Optimization of Well Casing Perforation Using HPC NY

Headquartered in Murray, Utah, Reaction Engineering International (REI) is a growing R&D consulting firm with an internationally recognized expertise in energy and defense solutions. REI offers consulting services and products to clients in the energy and defense sectors, including state and federal government agencies, private and public utilities, major industries, manufacturers and vendors.

REI was founded in 1990 on the premise that a company composed of full-time professionals working with technically specialized university faculty could most easily apply cutting edge technology to real-world problems. REI's reputation for providing high quality service and solutions to tough problems has attracted significant business opportunities.

REACTION ENGINEERING INTERNATIONAL

Company: Reaction Engineering International
Industry: Energy, Environment & Defense
Location: Murray, Utah
Website: http://www.reaction-eng.com/

THE CHALLENGE

Well perforations, which have a significant impact on oil and gas production, are routinely performed in the well completion process using shaped-charge jets. Because of the complexity of the perforation process, charge designers rely on expensive experimentation and end-users (operators and service providers) of perforators rely primarily on vendor catalog data to select shaped-charges for their wells.

Significant improvements could be achieved in shape-charge designs and in end-user selection of charges with predictive modeling and simulation capabilities for perforation with accurate representations of down-hole conditions and target formation properties. Industry experts estimate that optimized shaped-charges could increase production by 20-50%.

NEXT-GENERATION SOLUTIONS

Only recently has computer modeling of the extremely complex phenomenon of shaped-charge perforations been feasible due to developments by the DoE ASC Center (CSAFE) and advances in the state-of-the-art geomaterials model at the University of Utah. The computational requirements of the software are significant and the level of expertise required to set up and perform the simulations is high, making the use of the software

prohibitive to most small and medium sized companies. Using REI's expertise and CCR's high performance computing resources, these problems can be simplified for the end user. By simplifying the process and reducing financial cost, the state-of-the-art modeling tools can be utilized to design and select the correct shaped-charge for well completion.

Access to UB's high performance computing (HPC) resources is supported by funding from the Division of Science Technology and Innovation (NYSTAR) of the Empire State Development Corporation (ESD) through its High Performance Computing Consortium (hpc-ny.org) and the New York State Regional Economic Development Council.

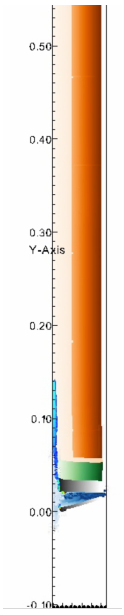
ECONOMIC IMPACTS

REI is using UB CCR resources to validate a cloud-based simulation-optimization framework for shaped-charge well completion. Designing cost-effective shaped-charges can significantly increase the yield of a give well (20-50%), thereby generating additional revenue for the petroleum industry and better utilizing the country's natural resources.

This collaboration has allowed for support of engineers and developers performing the research. One of the primary engineers on the project is a former UB graduate. REI is working with a former employee and current independent contractor on this project who is now based in New York State.

RESULTS

Current modeling efforts are focused on the validation of the state-of-the-art geomaterials model with experimental data. Despite being conceptually simple 2D axisymmetric problems, simulating the complex physics involved requires significant computational resources for reasonable turn-around times.



Access to these computational resources has allowed REI to develop and debug models on the order of hours and days as opposed to weeks. By making the simulation times tractable these resources help to ensure the success of the program.

Each simulation produces significant data resulting in storage sizes ranging from 25 to 100 gigabytes of data. This data includes the transient history of the shaped-charge jet and rock thereby allowing the determination of depth of penetration and well-performance. Post processing such significant data requires custom software paired with the Visit visualization toolkit. When run on CCR's resources, this software allows for fast analysis of the results required by end-customers.

"The HPC resources and tremendous support provided by UB CCR and New York State are helping REI pioneer this cutting edge technology." — Matthew McGurn, Ph.D., Senior Engineer REI

ABOUT HPC^{NY}

Funded by ESD Division of Science, Technology & Innovation, HPC^{NY} is a partnership between NYSERNet, a private not-for-profit corporation created to foster science and education in New York, and three supercomputing centers: the Rensselaer Polytechnic Institute Center for Computational Innovations, Stony Brook University/Brookhaven National Laboratory's New York Center for Computational Sciences, and the University at Buffalo's Center for Computational Research.

NEW YORK STATE OF OPPORTUNITY. Division of Science, Technology & Innovation
A Division of Empire State Development

HPC^{NY} provides businesses and research organizations with access to world-class advanced computing expertise through accelerating the engineering and development path of complex, ground-breaking designs to reliable, accurate, innovative product and process performance that can provide a distinct competitive advantage.

ABOUT CCR

The Center for Computational Research (CCR), part of the University at Buffalo (UB), is a leading academic supercomputing facility. CCR maintains a high-performance computing environment, high-end visualization laboratories, and support staff with expertise in computing, visualization, and networking.

The mission of CCR is to (1) enable research and scholarship at UB by providing faculty with access to high-performance computing and visualization resources, (2) provide education, outreach, and training in Western New York, and (3) foster economic development and job creation in Western New York by providing local industry with access to advanced computing resources, including hardware, software and consulting services.

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