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On nonlinear mathematical models in technological processes

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To create a common methodology for optimizing the technological processes of sugar production, the creation of methods for thermal analysis of mixtures in the production of food products with different chemical composition, and the products heat treatment process, a need arise to create and solve mathematical models of these processes. The simplest and at the same time, the least precise formulation of laws leads naturally to linear problems of mathematical physics. Unfortunately, most research in food sciences are based on these problems. It is caused on the one hand with low success mathematicians in solving nonlinear differential equations, and on the other with insufficient mathematical background of researchers in food sciences. But the description of the processes in terms of linear equations is unsatisfactory because the corresponding mathematical model does not reflect more accurate nonlinear effects that the process possesses. A classic example here is the soliton equations describing the nonlinear effect of phase shift of the interacting soliton solutions. Thus, the next more precise step of approximation of the real process corresponds to a nonlinear mathematical model, for the study of which, unlike in the case of linear models, only rather limited set of mathematical techniques is available to the researchers. Moreover, in the study of differential equations with arbitrary functions, there is no general method for their exact integration. This situation changes significantly if the nonlinear differential equation corresponding to a certain model has a nontrivial symmetry properties. In this case, powerful methods of group theory and Lie groups can be used in the study and construction of solutions of the corresponding equations. The subject of our research was the nonlinear reaction-diffusion equation $u_t - u_{xx} = f(u)$, where $u = u(t,x),\ f(u)$ is some fixed function of the dependent variable. We introduce a special substitution for reduction and efficient search of exact solutions of this equation with a cubic polynomial and exponential nonlinearity. In the case where $f(0) = f(1) = 0$ we obtained essentially new partial solutions of soliton type, and therefore have good prospects for various applications. We established that for the nonlinear reaction-diffusion equation with an arbitrary number of independent variables, there are the operators of conditional symmetry, and these operators are found in an explicit form. Using the Jacobi elliptic functions, we constructed infinite series of exact solutions, which can be applied to mathematical models of technological processes.

KEY WORDS : non-linear models, soliton equations, partial solutions, exact solutions

Indicate type of presentation: ☐ **Oral** ☐ **Poster**