On motion of a double helical vortex in a cylindrical tube

Pavel A. KUIBIN

Institute of Thermophysics
Lavrentiev ave., 1, 630090 Novosibirsk, Russia
kuibin@itp.nsc.ru

Abstract New approach is developed for the velocity estimation of a double helical vortex motion in boundless space as well as in a cylindrical tube.

The system under consideration is two thin helical vortices winding around common axis and propagating in surrounding irrotational fluid. The problem on the determination of the velocity of the vortices motion is solved with help of formulae describing the velocity field induced by infinitely thin helical vortex inside a cylindrical tube (Okulov 1995) and using the technique of the singularities separation from this solution (Kuibin & Okulov 1998). As a result an analytical formula for the vortices propagation velocity is found with account for the self and mutual induced velocities, influence of the solid boundary and translational motion. The formula contains infinite series from the modified Bessel functions. Nonetheless it is shown that impact of these series is small enough and can be neglected to give a more simple formula.

Vortices coiled up in doubles
Bring great analytical troubles;
But with series of Kapteyn
We're able to obtain
Their speed, in the absence of bubbles!

1.   Introduction

The phenomenon of double helical vortex is known for a long time. First of all such vortex is being generated in the wake of two-blade propeller or turbine. Double helix represents one of the possible vortex states after vortex breakdown (Faler & Leibovich 1977). A perfect double helix rotates and moves translationary without change of its form. The problem on determination of the vortex velocity and frequency of velocity pulsations induced remains actual one. In a bounded space double helix can be immobile. Such vortex system was observed in a vortex chamber of square cross-section with two-slopes bottom (Alekseenko et al. 1999).