

# Difficulties in implementation of viscosity models in the fragmenton-based vortex methods

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## ABSTRACT

Simulation of the viscous fluid with the vortex methods has been extensively investigated over the last 40 years. Wide range of approaches has been created to account for the diffusion term in the vorticity evolution equation, starting from the stochastic "random-walk" model of Chorin, particle strength exchange (PSE), diffusion velocity method (DVM), hybrid DVM-PSE scheme and ending with hybrid particle-mesh methods, where the diffusion term is discretized on the mesh.

In all mentioned approaches vorticity is discretized over the pointwise singular or regularized vortex particles (vortons), somehow distributed in the flow. Here instead of pointwise particles we consider line fragment "particles" (fragmentons) [1], which showed to be more effective in specific inviscid cases [2]. Fragmenton model is also the basis of the vortex filament method, where fragmentons serve as constructing blocks for filaments.

The main problem of the application of viscosity models for fragmenton-based vortex methods is that the material lines, initially chosen as vortex lines, do not stay vortex lines during their evolution in a viscous flow. This fundamental fact does not let a simple transmission of the above mentioned viscosity models from particle-based vortex methods to fragmenton-based ones without any assumptions.

The use of any viscosity model leads to splitting of fragmenton into material vector and vorticity vector, which generally do not stay collinear with time. This leads to accumulation of errors during the restitution of the velocity field. A good viscosity model, although cannot eliminate the splitting completely, must diminish this effect.

In the paper we discuss the implementation of the classical PSE model, as well as the hybrid DVM-PSE approach suggested by Mycek [3], for the fragmenton-based vortex methods. We show that the both concepts lead to excessive splitting in the test problems of vortex oval evolution in viscous fluid. We also discuss the means to improve the viscosity model and use the fragmenton splitting effect as the vortex lines reconnection criterion.

## REFERENCES

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