Questions for state doctoral exam – field of study: Chemical and Process Engineering
Subtopic: Mass transport/Diffusion Processes

1. Basic equations for diffusion in one phase, diffusive and convective flow. Velocity and diffusive velocity of a component, mass and molar flux (intensity of flow) of a component. First Fick's law and Stefan-Maxwell equation –interchangeability for diffusion in two-component mixture. Comparison of diffusion in gas, liquid, solid and porous material.
2. Continuity equation for a component, its combination with the first Fick's law and reduction to the second Fick's law. Continuity equation for turbulent flow with axial dispersion.
3. Principles of turbulent diffusion and thermal diffusion.
4. One-dimensional steady diffusion in a stagnant layer of finite thickness: equation for concentration profile and flux of a component. Significance of convective transport in the case of one component diffusing in a medium of non-diffusing components. Expression for mass transfer coefficient according to the film theory and simplification for low concentrations of the diffusing component.
5. Steady diffusion through film where an irreversible homogeneous pseudo-first order chemical reaction takes place. Definition and physical meaning of the Hatta number. Boundary conditions for liquid film of finite thickness when in contact with gas having uniform concentration of a component and with a turbulent liquid core or with non-permeable wall.
6. Concentration profiles in liquid film at steady absorption with irreversible pseudo-first order chemical reaction. Effects of the rate of associated chemical reaction. Definition of the reaction factor and its physical meaning.
7. Concentration profiles in liquid film in the case of absorption with an instantaneous homogeneous chemical reaction. Effects of concentration of the active component in liquid on the location of the reaction zone and effects of the resistance in gas.
8. Absorption into film flowing down the vertical wall. Transformation of the description of two-dimensional steady diffusion to the one-dimensional unsteady diffusion.
9. Basic formulation of the penetration theory, comparison of mass transfer coefficient expressed from this theory with the expression based on the film theory and its use when expressing the reaction factor.
10. Basic ideas of the two-film theory, (partial) mass transfer coefficient and overall mass transfer coefficient.