Target Group

The course is aimed at scientists, engineers and technicians dealing with crystallization and precipitation processes.

Required knowledge

Basic knowledge in Physical Chemistry and/or Chemical Engineering.

Time Schedule

The course contains six lectures and four seminars over a course of three days. On demand, special topics can be included into the program.

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Training Course

Graphical representation and quantitative analysis of salt – solution – equilibriums

- An introduction -

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Aims

The knowledge of salt – solution equilibriums is the basis for the description of crystallization as well as precipitation processes. Phase relationships in simple systems, however, can already be so complex that understanding them becomes difficult. One possibility to overcome this obstacle is the usage of phase diagrams. The visualization of equilibriums allows one to distinguish between stable and metastable conditions as well as the deduction of crystallization or dissolution paths. The same is true for phase changes during evaporation or cooling.

Phase diagrams' beneficial quantitative descriptions of crystallization or dissolution processes are often neglected. The amounts of formed minerals can be calculated exactly, both for isothermal and polythermal processes. In many cases, mixing of different salt brines results in the crystallization of salts. Phase diagrams allow one to calculate the crystallization paths and to determine amount and nature of the formed salts.

Based on his experiences in teaching at university level for many years, the lecturer Dr. G. Ziegenbalg presents an overview on the graphical representation of different types of equilibriums. Starting with simple binary systems, a stepwise introduction into the graphical representation of complex systems is given. The course discusses similarities and differences between solubility and melting diagrams as well as the behaviour of salts during thermal treatment. Special lectures deal with using phase diagrams for the deduction of conditions favourable for Sylvinite or Carnallite processing. The production of potassium sulphate serves as an example for salt production through double conversion. Since learning by doing is most efficient way, the course is divided into six lectures and four special seminars in which construction and use of phase diagrams is trained.

Program

1. The fundamentals of salt-solution equilibriums

1.1 Thermodynamics
1.2. Criterions of equilibrium
1.3 The phase rule
1.4 Concentration units
1.5 Factors influencing the solubility

2. Binary systems

2.1 Solubility diagrams
2.2 Driving forces of crystallization
2.3 Fundamentals of crystallization kinetics
2.4 The system $NaCl-H_2O$
2.5 The system $MgCl_2-H_2O$
2.6 Stable/metastable equilbriums

3. Ternary systems

3.1 Isothermal representation
3.1.1 Rectangular co-ordinate systems
3.1.2 Gibbs triangle
3.2 Polythermal representation
3.3 The system $NaCl-KCl-H_2O$
3.3.1 Isothermal//polythermal representation
3.3.2 Crystallization paths during isothermal evaporation
3.3.3 Processing of Sylvinite
3.4 The system $NaCl-CaCl_2-H_2O$
3.4.1 Salting out processes
3.5 The system $KCl-MgCl_2-H_2O$
3.6 Congruent / Incongruent melting / solubility
3.7 Carnallite processing

4. Quaternary systems

4.1 Isothermal representation
4.2 Polythermal representation
4.3 Systems with a similar ion
4.3.1 The system $NaCl-MgCl_2-CaCl_2-H_2O$
4.3.2 The system $NaCl-Na_2SO_4-NaNO_3-H_2O$
4.4 Reziprocal salt systems
4.5 Isothermal/Polythermal representation
4.6 The system $Na^+, K^+/Cl^-,NO_3^-//H_2O$
4.6.1 Isothermal, quantitative representation
4.6.2 Polythermal representation
4.7 The system $K^+, Mg^{2+}/Cl^-, SO_4^{2-}//H_2O$
4.7.1 Isothermal/ Polythermal representation
4.7.2 Production of K_2SO_4

5. Outlook