Explicit Analytical Solutions of Radial Permeable
Power Rate Flow

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Abstract: The research of different kinds of permeable non-Newtonian fluid flow is increasing day by day owing to the development of science, technology and production modes. It is most common to use power rate equation to describe such flows. However, this equation is nonlinear and very difficult to derive explicit exact analytical solutions. Generally, people can only derive approximate solutions with numerical methods. Recently, an advanced separating variables method which can derive exact analytical solutions easier is developed by Academician CAI Ruixian (the method of separating variables with addition). It is assumed that the unknown variable may be indicated as the sum of one-dimensional functions rather than the product in the common method of separating variables. Such method is used to solve the radial permeable power rate flow unsteady nonlinear equations on account of making the process simple. Four concise (no special functions and infinite series) exact analytical solutions is derived with the new method about this flow to develop the theory of non-Newtonian permeable fluid, which are exponential solution, two-dimensional function with time and radius, logarithmic solution, and double logarithmic solution, respectively. In addition, the method of separating variables with addition is developed and applied instead of the conventional multiplication one. It is proven to be promising and encouraging by the deducing. The solutions yielded will be valuable to the theory of the permeable power rate flow and can be used as standard solutions to check numerical methods and their differencing schemes, grid generation ways, etc. They also can be used to verify the accuracy, convergence and stability of the numerical solutions and to develop the numerical computational approaches.

Key words: non-Newtonian fluid, analytical solution, permeable power rate flow, method of separating variables with addition

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