

# Dissolution Polydisperse Solid Phase in the Gas-Liquid Flow

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**Abstract** – The thesis investigates dissolution polydisperse solid phase to gas-liquid flow. In particular, a study of single particle dissolution of  $K_2SO_4$  in a suspension and determined mass transfer coefficient  $\beta$ . The scheme of the experimental setup is presented. Confirmed independence factor mass transfer the diameter of the particles during dissolution in the gas-liquid flow. Theoretical calculation dissolution of polydisperse phase based on the kinetic process model and compared with experimental data.

Key words: dissolution, mass transfer, gas-liquid flow, polydisperse phase, halurhiya.

## I. Analysis of recent research and publications

Dissolution is a transition phase to a solid solution and can be accompanied by the complete disappearance of the solid phase. Dissolution is a complex process that can occur in diffusion, kinetic or mixed areas [1]. Solvent can be water or aqueous solutions of acids, bases and salts. Widespread use of dissolving was determined in halurhiya during the process of natural salts refinery [2].

Given the significant amount of production (for example, production of potash fertilizers), devices for their implementation is rather cumbersome, and the dissolution process requires significant capital and energy costs. Reducing costs associated with the intensification of the process of dissolution. There are many ways of intensification of this process, mechanical and pneumatic mixing, creating a fluidized bed, ripple motion of fluid, cavitation and ultrasound sparks [1]. Most of the methods of intensification characterized by high energy costs, so we investigated the method by intensifying creation the gas-liquid flow. This method is accompanied boiling liquid and vaporization.

As we know, the birth and growth of vapor (gas) bubbles is considerably strong in the case of heterogeneous nucleation, that it is on the surface of the solid particles and the wall of the devices [6].

Mass transfer in systems with dedicated solid phase [3,4], and mathematical modeling of these processes is considered in [7]. The process belongs to the dissolution of non-stationary processes because the time change levels dissolution and concentration of the substance in the liquid [5,8].

Represented in the literature data about dissolution refer to some solids or solids monodisperse ensembles. Natural salts are polydisperse mixtures that before the dissolution are subjected to dissolution.

Calculating of dissolution machines in case of polydisperse solvent mixture is much more difficult

comparing to monodisperse mixture, that's why this problem in the available literature is insufficient covered. In addition, the dissolution gas-liquid flow, in which the inert gas phase serves as intensifier mass transfer processes, is the subject of interest.

## II. The aim of the work

The aim is to study the kinetics of dissolution of polydisperse solid phase to gas-liquid flow in case of dissolution of potassium sulfate.

## III. Experimental study and its analysis

Experimental study of dissolution polydisperse solid phase was conducted on the experimental unit (Fig.1). The solvent is a vertical column, the bottom of which was a gas distribution grid. Fluid was delivered to upper part of lattice and gas-liquid mixture raised to the upper part of column, where performed its separation. Lodged sample polydisperse mixture was delivered in the apparatus, which was suspended inside gas-liquid flow.

Steam phase arises and grows to detachable diameter on a solid particle. It directly affects the diffusion boundary layer. Stopping, bubble takes a couple with a liquid rich in soluble solid phase. In the ir place comes clean solvent in creases the driving force of the process.

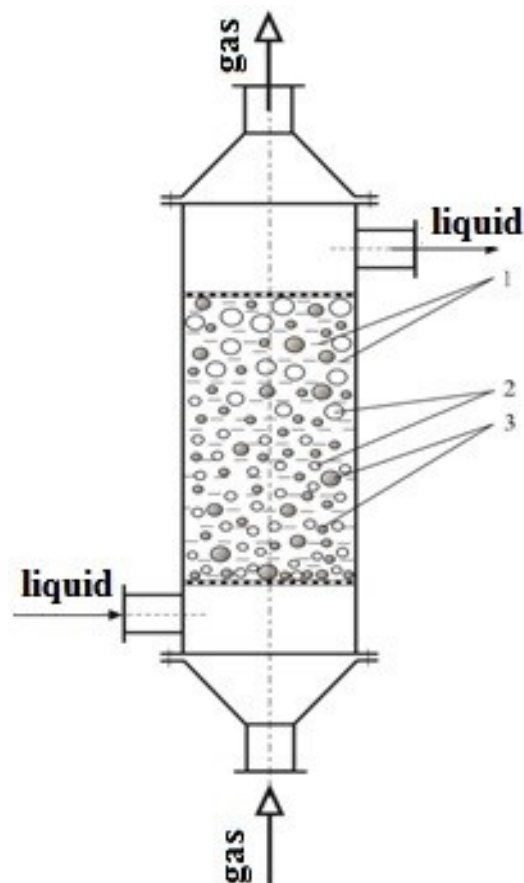


Fig.1 The scheme of the experimental setup for dissolution polydisperse solid phase in the gas-liquid flow:

