Summary

One simple method to intensify the solids mass transfer process in a liquid solvent is to dissolve it in a stirred tank equipped with rotating mechanical impeller. The process of dissolving solids in such devices is used in many processing industries, such as chemical, food, pharmaceutical or biotechnological.

The kinetics of solid dissolution process in a liquid is closely related to the hydrodynamic conditions inside a mixer. The mixing process is dependent on the fluid hydrodynamics in a stirred and the agitator shape of the and the tank construction. Therefore, the search for new construction of mechanical mixers and the alternative methods of dissolution process is the task of many researches an engineers. In many cases, the liquid pulsation, electric discharge, reciprocating motion of agitator or magnetic field can be successfully used in order to enhance the dissolution process of solid in liquid.

The main aim of this PhD dissertation is to present the effect of rotating magnetic field on the dissolution process. This time-varying magnetic field was generated by a stator of a three-phase squirrel cage electric motor. Measurements were made for the frequency of rotating magnetic field varied in the range between 2 Hz and 120 Hz. The maximum magnetic induction value obtained for the frequency equal to 120 Hz was 20.7 mT. The experimental investigations were carried out for the three apparatus: i) mixer assisted by rotating magnetic field; ii) stirred tank equipped with a mechanical impeller; iii) hybrid mixer (the mixing process was realized by means of the rotating magnetic field and a Rushton turbine). It has been decided that the results for the mechanical mixer were considered as the reference results.

The following conclusions may be drawn from the experimental material presented in this work:

1. The magnetic induction of the rotating magnetic field is changed with frequency (the magnetic induction is increased with increasing of the frequency of rotating magnetic field).
2. The energy consumption of mixer equipped with the generator of rotating magnetic field is much higher than that of a mechanical stirrer, which can be considered as a drawback of magnetic mixers. The advantage of these mixers, however, is that the efficiency of the mass transfer process in a magnetic mixer operating in the laminar flow range is similar to the efficiency of this process carried out in a mechanical mixer in a turbulent regime;
3. The shortest mixing times were obtained for the hybrid mixer with the addition of magnetically susceptible particles;
4. Tests carried out in the tested mixers have shown that there is an influence of the rotating magnetic field on the mass transfer process;
5. The highest values of the $Sh/Sc^{1/3}$ module showing the most intensive solid dissolution process were obtained with a magnetite additive hybrid mixer with an average diameter of 0.18 mm and the opposite direction of spin of the magnetic field terms to the rotation of the mechanical stirrer;

6. Based on experiments which were carried out for the mixer assisted by rotating magnetic field it was found that the most advantageous results of the analysed parameters involving mixing time, mass transfer process, energy density and dissipation, were obtained in case when magnetically susceptible particles were added to the volume of the stirred liquid.

By analysing the total scope of the work, it can be stated that the intended research objectives, including the construction of experimental set-ups, the analysis of hydrodynamic problems of the fluid subjected to the effects of the rotating magnetic field, the analysis of the influence of the rotating magnetic field on the mass transport process, as well as the comparative analysis of the mass transport process using rotating magnetic field and mechanical stirred tank have been achieved. The above-mentioned main conclusions do not, however, fully reflect the work done on the experimental set-ups. There are not many other equally important conclusions as to the influence of rotating magnetic field on the dissolution process of the solid body and on the other processes analysed in the experiments covered by this PhD dissertation. These conclusions are included in the individual chapters of the dissertation.

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