Using the dipole particles for simulation of 3D vortex flow of a viscous incompressible fluid

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ABSTRACT

A fully Lagrangian numerical method for simulation of 3D nonstationary flow of viscous incompressible fluid is developed. This method is based on the representation of a vortex field as a set of dipole particles [1]. The introduced vector-function D describes density of dipole momentum. The equation for this function is in accordance with Navier-Stokes equations [2]. The vorticity is equal to curl of dipole momentum density. Thus vortex field is always solenoidal. The dipole particles are generated at a body surface and are moving interacting. The region where function D is essentially non-zero approximately coincides with the vortex region. Each dipole particle induces the velocity field which is equal to field of a point dipole at large distance from the particle. But near a particle the induced velocity field is another taking into account the particle volume and viscosity of the liquid. The method can be applied for simulation of an ideal and viscous flow.
In this work the method is tested using the next tasks:

- the flow of ideal fluid around the thin rectangular plate at attack angle;
- simulation of a vortex ring motion in an unbounded space of ideal fluid;
- the flow of viscous fluid around the sphere;
- the ideal fluid flow generated by the propeller;
- oscillating plate in a flow of ideal fluid, and others.

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