Intensification of the mass transfer processes in the system “solid-liquid” by use of inert gas

Jaroslaw Gumnitsky[1], Volodymyr Atamaniuk[2], Vira Sabadash[1], Liubov Venger[1]

[1]Department of Ecology and Sustainable Environmental Management, Lviv Polytechnic National University, UKRAINE, Lviv, 12, S.Bandery St., 79013, E-mail: jgumnitsky@ukr.net

[2]Department of Chemical Engineering, Lviv Polytechnic National University, UKRAINE, Lviv, 12, S.Bandery St., 79013

Abstract – The methods of intensification of mass transfer processes in the solid - liquid system are considered. The classification of methods and conditions of action for this system is given. Attention is paid to non-stationary phenomena and analogy to heat transfer processes. An overview of the methods used for the intensification of chemical processes is given.

Keywords – mass transfer, heat transfer, intensification, dissolution.

In the chemical industry various methods of intensification of technological processes are used. These methods include mechanical mixing, fluid circulation, inertial and centrifugal regimes, overlaying of stationary force fields, mechanical and physical vibration overlays, and others. The above methods show intensifying action, increasing the rate of flow of solids and the surface of interaction, updating the interaction surface. Significantly intensifying action for mass transfer in the solid-body system is a gas phase that generates various effects in the two-phase system, which facilitate the acceleration of mass transfer. Below we will present methods for using the gas phase to intensify technological processes, their impact on mass transfer and gas generation methods. The main role of the gas phase is in its influence on hydrodynamics, which is the main driving force of mass transfer. The gas phase causes the fluid to move or accelerates it. The task of researchers is determftion or evaluation of this speed.

1. Inert gas delivery to the system “solid-liquid”:

Continuous process of motion of a gas-liquid emulsion in the apparatus: fluid turbulization; increase in speed due to the presence of gas; reduction of the thickness of the boundary diffusion layer (BDL), which increases the coefficient of mass transfer; partial shielding of the surface and installation of non-stationary phenomena is possible.

Dissolution in periodic apparatus: occurrence of turbulent fluid fluctuations; evaluation of the pulsating velocity of the process; non-stationary dissolution process; determination of the characteristic linear dimension of the pulsation motion.

2. The emergence of the vapor phase on the surface of solids: turbulence of the BDL due to bubble vapors that arise and grow on the surface; non-stationary process; the movement of liquid in the capillaries of the solid phase and the replacement of molecular diffusion by turbulence; partial concentration of the solution.

3. Isolation of gas phase in diffusively controlled processes: dependence of the coefficient of mass transfer on the concentration of the reagent; analogy with heat exchange with boiling liquids; influence of mechanical and pneumatic mixing on mass transfer; thermal aspects of these processes.

4. Cavitational processes with the formation of steam-gas mixtures: the occurrence of ions and radicals; intensification of diffusion processes; intensification of kinetic-dominated chemical processes; effect on microorganisms.

5. Vibration, microwaves, ultrasound and other physical methods of intensification.

6. Joint action of gas phase with other methods of intensification.