process, Harris will develop a reservoir model which will be used to develop and analyze an RF extraction process.

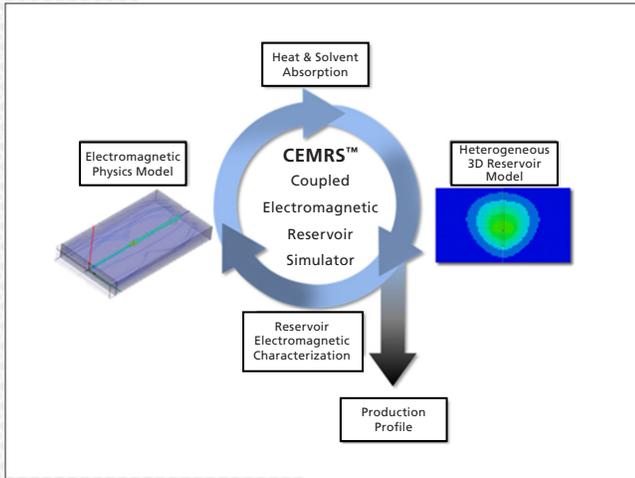
Reservoir Characterization

Reservoir characterization is most easily achieved by providing Harris a reservoir model. In the absence of a reservoir model, reservoir properties will be supplied to Harris as available. The reservoir model to be provided should contain the following reservoir characteristics:

Reservoir Characteristics:	
Oil viscosity and API	Oil and water saturation
Native reservoir and max operation pressure	Hydrocarbon components
Depth, temperature, porosity, and permeability	Relative permeability curves
Overburden, payzone, and underburden thickness	Electrical conductivity

Reservoir Model Development

Harris adapts the supplied reservoir model to be compatible with the RF extraction process analysis. The resulting reservoir model will be analyzed using CEMRS, a tool developed by Harris, which couples the reservoir model with an EM model. Furthermore, CEMRS accommodates horizontal and vertical wells for both 2D and 3D analysis. A production profile will be created through this simulation and will be incorporated into a business model during the economic assessment.



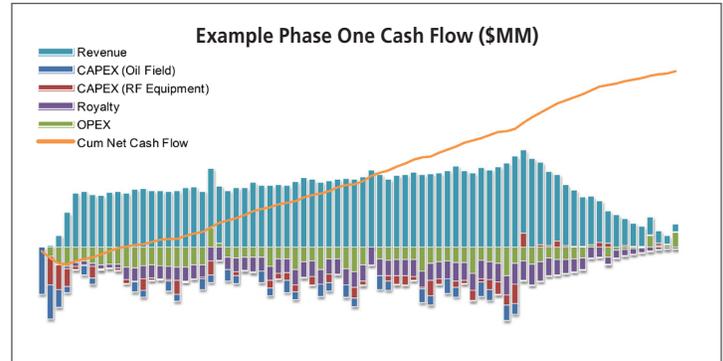
Process Development

Through a series of simulations, Harris develops a workable range of process parameters. Once ranges are established, an array of screening runs determine the sensitivity to the process parameters. A sequence of focused runs finalize the initial optimization of the process parameters.

- Typical process parameters input
 - Power profile
 - Solvent choice
 - Well spacing
 - RF frequency
 - Pressure and flow rate constraints
 - Solvent injection, oil and gas production
- Process development output
 - Oil production rates
 - Energy efficiency
 - Operational expenses for electricity and solvent

Economic Assessment

Harris develops a full-field deployment plan and analysis tool designed to meet the client's defined targets/constraints. Single-well production estimates and the results of the system architecture assessment are used to collaboratively develop a business model (maintained by Harris) to represent a full-field operational scenario.



This assessment includes a complete field rollout schedule (including the RF system equipment) with the resulting production curves and revenues. Based on given discount rates and oil prices, the model calculates the overall project net present value (NPV), total operational expenditure (OPEX), total capital expenditures (CAPEX), netback, internal rate of return (IRR), and capital intensity for the field.

The Path Forward

Effective Solvent Extraction Incorporating Electromagnetic Heating (ESEIEH™, pronounced "easy") offers an innovative method of oil extraction, yielding substantial economic and environmental benefits over current extraction processes. The first step in implementing ESEIEH in your fields is to understand the economic impact it can provide. CEMRS offers the fastest and most cost effective path toward quantifying the impacts of ESEIEH on your business.

Now is the time to explore the potential of your resources!

HARRIS

Government Communications Systems
P.O. Box 37
Melbourne, FL USA 32902-3700
1-800-4-HARRIS (1-800-442-7747)
harris.com/rfheating

Non-Export-Controlled Information

harris.com

Harris is a registered trademark of Harris Corporation.
Trademarks and tradenames are the property of their respective companies.
© 2015 Harris Corporation 4/15 54832 ECL d0772