# Foreword

Vortex flows find a wide application in various engineering devices. The basis for the engineering application of vortex flows is the field of centrifugal accelerations, whose values can be huge. Devices, where centrifugal forces are used, are separators, cyclone dust separators, driers, combustion chambers, vortex nuclear reactors, etc.

The domestic literature has many highly specialized books, where the heat-and-mass transfer of rotating flows are studied as applied to only one of the engineering devices. The level of presenting experimental and theoretical investigations in the books is different. In some books, the material is given on the basis of equations for ideal liquid, whereas in other books, on the basis of equations for viscous liquid in the Navier–Stokes form.

Therefore, no general laws of vortex flows, which are inherent in both atmospheric vortices and flows in apparatuses using centrifugal forces, are presented in the books dealing with the problem.

This book eliminates the disadvantages of the modern literature in the field of vortex flows and heat-and-mass transfer in them.

In Chapter 1, an analysis of experimental results on atmospheric vortices and vortex flows in engineering devices is used to form a hydrodynamic model of an insulated trailing swirl and to study the kinetics of a liquid particle in the vortex. The kinematic properties of the vortex allowed the author to describe laboratory models of an insulated trailing swirl. When describing experiments in laboratory models of vortex, the author comprehensively analyzes the errors of measurement caused by flow gradient and the errors in determining the center of vortex.

Usually, the errors are not discussed in the modern literature, whereas they are significant, as shown in this book.

One of the significant author's results is the detection of stable and unstable states both in laboratory and atmospheric vortices. This finding opens up the way to controlling vortex motions, which is important for designing optimum vortex apparatuses.

In Chapter 2, the general principles of turbulent motions are given. Here, the author presents a new hypothesis of closing equations of turbulent motion, which assumes that turbulent stresses are proportional to the pair products of the components of the vector of averaged motion velocity. Within the limits of the hypothesis, an analog of Bernoulli's integral in turbulent flows was obtained, and the basic properties of isoentropic flows were studied.

In Chapter 3, a convective heat transfer in an insulated trailing swirl is analyzed. Equations of the heat-and-mass transfer in a turbulent insulated trailing swirl are given in the context of the hypothesis. The equations are used to obtain the laws of interaction between the vortex line and the surrounding medium under the conditions of a self-simulating boundary-value problem.

The closed calculation scheme for the heat-and-mass transfer phenomena in an insulated trailing swirl, which is described in Chapter 4, is used for calculation of the main hydrodynamic and design parameters of vortex hydropneumatic apparatuses, such as a vortex chamber and tube, a centrifugal atomizer, and a vortex element.

This book contains original theoretical concepts of heat-and-mass transfer phenomena in a vortex, which are used to create reliable engineering calculation schemes for the hydrodynamic and design parameters of vortex hydropneumatic apparatuses.

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