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Methodology of Petrov-Galerkin weighting functions choice with usage of neural networks and group method of data handling for convection-diffusion problem

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Over the past four decades, the finite element method has become one of the most widely used methods for solving boundary value problems of mathematical physics. However, for problems with superior convection processes, classical approaches may give unstable solutions. To overcome this drawback is proposed to use the weighting function different from basic function (Petrov-Galerkin method). The disadvantage of such approaches is an empirical selection of the weight parameters that need to be reconstructed for each new task. Most Petrov-Galerkin formulations take into account the spatial discretization and the weighting functions developed give satisfactory solutions for steady state problems. Though these schemes can be used for transient problems, there is scope for improvement. Nowadays, research is being carried out for the selection of the weighting functions using neural networks and group method of data handling [1]. This approach allowed us to dynamically adapt the weighting functions during the integration. Also were proposed a new way of determining the parameters of the SUPG weighting functions based on GMDH. Both of these approaches had shown high efficiency for dominant convection process. Proposed methods of adaptive selection of stabilizing parameters of the proposed weighting functions that take into account the evolution of the solution, the vector field of the convective flow and depending convection-diffusion flow. Reducing the amount of calculation of parameters of the weighting function, based on the behavior of the velocity field of the convective flow, significantly reduce the dimension of the problem.

[1] I. A. Tereshchenko *International Journal of Innovative Technology and Research* **2(5)** , (2014), pp 1237-1242.