

Steady Stokes flow in a trihedral corner

Vladimir S. MALYUGA & Alexandre M. GOMILKO

*Institute of Hydromechanics, NAS of Ukraine
8/4 Zhelyabov str., Kyiv 03680, Ukraine
malyuga@ihm.kiev.ua*

Abstract The flow in a trihedral corner formed by three pairwise perpendicular planes, induced either by uniform translation of one of the corner's sides or by uniform rotation of a side, is considered in the Stokes approximation. An analytical solution of the problem is constructed. Numerical study of streamline patterns confirms existence of the corner eddies near the quiet edge in the antisymmetric flows. If the wall rotates about a centre displaced from the vertex, the induced flow is essentially three-dimensional. In the antisymmetric velocity field, there appears a stagnation line composed of stagnation points of different types. Otherwise the three-dimensionality manifests itself in a non-closed spiral shape of the streamlines.

*Stokes flow in a trihedral corner,
Of the kind where sat little Jack Horner,
Can be solved without sham
By the method of Lamb;
When I've finished, you won't feel forlorn.*

1. Introduction

Study of laminar motion of a viscous incompressible fluid in a container bounded by a surface with singular points is one of the most interesting problems in the fluid mechanics that involves considerable mathematical difficulties. One of the examples is the Stokes problem in a driven cubic cavity where the motion of a lid generates the fluid motion. Although the geometry of the problem and the governing equations are seemingly simple, the difficulty is that the asymptotic behaviour of the flow near the corners is not well-studied yet. Recently Hills & Moffatt (2000) analysed the asymptotic behaviour of the flow near the edge formed by two fixed triangular fins placed in a rotating cone and concluded that there existed a sequence of eddies. This result was extended to the trihedral corner treated as the cone of the angle $\pi/2$ with the fins. A similar conclusion was reached by Shankar (2000) who studied the Stokes problem in a trihedral corner with a non-zero boundary ve-