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I. Nochnichenko
O.Jakhno
D. Kostiuk
A. Murashchenko

ANALYSIS OF THE TRANSFER PHENOMENON IN THE INTENSIFICATION OF WORKING PROCESSES IN THE CONTINUOUS MEDIUM

National Technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute"

Abstract *The paper considers and analyzes the methods of intensification of work processes with the use of the apparatus of transfer phenomena, in particular on the example of processes in film flows of gravitational motion. Rational choice of transfer coefficients depending on operating conditions and properties of materials allows analyzing the efficiency of the process. Also, the increase in intensity can be obtained through the use of hydrodynamic and ultrasonic cavitation or profiling of contact surfaces. The considered methods can be applied to Newtonian and abnormally viscous liquids.*

Keywords: transfer phenomena, nonlinear transfer phenomena, transfer coefficients.

In the technological processes associated with the intensification of mass and heat transfer, in the apparatus for evaporation of liquids, in the purification of liquids and gases, currents in thin liquid layers are increasingly used [1]. Intensification of transfer processes in hydraulic and heat exchange systems is associated with the solution of many problems, including the rational choice of their coefficients in the gradient transfer equations [1-3].

As is known, the theory of the transfer phenomena in different media is based on the Boltzmann equation. As an example, consider the intensification of transfer processes in the film flows of gravitational motion in thin liquid films on flat surfaces presented by well-known scientists as, Alekseenko A.V., Nakoryakov V.E., Pokusayev B.M., Shkadov V.Y., Malyusov V.A., Zhivaikin L.Y., Vorontsov E.G., Kapitsa P.L., Levich V.G., Kholpanov L.P., Tananayko Y.M., Fulford G.D., Boyadzhiev H., Beshkov V., Shulman Z.P.

Also, the analysis and selection of appropriate contact surfaces and roughness require careful consideration of factors influencing the wear resistance of materials, which depend on the chemical composition, microstructure and properties of the material selected as the basis for heat transfer in energy transfer processes. Depending on the operational and physicochemical conditions and properties of materials, there is a need for a rational choice of transfer coefficients. Given that such coefficients - viscosity, thermal conductivity, diffusion are dimensional values - their choice is associated with the actual processes of intensification following the data of physical phenomena.

Mass transfer, Fick-Nernst diffusion law is determined by a known dependence [3]:

$$q_t = -D \times \text{grad}\ C,$$

where D – diffusion coefficient, C – the concentration of molecules in the substance.

The diffusion coefficient is calculated by the following dependence [3]:

$$D = D_0 e^{-\frac{W}{kt}}$$

where D_0 – longitudinal oscillation frequency, W - activation energy, kt - the average energy of chaotic motion

For example, the diffusion coefficient may have the following values depending on the respective media (Table 1).

The viscosity coefficient is related to the rheological properties of the medium and must be determined according to the medium, gas-gas, liquid-liquid, gas-liquid. It should also be noted that it is important to choose the contact surface in the environment under consideration. To increase the intensity of the transfer phenomena, several types of contact surfaces can be used. Due to this, the intensification

of transfer processes may be associated with the presence of hydrodynamic and ultrasonic cavitation, accompanied by wave, sound and pulsation processes in the media. It is shown how the efficiency of heat and mass transfer processes increases during the formation of the liquid film [1-3].

Table 1

Diffusion coefficients for different media

Environment	D,м^2/с
Molecules in gases	1×10^{-4}
Molecules in solutions	1×10^{-9}
Ions in solutions	1×10^{-8}
Colloidal particles	1×10^{-10}
Atoms in solids	1×10^{-12}

These processes are described quite deeply in the classical literature in solving problems of mixing, destruction of media and improving heat transfer conditions [4-5]. However, the increase in the intensity of the transfer processes, in this case, can be obtained by contact of a thin liquid layer with the surface. Such an increase in efficiency can be realized if the surface is made profiled and described by a given function such as a sine wave or an Archimedean, Schauberger spiral. Then the hydraulic problem will be related to the determination of the liquid layer, both for stable and unstable flow.

In this paper, we consider the flow for two cases when the fluid is anomalous-viscous (i.e, the viscosity is not a constant value) and for the case of a Newtonian fluid. The corresponding equations of motion of the liquid are made and recommendations for determining the velocity field under different conditions of contact of the liquid with the gaseous medium are given.

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Nochnichenko Ihor Victorovych, PhD. Techn. Sc., Ass. Prof., National technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, igornoch@gmail.com

Jakhno Oleg, Prof. Dr. Eng., National technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, oleg.yakhno@gmail.com

Kostiuk Dmytro Victorovych, PhD. Techn. Sc., Senior Lecturer National technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, kostiukdv@ukr.net

Murashchenko Alona Mykolayivna, PhD. Techn. Sc., Senior Lecturer National technical University of Ukraine "Igor Sikorsky Kyiv Polytechnic Institute", Kyiv, a_kirya@i.ua

АНАЛІЗ ЯВИЩА ПЕРЕНОСУ ПРИ ІНТЕНСИФІКАЦІЇ РОБОЧИХ ПРОЦЕСІВ У СУЦІЛЬНОМУ СЕРЕДОВИЩІ

Анотація *В роботі розглянуто та проаналізовано способи інтенсифікації робочих процесів з застосуванням апарату явищ переносу, зокрема на прикладі процесів в плівкових течіях гравітаційного руху. Раціональний вибір коефіцієнтів переносу в залежності від умов експлуатації та властивостей матеріалів дозволяє аналізувати ефективність процесу. Також підвищення інтенсивності може бути отримане за рахунок використання гідродинамічної та ультразвукової кавітації або профілювання поверхонь контакту. Розглянуті способи можуть бути застосовані для ньютонівських та аномально в'язких рідин.*

Ключові слова: явища переносу, нелінійні явища переносу, коефіцієнти переносу.

Ночніченко Ігор Вікторович, к.т.н., доцент, Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського», Київ, igornoch@gmail.com

Яхно Олег Михайлович, д.т.н., професор., Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського», Київ, oleg.yakhno@gmail.com

Костюк Дмитро Вікторович, к.т.н., ст.викладач, Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського», Київ, kostiukdv@ukr.net

Муращенко Альона Миколаївна, к.т.н., ст.викладач, Національний технічний університет України «Київський політехнічний інститут імені Ігоря Сікорського», Київ, a_kirya@i.ua