Using the resources of a distributed information system for solving applied problems of hydrodynamics

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Abstract: High performance hardware is developing very rapidly with the advances in industrial productions. It contributes to the introduction of numerical methods [1]. Possibilities of solving labor-consuming mathematical problems using distributed computing are considered. Distributed computing is a way to solve time-consuming computational problems using several computers, most often combined into a parallel computing system. Distributed computing is also applicable in distributed control systems. The created distributed information system fully provides the necessary computing resources for current research and educational processes simplifying the prospects for its further development, and allows you to create a developed IT infrastructure for managing intellectual property, an electronic library designed to store all books and scientific works of the Kazakhstan Engineering and Technological University and research institutes of Almaty [2-3]. On the basis of the created distributed information system, further on the portal https://www.acagor.kz/, it is possible not only to store digitized works of scientists from research institutes in Almaty, but also to use the resources of this portal to solve applied mathematical problems. For a numerical solution using the portal resources, the following industrial applications were considered. One of these tasks is to evaluate the efficiency and predict the indicators of oil field development. Due to the complexity of the mathematical models describing these processes, calculations for one field can last from several hours to several days. Therefore, the issue of developing efficient parallel algorithms based on distributed computing systems that can significantly speed up computations becomes relevant. Along with the classical filtration model based on Darcy's law, a number of other models are widely used in the study of fluid flows in oil reservoirs, such as the models of Zhukovsky N.E. [4], Forchheimer [5] and Navier-Stokes [4, 5].

The use of these models is associated with violation of Darcy's law under certain conditions, the need for a detailed study of filtration processes near wells, etc. The second problem considered is the numerical simulation of convective flows based on the Navier-Stokes equations. Initially a stable explicit difference scheme is constructed for the numerical solution of the Navier-Stokes equations in a multiple connected domain using the pressure uniqueness condition and the fictitious domain method for solving this problem. To solve this problem, an alternative approximate method is considered based on the method of fictitious domains with continuation by lower coefficients. The discretization of the obtained equations in the work is carried out by the method of finite differences. The distributed information system has the following functionality:

- Providing efficient high-performance computing for solving problems of numerical modeling;
- Reliable storage and management of large data, and the results of numerical simulation;
- Organization of work with the possibility of remote access.

Using installed servers on the basis of the created integrated distributed information system, it is possible to numerically solve time-consuming mathematical problems. These are very good opportunities for a researcher who does not have his own resources to solve any labor-intensive tasks.

Keywords: IT infrastructure, cloud solutions, data center, server, distributed computing systems, hydrodynamics, numerical solution

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