FRACTAL AGGREGATE FORMATION PROCESSIN FERROFLUID: THE VARIOUS KINETIC OF GROWTH

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Imbalance of attraction and repulsive interparticle interactions leads to formation of various aggregates in ferrofluids. The structure of these aggregates is determined by physical and chemical properties of the system. Fractal aggregates may arise in ferrofluids [1] due to the action of molecular forces in a way similar to classical mechanism of colloidal coagulation. As far as the physicochemical reasons of ferroparticle coagulation are concerned, there could be a strong van der Waals attraction, as well as deformation or destruction of surface sterical layers and low values of interparticle repulsive electrostatic barrier in ionic ferrofluids. In all these cases van der Waals attraction can cause an uncorrelated particles attachment to the aggregate skeleton. The presence of aggregates and their internal structure influence greatly properties of ferrofluids [2, 3]. So, it is important to develop analytical models of aggregation process, combining the possibility of obtaining information on the spatial structure, the principles of an aggregate ensemble evolution and the determination of these aggregates influence on the properties of ferrofluids.

This paper is devoted to the theoretical study of the fractal cluster formation process in magnetic fluids. The aggregation of the ferroparticles can be initiated by two ways. Let us call the first way of aggregation caused by the presence of specific nuclei in the system by term "heterogeneous aggregation". The second mechanism, which we call "homogeneous aggregation" take place in the system without specific centers of nucleation.

1. Heterogeneous aggregation. The part of nucleation centers can play, for example, the large particles, the interaction of which is the strongest in the system. Fractal clusters grow due to the addition of single particles dispersed in colloidal system. The developed theoretical model takes into account the decrease of a disperse phase concentration. As a result, aggregate fractal dimension has been found equal to $d = 2.5(1 - I)$, where coefficient I is a small positive value dependent on physical and chemical properties of a magnetic fluid. Also, the concentration of dispersed particles and the aggregate size as functions of time have been found.

2. Homogeneous aggregation. The aggregates appear as a result of occasional meeting of some ferroparticles. In this case the aggregate size distribution is taken into account. The theoretical model is very complex therefore analytical solution cannot be found. Finally, the concentration of dispersed particles as function of time and fractal dimension have been found numerically.

In the both cases, the theoretical results goes in a good agreement with experimental data and computer simulations [3].

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