

Managed Pressure Drilling

Modeling, Strategy and Planning

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Preface

My first exposure to the importance of good hole cleaning and pressure analysis occurred in 1981 when I was initiated into the petroleum industry, having left the aerospace industry, for which I had trained diligently. The new subject matter was not glamorous, to say the least, but years later I would come to understand its significance in both drilling and cementing. The advent of deviated and horizontal wells elevated the role of annular flow in oilfield operations.

A decade later, I published my first book on borehole flow modeling, introducing the use of curvilinear grid systems to accurately capture the physics. Over the years, this effort was self-funded and undertaken as a labor of love. However, another decade later I launched my consulting company, Stratamagnetic Software, LLC, supported by the U.S. Department of Energy through its Small Business Innovation Research Program, under Grant DE-FG03-99ER82895, to improve grid generation techniques for the oil industry. Related work in this area with several clients continued over the years in different and varied applications.

In 2009, the Department of Energy awarded a contract to support my technical proposal “Advanced Steady-State and Transient, Three-Dimensional, Single and Multiphase, Non-Newtonian Simulation System for Managed Pressure Drilling.” This comprehensive effort was administered by the Research Partnership to Secure Energy for America (RPSEA) through its Ultra-Deepwater Program under Subcontract No. 08121-2502-01. This award enabled my colleagues and I to “tie up loose ends” and integrate numerous models developed over two decades. More important, it provided us the opportunity to significantly extend our models in numerous directions—rotating flow, fully transient effects, three-dimensionality, multiphase, and so on—and to perform research and develop software models that we felt would have a lasting influence on the petroleum industry.

We are very fortunate that many in the industry have recognized our efforts. Aside from those who have provided us this source of important funding, anonymous reviewers have made it possible for us to publish five recent papers: four for the American Association of Drilling Engineers (AADE) National Technical Conference and Exhibition, during April 2011 in Houston and one for the Offshore Technology Conference during May 2011, also in Houston. We are of course gratified that Gulf Professional Publishing/Elsevier has agreed to publish this book, *Managed Pressure Drilling: Modeling, Strategy and Planning*, which will no doubt achieve wide dissemination of our ideas.

Consistent with my belief that scientific research should be openly shared by industry, this book and the papers my colleagues have presented disclose all elements of the new annular flow models: mathematical theory, numerical implementation, source code examples, and computational validations, with comparisons to laboratory and field data and results whenever possible. Because of our research focus, and because our ideas are always evolving, the methods developed here and implemented in software are provided “as is” and no claim is made that they address all potential technical issues.

It is hoped, however, that others will study the models and help to improve them through use and research. Over the next several months, the plan is to widely disseminate the software, on which great effort has been expended in order to optimize the user’s experience through a versatile

and intuitive interface so we can obtain the feedback needed to support continued product development. Access to the fully functional software system flow simulation modules executable over the Internet are available from the book's website at gulfp.com/9780123851246

I am deeply appreciative of the U.S. Department of Energy and the Research Partnership to Secure Energy for America for the opportunity they have provided me to work in this exciting technology area, and I look forward to a long collaboration with them and all interested parties.

Acknowledgments

My colleagues and I gratefully acknowledge the U.S. Department of Energy for its support of our technical proposal "Advanced Steady-State and Transient, Three-Dimensional, Single and Multiphase, Non-Newtonian Simulation System for Managed Pressure Drilling" during the period 2009 through 2011. This support was administered and directed by the Research Partnership to Secure Energy for America (RPSEA) through its Ultra-Deepwater Program under Subcontract No. 08121-2502-01. Our curvilinear grid generation research was also supported by the U.S. Department of Energy, under Small Business Innovation Research Grant DE-FG03-99ER82895 from 1999 through 2000.

We thank all of the industry partners we have been privileged to work with for motivating many of the problems and methods addressed in this research. We are indebted to Art Schroeder of Energy Valley, to Jim Chitwood of Chevron, and to James Pappas of RPSEA for their encouragement and advice. We are especially grateful to John Lofton of Chevron for his engineering insights and guidance related to several areas of our modeling of rotating pipe flow effects. James Pappas, in particular, contributed significantly to the manuscript through his meticulous reading and valued comments.

Finally, we thank Ken McCombs, senior acquisitions editor at Elsevier, for his interest in the book and for his support and encouragement throughout the research and writing. Marilyn Rash, with assistance from Dianne Wood and Deborah Prato; Jill Leonard; and other Elsevier staff contributed greatly to the editorial and production efforts and their labors are deeply appreciated.

The views expressed here, of course, are my own and are not necessarily the opinions of any program sponsors or individuals.

About the Author



Wilson C. Chin earned his Ph.D. from the Massachusetts Institute of Technology and his M.Sc. from the California Institute of Technology. His early interests focused on applied mathematics, fluid mechanics, and electrodynamics. Prior to founding Stratamagnetic Software, LLC, in Houston in 1999, he was affiliated with Boeing Aerospace, United Technologies, Schlumberger Anadrill, BP Exploration, and Halliburton.

Mr. Chin has authored more than 80 technical papers, received almost 20 U.S. patents in oilfield technology, and won 5 Department of Energy awards. In addition, he has written 8 other textbooks on advanced research in petroleum technology:

- *Borehole Flow Modeling in Horizontal, Deviated and Vertical Wells* (Gulf Publishing, 1992)
- *Modern Reservoir Flow and Well Transient Analysis* (Gulf Publishing, 1993)
- *Wave Propagation in Petroleum Engineering, with Applications to Drillstring Vibrations, Measurement-While-Drilling, Swab-Surge, and Geophysics* (Gulf Publishing, 1994)
- *Formation Invasion, with Applications to Measurement-While-Drilling, Time Lapse Analysis and Formation Damage* (Gulf Publishing, 1995)
- *Computational Rheology for Pipeline and Annular Flow* (Elsevier, 2001)
- *Quantitative Methods in Reservoir Engineering* (Elsevier, 2002)
- *Formation Testing Pressure Transient and Contamination Analysis* (E&P Press, 2008)
- *MWD Signal Analysis, Optimization and Design* (E&P Press, 2011)

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