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CONVECTION IN CHANNELS*

Reviewed by A. A. Pomerantsev

Convective flow of a liquid or a gas through channels of various shapes and through confined regions finds many applications in engineering practice. It is to be noted that, while channel flow was earlier found useful only in hydroengineering, new developments in laser and communication systems have broadened the applications for such a type of flow. They are primarily tied in with the effect of hydrodynamic currents on the refractive index of moving media, which makes it possible to focus not only ordinary but also strong laser beams for carrying a large volume of information. In the latter case it is sometimes feasible to replace a cable line by an optical one.

It is exactly here where the classical Hertz–Nusselt problem of heat transfer during fluid flow becomes pertinent again. An attempt to extend the solution to this problem to these modern branches of engineering reveals gaps in the theory. Experiments have pinpointed such gaps as resulting from an underestimation of the effect which gravitational forces have on the forced flow of a gas through a nonuniformly heated pipe. The effect of natural convection on forced convection appears sufficiently strong to present serious difficulties in the construction of gas lenses.

For this reason, it has become necessary to eliminate the parasitic effects of gravity on the flow of liquids and gases. It must be noted that a passage of laser beams through liquids or gases can not only induce natural convection but also change the chemical structure of these media.

The engineering problems mentioned earlier confront researchers with many new challenges such as, for instance, the problem of heat and mass transfer during flow through channels of various shapes. The answers to some of these problems can be found in the collection of articles "Convection in Channels," which we are reviewing here.

The collection contains reports on theoretical and experimental studies made at the Institutes of the BSSR Academy of Sciences.

The effect of natural convection on forced convection in both straight and bent pipes is analyzed in the article by O. G. Martynenko, V. L. Kolpashchikov, and V. I. Kolil'ts. The problem is solved by methods of mathematical physics. The calculations are made on a high mathematical level and the results agree closely with test data. The authors describe also a method of eliminating the parasitic effect of natural convection.

This problem is also studied experimentally by S. A. Fedyushchin, A. G. Muradyan, and G. N. Pustyntsev.

In a theoretical analysis of channel flow there arise mathematical problems pertaining to the simplification of the equations which describe the viscous flow of a compressible gas. These problems are treated in the article by G. Ya. Borodyanskii.

A flow with free convection has been analyzed numerically by E. F. Nogotov and experimentally by V. E. Fertman.

Interesting is the theoretical study made by B. M. Berkovskii, L. P. Ivanov, and E. F. Nogotov, dealing with photoabsorptive convection caused by absorption of electromagnetic radiation of optical wavelengths in a heavy fluid.

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The equations of hydrodynamics and the conditions of fluid slippage along a wall have been refined by V. A. Bubnov and T. Ya. Gorazdovskii.

Somewhat beyond the scope of this collection are the article by I. S. Kovalev, N. S. Kolesnikov, P. M. Kolesnikov, and N. N. Stolovich, as well as the article by V. T. Maksimov, both of which deal with electrodynamics.

In a study made at the M. V. Lomonosov Moscow State University, A. A. Solov'ev has measured the hydrodynamic parameters by the acoustic method.

On the whole, the collection of articles on "Convection in Channels" should spur further interest in work on engineering problems mentioned at the beginning of this review.