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A family of analytical solutions of a nonlinear diffusion-convection equation

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Despite its popularity in many engineering fields, the nonlinear diffusion-convection equation has no general analytical solutions. This work presents a family of closed-form analytical traveling wave solutions for the nonlinear diffusion-convection equation with power law nonlinearities. This kind of equations typically appears in nonlinear problems of flow and transport in porous media. The solutions that are addressed are simple and fully analytical. Three classes of analytical solutions are presented depending on the type of the nonlinear diffusion coefficient (increasing, decreasing or constant). It has shown that the structure of the traveling wave solution is strongly related to the diffusion term. The main advantage of the proposed solutions is that they are presented in a unified form contrary to existing solutions in the literature where the derivation of each solution depends on the specific values of the diffusion and convection parameters. The proposed closed-form solutions are simple to use, do not require any numerical implementation, and may be implemented in a simple spreadsheet. The analytical expressions are also useful to mathematically analyze the structure and properties of the solutions.

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