Proceedings of the International Conference on Heat Transfer and Fluid Flow
Prague, Czech Republic, August 11-12, 2014
Paper No. 209

Practical Finite-analytic Method (PFAM) for Effective Temporal-Spatial Numerical Solution of Phenomenological Partial Differential Equations

Faruk Civan
Mewbourne School of Petroleum and Geological Engineering, University of Oklahoma
Norman, Oklahoma, United States
fcivan@ou.edu

Extended Abstract

The Practical Finite-Analytic Method (PFAM) has been first introduced by Civan (1991, 1995, and 2009) in the literature for effective temporal-spatial numerical solution of phenomenological partial differential equations.

This method is based on the reduced-power series formed by piece-wise analytical solutions of the general types. This method seeks determining the equation of the solution surface. However, the numerical values can be calculated from the equations of the surfaces. The primary advantage of this method is the algebraic-numerical description of differential (and in fact integral and integro-differential) equations on arbitrarily selected grid systems without requiring the determination of the coefficients of the terms of the series. This is the only numerical method that has this outstanding feature. All other presently available methods including the finite-difference method require the determination of the coefficients. Civan's Practical Finite-Analytic Method (PFAM) is therefore very different in principle from Chen's Finite-Analytic Method (FAM) which uses complicated and tedious analytical solutions obtained by the common analytical solution methods such as the method of separation of variables and the Laplace transformation method.

In this presentation, first the outstanding features and basic principles of the PFAM are explained. Then, how this method can successfully avoid the determination of the coefficients of the series solution is elaborated. Finally, several examples are presented to demonstrate the application and efficiency of this method. It is shown that the present method is significantly advantageous because of simplicity, higher numerical stability, and applicability with arbitrarily selected grid systems. This is because this method is based of representing the overall solution by patching the multi-dimensional solution surfaces in a piece-wise continuous manner. In contrast, all the commonly used methods attempt to obtain directly the numerical values of the solution at selected discrete grid points.

References

Civan, F. (1991) Finite Analytic Method for Numerical Solution of Mathematical Models, Integral Methods in Science and Engineering (90), series in computational and physical processes in mechanics and thermal sciences, Haji-Sheikh, A., Corduneanu, C., Fry, J.L., Huang, T., and Payne, F.R. (Eds.), Hemisphere Pub. Co., New York, 270-281.

Civan, F. (1995) Practical Implementation of the Finite Analytic Method", Applied Mathematical Modeling, Vol. 19, No. 5, pp. 298-306.

Civan, F. (2009) Practical Finite-Analytic Method for Solving Differential Equations by Compact Numerical Schemes," Numerical Methods for Partial Differential Equations, pp. 347-379, Vol. 25 No. 2.