1 – liquid, 2 – air bubbles,  
3 – solids (2, 3 – dispersed phase)

We analyzed the process on the following parameters: a sample of the solid phase was 0.1 kg; flowrate  $W_c = 3,3 \cdot 10^5 \text{ m}^3/\text{sec}$ ; the gas phases consumption  $V_{rc} = 1,04 \cdot 10^4 \text{ m}^3/\text{sec}$ ; ambient temperature  $20 \pm 0,5 \text{ C}$ .

At regular intervals taken away fluid and analyzed for potassium sulfate. Scattering solids installed size distribution, distribution function which is shown in Figure 2

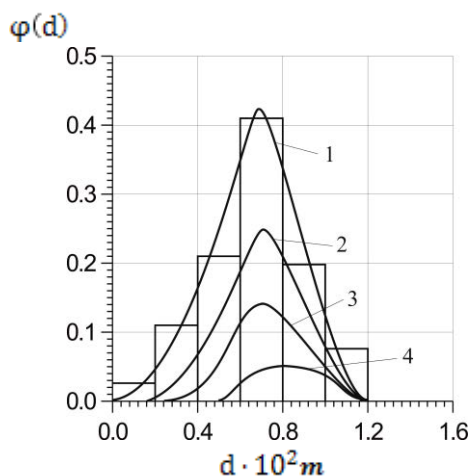


Fig. 2. The distribution function of particle diameter:

1 – original size, 2 –  $\Delta = 1 \cdot 10^{-3} \text{ m}$ , 3 –  $\Delta = 2 \cdot 10^{-3} \text{ m}$ ,  
4 –  $\Delta = 4 \cdot 10^{-3} \text{ m}$ .

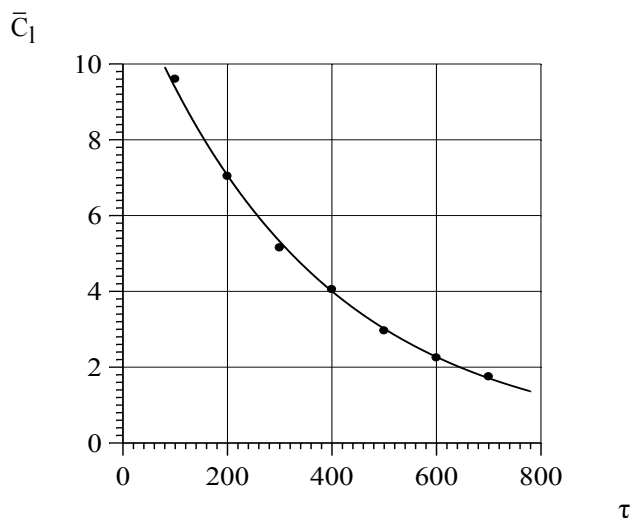


Fig. 3. The dependence of the salt concentration in the solution on time (● – experimental data, ◆ – calculation results)

We also investigated the dependence of the salt concentration over time (Fig. 3).

## Conclusions

There was conducted a study of single particle dissolution of suspended  $\text{K}_2\text{SO}_4$  and determined mass transfer coefficient  $\beta$ . In addition, there is represented the scheme of the experimental setup. There was built tracker distribution of particle diameter. We have also built graphical dependence of the salt concentration of the solution in time.

It was confirmed independence of the mass transfer coefficient against the diameter of the particles during dissolution in the gas-liquid flow.

There was performed theoretical calculation dissolution of polydisperse phase based on the kinetic process model and compared with experimental data.

Comparison of theoretical results with experimental data shows their satisfactory coincidence.

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