

Preface

This book compiles and systematizes analytical solutions describing groundwater-level changes in aquifers during aquifer tests, carried out under different hydrogeological conditions. The book integrates the majority of known solutions from well hydraulics and subsurface flow theory, starting from the works of the early twentieth century by G. Thiem, P. Forchheimer, C.V. Theis, and M. Muskat up to the most recent publications in periodicals. In this context, special mention should be made of the invaluable contribution to the development of methods for the mathematical analysis of hydrological processes made by M.S. Hantush, H.H. Cooper, C.E. Jacob, N.S. Boulton, S.P. Neuman, and A.F. Moench, whose efforts gave renewed impetus to the theory and methods of aquifer test analysis. The book also contains interesting, though little known, solutions obtained by Russian researchers (e.g., F.M. Bochever, V.M. Shestakov, V.A. Mironenko, etc.), which have not been mentioned in widely distributed scientific publications.

This publication is designed as a handbook. It presents analytical equations for most of conceptual models. Confined, unconfined, confined-unconfined, inhomogeneous, fracture-porous aquifers, as well as leaky aquifers and stratified (multi-layer) aquifer systems are described in the book. A wide range of groundwater-flow equations are given, accounting for complicating factors: anisotropy, flow boundaries in horizontal and vertical planes, partial penetration of the aquifer, wellbore storage, wellbore skin effect, the effect of capillary forces, etc. Considered separately are constant-head tests, pumping tests with horizontal or slanted wells, dipole flow tests, and slug tests.

The book comprises about 300 transient solutions for a single-well test with a constant discharge rate. They create the basis for numerous equations for groundwater-level recovery and drawdown in multi-well pumping tests, with constant or variable discharge rate of the pumping wells.

In addition, quasi-steady-state and steady-state solutions are described, intended for graphical processing of aquifer test results by the straight line method (more than 100 solutions) and the type-curve method (more than 50 varieties of type curves). Formulas for evaluating hydraulic characteristics are proposed for each

graphical method. Many steady-state solutions are given, which can be used for point-wise methods for evaluating hydraulic characteristics by maximal water-level changes in complicated hydrological settings, for which transient relationships acceptable for practical application have not been developed.

A set of both alternative and complementary solutions and methods of data processing are proposed for each combination of conceptual model and test conditions, thus making it possible to evaluate aquifer hydraulic characteristics. The author's own results are given, providing new graphical methods for field data analysis and improving the reliability of parameter estimates.

The book is supplemented with appendices: here a hydrogeologist can find a vast body of useful information. The appendices give mathematical descriptions to the majority of functions used in the book, present their plots and possible approximations, and analyze the algorithms for application of complicated numerical-analytical solutions utilized in rather well-known software developed by S.P. Neuman, A.F. Moench, and others.

The presented analytical solutions have been implemented and tested in a multifunctional software complex ANSDIMAT, developed by the author. The reader is provided with a brief characteristic of the program and, if need be, can run a test module. A trial version of the software and the complete commercial version are available at www.ansdimat.com.

The book comprises three parts, supplemented by appendices. The first two parts contain a systematized set of analytical relationships and methods for aquifer test treatment. The solutions for a pumping test in single vertical wells are described in the first part. The second part is devoted to various types of aquifer tests: pumping from horizontal and slanted wells, pumping with variable discharge rates and multi-wells pumping tests, dipole flow tests, constant-head tests, slug tests, and recovery tests.

The third part gives a brief characteristic of ANSDIMAT software, which incorporates all the potentialities illustrated in this book. The last part of the book gives algorithms for evaluating groundwater-flow parameters by analytical and graphical methods. An alternative approach is proposed to simulate well systems, and additional capabilities of the program are considered, which are intended to solve specific engineering-hydrogeological problems based on groundwater-flow equations, describing liquid flow toward wells.

The author very much appreciates the invaluable help of Dr. Vyacheslav Rumynin in the preparation of the book, including useful hints, comments, and fruitful discussions which enabled the author to improve the quality of the present publication in many respects. The author also appreciates the help of Dr. Gennady Krichevets, who is not only a translator of the book but also a real expert attentive to the works of his colleagues. His remarks regarding the work's contents helped the author to correct deficiencies made apparent during its preparation.

Aquifer Test Solutions

A Practitioner's Guide with Algorithms Using ANSDIMAT

Sindalovskiy, L.N.

2017, XIX, 392 p. 179 illus. With online files/update.,

Hardcover

ISBN: 978-3-319-43408-7