

[0149] Convective heat transfer, often referred to simply as convection, is the transfer of heat from one place to another by the movement of fluids. Convection is usually the dominant form of heat transfer in liquids and gases. Although often discussed as a distinct method of heat transfer, convective heat transfer involves the combined processes of unknown conduction (heat diffusion) and advection (heat transfer by bulk fluid flow). For example, thermal expansion of fluids may force the convection. In other cases, natural buoyancy forces alone are entirely responsible for fluid motion when the fluid is heated, and this process is called “natural convection”. An example is the draft in a chimney or around any fire. In natural convection, an increase in temperature produces a reduction in density, which in turn causes fluid motion due to pressures and forces when fluids of different densities are affected by gravity. For example, when water is heated on a stove, hot water from the bottom of the pan rises, displacing the colder denser liquid, which falls. Thereby, a heating component submerged in water repels adjacent fluid portions, i.e. the heating component itself is interpreted as fluid-repellent: either hydrophobic, or oleophobic, or omniphobic. In other words, the heating component originates the phobic-repulsive van der Waals forces. Again, the fluid repellency occurs at the expense of the heat energy, which, first, is acquired by the adjacent fluid portion, and then, become transformed into the kinetic energy of the convective motion.

Thus, all the mentioned kinds of fluid repellence are characterized by inserted spatial asymmetries of:

[0150] degrees of freedom of molecular motions, and

[0151] the phobic-repulsive van der Waals forces, both causing a distortion of the Brownian distribution of the fluid molecular motions, wherein the energy of the distorted Brownian distribution is interpreted as composed of the reduced actually-Brownian motion energy and energy of the fluid molecular motion in a prevalent direction (for instance, convective motion). In other words, the mentioned motion in the prevalent direction occurs at the expense of the Brownian motion energy (i.e. the heat energy) yet to be distorted.

#### Model Simplifications in the Continuum Mechanics

[0152] In order to describe both the Venturi effect and the de Laval effect, the flowing fluid is modeled in the classical fluid dynamics theory as hypothetically consisting of many small volume portions. This approach is described in book “The Feynman Lectures on Physics”, volume 2, chapter 40 “Flow of Dry Water” by Richard P. Feynman, Robert B. Leighton, and Matthew Sands, where the term “dry water” is applied to stress the model simplifications, namely:

[0153] first, the assumption that there are no viscous forces between the fluid small volume portions;

[0154] second, the fluid small volume portions are connected spaces;

[0155] third, the fluid being studied is a continuum, i.e. it is infinitely divisible and not composed of particles such as atoms or molecules;

[0156] forth, the small volume portion boundaries are impermeable for the fluid matter and impenetrable for temperature; and

[0157] fifth, the assumption that the static pressure, acting on the small volume portions’ boundaries and being the only reason of mechanical forces, is an

abstraction having no molecular nature, and wherein the small portions’ boundaries are hypothetically inert to the fluid’s inter-molecular forces, i.e. are not phobic with repulsive forces and not sticking with attractive forces, as soon as the problem is formulated in frames of the continuum mechanics.

In other words, the simplifications are inherent assumptions in the classical continuum mechanics theory, ignoring the molecular structure of fluid and ignoring the static pressure as a thermodynamic parameter interrelated with the fluid density and temperature in accordance with the van der Waals law of the fluid state. In this approach, the classical equations of fluid motion are derived. In a particular case of hypothetically inviscid flow, the classical equations of fluid motion, known also as the Euler equations, are applied. For viscous flow, to overcome said first simplification, the Navier-Stokes equations are used. The Navier-Stokes equations are the Euler equations modified by involving into the consideration the viscous forces between the fluid small volume portions. Again, the viscous forces are introduced irrelative to the viscosity effect physical nature. In 2000, the problem of the Navier-Stokes equation solution existence and smoothness became one of the Millennium Goals formulated by the Clay Mathematics Institute. It is noted in the “The Feynman Lectures on Physics”, volume 2, chapter 40, cited above, that even in the simplest case of no moving fluid, the equation of hydrostatics:  $-\nabla P - \rho \nabla \phi = 0$ , where  $\nabla$  is vector differential operator,  $P$  is the fluid static pressure,  $\rho$  is the fluid density, and  $\phi$  is the stand for the potential-energy-per-unit-mass (for gravity, for instance,  $\phi$  is just  $gz$ , where  $g$  is the gravitational acceleration and  $z$  is the height above the Earth’s ocean surface level), in general, has no solution, as soon as both: the pressure  $P$  and the density  $\rho$  are spatially dependent and not interrelated in the mentioned simplified approach of the continuum mechanics theory. To facilitate a numerical analysis in practice and to overcome said second simplification, the Navier-Stokes equation further modifications (for example, the Spalart-Allmaras hypothetical model of turbulences), assuming that the chosen fluid portions could be dismembered into smaller connected spaces, are applied to computational fluid dynamics. However, the third, fourth and fifth simplifications remain inexact, making that the fluid model loses physical sense for thermodynamic and kinetic theory of matter and, as a result, the classical fluid model, on the one hand, has not exact solutions for compressible fluids, and on the other hand, leads to paradoxical solutions for incompressible and inviscid fluids. For example, the d’Alembert paradox, derived from the Euler equations, in particular, says that a body, moving in an incompressible fluid, does not experience a drag force as an impact effect. Describing this paradox, for example, “Encyclopedia of Fluid Mechanics” by J. D. Jacob, Department of Mechanical Engineering, University of Kentucky, Lexington, Ky. 40506-0108, comments that “in the 18<sup>th</sup> century, it was at odds with both observation and intuition of flow about a body in motion”, and further defines the term “drag” as primarily related to a viscosity phenomenon, neglecting by the impact effect. The Navier-Stokes equation having introduced viscous forces makes the d’Alembert paradox as latent. To provide the principles of thermodynamics, one adds equations of gas laws to the Euler system of equations and further approximates the equations numerically.

[0158] There is, therefore, a need in the art for a method to provide a proper model of fluid motion to exclude