Dr. Faruk Omer Alpak, Principal Science Expert & Senior Research Reservoir Engineer, Shell International Exploration and Production Inc.

Research Summary

Dr. Alpak has been developing leading-edge methods for dynamic subsurface modeling addressing the complete pore-to-field scale spectrum that have been successfully applied in real-life projects across the entire exploration & production lifecycle. His scientific contributions include new (a) multiphysics/multiscale reservoir simulation methods, (b) fast and accurate digital rock physics modeling methods, (c) flow-based scaleup techniques, (d) optimization methods for field development, history matching and multiphysics inversion, and (e) engineering knowledge in clastic geology. His methods have been successfully validated and are currently being deployed in real-life field-development projects to accurately and efficiently forecast and optimize hydrocarbon recovery from subsurface reservoirs. Dr. Alpak' s range of expertise covers multiple physical disciplines including computational and applied mathematics, computational fluid dynamics, reservoir engineering, geomechanics, inverse problems, electromagnetics, and turbidite geology. Specifically, he is responsible for the following impactful and original scientific contributions:

(1) **Development of new methods for multiscale/multiphysics reservoir simulation**

This branch of Dr. Alpak's work encompasses development, validation, and application of (a) innovative methods for computationally efficient multiphysics simulation of subsurface hydrocarbon reservoirs, (b) new fast and accurate multiscale numerical flow simulation methods for hydrocarbon recovery in geologically complex reservoirs as well as for physically complex unconventional thermal-reactive recovery techniques such as In-Situ Conversion Process (oil shale) and In-Situ Upgrading Process (heavy oil), (c) state-of-the-art fundamental numerical methods and their simulator implementation with demonstrated application in real-life reservoir modeling problems; (d) multiphysics simulation studies to uncover new phenomena that would not be possible to quantify otherwise.

Relevant References:

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(2) **Development of new methods for digital rock physics modeling**

Dr. Alpak pioneered the development of a leading-edge pore-scale direct numerical simulation system for multiphase multicomponent flow, transport, and thermodynamics using scale-relevant models and consistent with experimental measurements. This industrial-strength Digital Rock Physics (DRP) simulation system is developed by Dr. Alpak and his team using novel thermodynamically based computational fluid dynamics formulations and state-of-the-art programming paradigms taking advantage of distributed parallel computing on General Purpose Graphics Processing Unit (GPGPU) processors and cloud computing. The DRP simulation system development work included a research collaboration project with Dr. Beatrice Riviere (Department of Computational and Applied Mathematics) and Dr. Walter G. Chapman (Department of Chemical and Biomolecular Engineering) of the Rice University. The DRP simulation system has been extensively verified and recently extended to include pore-scale electromagnetics and geomechanics simulators, machine-learning based image processing and segmentation algorithms, and novel industry-first transforms to incorporate the effects sub-pore-scale phenomena into effective properties subject to computation. Unique workflows have been developed for the business application of the DRP simulation system to augment and accelerate time-consuming petrophysical and special-core analysis laboratory measurements, and sensitivity and parameter optimization studies for chemical EOR.

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(3) Development of new methods for flow-based numerical scaleup in geologically complex reservoirs

This branch of Dr. Alpak's research work involves the development of a number of leading-edge numerical single- and multiphase flow-based scaleup methods with a special focus on two classes of problems: (1) Fast and accurate recovery forecasting under the influence of subsurface uncertainty in geologically complex clastic reservoirs with non-local heterogeneities (a class of reservoirs in which conventional scaleup methods fall short in delivering reliable predictions); (2) Accelerated simulation of computationally intensive thermal-reactive compositional and multiphase flow models associated with the In-Situ Conversion Process. Effective property computation protocols within a subset of the developed scaleup methods take advantage of seminal developments in machine learning.

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(4) Development of methods for field-development optimization, history matching, multiphysics inversion under the influence of subsurface uncertainty

Dr. Alpak developed, validated, and deployed to industrial projects a number of innovative and effective development optimization and inversion methods to accelerate iterative forward modeling workflows by rigorously taking into account the effects of subsurface uncertainties. These methods encompass (1) field-development optimization for deep-water and In-Situ Upgrading Process projects; (2) geologically consistent probabilistic assisted history-matching of deep-water reservoirs; (3) joint inversion of flow and electromagnetic measurements by honoring the physics of multiphase fluid flow taking place near the wellbore due to mud-filtrate invasion. The common denominator of these optimization and inversion methods is their robust applicability to problems where the forward model is a numerical simulator. All of these methods are designed from ground-up to operate under the influence of numerical noise (in addition to the measurement noise) and in a fault-tolerant fashion with numerical simulators on real-life field-development projects.

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(5) Development of methods and studies for enhanced understanding of clastic reservoirs with complex stratigraphic and structural architecture.

This branch of Dr. Alpak's research work involves the development of new methods and execution of detailed innovative studies to model, quantify and develop an improved understanding of the dynamic impacts of structural and stratigraphic architecture in clastic reservoirs. Results of his work have been adapted in the industry as part of integrated reservoir modelling guidelines for deep-water turbidite reservoirs.

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Education

- Ph. D., Petroleum Engineering, The University of Texas at Austin, Austin, Texas, May 2005.
- M. Sc., Petroleum Engineering, The University of Texas at Austin, Austin, Texas, December 1999.
- B. Sc., Petroleum and Natural Gas Engineering, Middle East Technical University, Ankara, Turkey, July 1997.

Professional Experience

- Principal Science Expert (March 2019 – present) and Senior Research Reservoir Engineer (November 2018 – present), Shell International Exploration and Production Inc., Projects and Technology Department, Quantitative Reservoir Management Team, Shell Technology Center Houston, Houston, Texas, U.S.A., March 2019 – present.
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- Adjunct Associate Professor, Computational and Applied Mathematics Department, Rice University, Houston, Texas, U.S.A., July 2014 – July 2020.
- Senior Reservoir Engineer, Shell International Exploration and Production Inc., Projects and Technology Department, In-Situ Upgrading & In-Situ Conversion Process (IUP/ICP) R&D and Subsurface Modeling Team, Shell Technology Center Houston, Houston, Texas, U.S.A., June 2011 – October 2013.
- Reservoir Engineer, Shell International Exploration and Production Inc., Projects and Technology Department, Clastics R&D Team, Bellaire Technology Center, Houston, Texas, U.S.A., June 2005 – May 2011.
- Summer Intern Reservoir Engineer, Shell International Exploration and Production Inc., Projects and Technology Department, Fluid Evaluation and Sampling Team, June 2004 – August 2004.

- Summer Intern Research Scientist, Schlumberger-Doll Research Center, Mathematics and Modeling Department, Ridgefield, Connecticut, U.S.A., June 2003 – August 2003.
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- Summer Intern Field Engineer, Schlumberger Oilfield Services, Cairo, Egypt, July 1996 – September 1996.
- Summer Intern Petroleum Engineer, Turkish National Gas Transmission Company (BOTAS), Ankara, Turkey, July 1995 – September 1995.