Summary

In this PhD thesis, results of experimental analysis and numerical modeling of the momentum and mass transfer process are presented. Experimental studies were conducted for gas - liquid systems differing from each other in the gas flow rate, as well as continuous phase (water, sucrose solutions, living baker yeast suspensions in the water and sucrose solutions) properties. For air - water system, the analysis of orifices area in the sieve plate (gas distributor) on hydrodynamics in the system was performed taking into account orifices number. In air - sucrose solutions systems, an effect of sugar concentration in the continuous phase on the hydrodynamics was evaluated. Results were complemented by the flow structure image analysis, in wide range of gas flow, taking into account the bubbles population balance in the homogeneous flow. In the next part of the studies, hydrodynamics by varying the concentration of biomass in water and aqueous solutions of food grade sucrose were analyzed. Investigations of the yeast cultures process were also conducted, taking into account a wide range of gas flow rate. In this part of the studies, in addition to the hydrodynamics, time dependent changes of the cell number, size and viability, nutrient concentration, the conductivity of the continuous phase, *pH* and dissolved oxygen concentration in the liquid were analyzed. The results of measurements of the hydrodynamics were used to develop generalized empirical equations in a wide range of process variables.

In the thesis part related to numerical modeling of the transient gas - liquid flow in the external loop air – lift column, the results of both qualitative and quantitative impact on a local scale of the gas flow rate, sucrose concentration, as well as applied gas distributor option on the hydrodynamics were performed. In the numerical model used for evaluation of the turbulence model effect on numerical results, experimentally obtained rheological model of the yeast suspensions in a sugar solution, was implemented. Implementation of the population balance model allowed a detailed characterization of the gas bubbles population, as well as setting the size of the gas - liquid interfacial area taking into account local gas holdup values.

Within the frame of qualitative analysis, the results of numerical simulations have been worked out in the form of contours of parameters, i.e. gas holdup, liquid velocity, kinetic energy, turbulence dissipation rate and mean bubbles diameter, in axial and radial cross - sections of the column. The direction of the liquid circulation was illustrated by a vector tangential to the surface of the analyzed cross - sections. Within the frame of quantitative analysis analyzed parameters in the systems, depending on the gas flow rate presented in the form of the dimensionless modified Froude`a Fr_g number, were performed taking into account process variables, as well as the local position in the apparatus. The average results of numerical calculations were compared with the results of the experiment and sufficient good agreement was observed, indicating the suitability of the detailed models in the numerical model.

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